

## **PRESENT STATUS AND PROBLEMS OF ENGINEERING SCIENCE IN MONGOLIAN AGRICULTURE**

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### **ABSTRACT**

*A farm power and machinery sets and equipment's using in branch of agriculture imported from European and Asian countries, also from North America. An agricultural machinery industry is not widely developed in Mongolia, however small size enterprises where can be assembly a tractors and machines launched last time. A comprehensive mechanization level reached a grain crop production and potato production partly, including some vegetables. The tractors from 50 HP up to 500 HP are used at farms. An Engineering science focused on the elaboration and testing new design of farm machines, increasing an economic and performance efficiency of imported tractors, self-propelled combine harvesters, other machines and agricultural equipment's, besides, working out the project papers of engineering politic in the Mongolian agriculture.*

**KEYWORDS:** Farm, livestock, process, development

### **INTRODUCTION**

The main foundation of Mongolia's economy, natural pasturing livestock husbandry still plays an important role in the economy. By the end of 2015 in total 55.957 million livestock heads were counted, which deals with a sheep's of 44.7 percent, a goats of 42.3 percent, a cows of 6.6 percent, a horses 5.8 of percent, a camels of 0.7 percent.

In the branch of pasturing livestock husbandry a mechanization of process is not yet fully adopted and even today most herders are using manual tools and

equipment's based on small power, such as tractor 15-20 HP, internal consumption engine 3-5 KW and renewable energy source.

In 2016, a farmers who cultivated plant productions was 367.9 thousand hectares area sowed, which consists of 377.2 thousand hectares of cereals, 14.5 thousand hectares of potatoes, 8.2 thousand hectares of vegetables, 28.0 thousand hectares of fodder crops. As a cultivation technology for grain crop production according to soil and

metrological condition in Mongolia is dominated the conservation and zero tillage version.

Today, scientific research on the agricultural engineering and mechanization technology, also designing of new machines are performing at the State University of Agriculture (School of Engineering and Technology, SET) , as well as the Agricultural Machinery Research and Industry Institute and Research-Industry << Initial Plough>> Co Ltd.

A conception of cultivation technology in crop farming of Mongolia contains in reducing wind erosion and drought consequences, in other words, necessity of application conservation and

zero tillage technology in plant crops production systems is in order.

The scope of research activity and development agricultural machines includes:

- Designing and modification of farm machines and equipment's,

- Innovation to improve the performance and use efficiency of the machinery and rational selection of new farm power,

- Field performance, fuel consumption and drawbar power test of tractor and self-propelled machines and other machine-tractor units,

- Assessment on engineering, ecological and economic aspects of technology adoption and machinery use

## SOME OF ACHIEVEMENTS IN ENGINEERING SCIENCE LAST DECADE YEAR

### In the frame of designing new machines and assembly of tractor, and field machines:

In recent years, made drawings and models for mould board plough, herbicide sprayer, vegetable seed planter to 15-25 HP tractor based on Mongolian soil and climatic conditions suitable and mower and grass dump rake with parameters according to the draught force of Mongolian horses.

At the Agricultural Machinery Research and Industry Institute has been assembled and delivered to market about 200 number of small tractor with 12-18 HP, 1.5 tone trailers and 180 of horse cutter bar mower and hay dump rake

cooperating with Russia and Chine farm machinery plant, during the last 10 year.

A new cutter bar mower and hay dump rake for compact 20 HP tractor was designed and produced by Research-Industry << Initial Plough>> Company Ltd.

More than 30 numbers of new designed mower and hay dump rake are using at farm field in resent year. The << Initial Plough>> Company Ltd designed set of potato cultivation machine (table 1), too.

A new design of building for dairy cow which may be heated by animal energy was elaborated by engineers and scientific researchers of MULS.

Table 1.

The specifications of potato cultivation and harvesting machines for small tractor

	plough	cultivator	planter	digger
Matched power, HP	18-20	18-20	15-20	18-20
Working width, cm	45	140	70	70
Inter row width, cm	-	70	70	70
Number of cultivated row	-	2	1	1

A new field sprayer for compact tractor 15-20 HP is designed at School of Engineering and Technology. The field sprayer is consist of boom 6 m, tank 200 l, centrifugal pump 50 l/min capacity and the machine can operate on the field with a speed up to 9.0 km/hour and cover 15-20 ha per hour.

A horse mower and cutter bar mower for small tractor designed and produced by << Initial Plough>> Company Ltd. are using at farms successfully. A new machinery increased a field capacity 4-5 times to compare with hand work in hay making process (table 2).

The specifications of horse cutter bar mower

Table 2.

Specifications	
Number of drag horse	2
Working width, cm	138
Working speed, km/hour	4-5
Weight, kg	278



Figure 1. Set of potato cultivation and harvesting machines



Figure 2. Cutter bar mowers for small tractor produced by "initial Plough" Co. L

### In the field of farm machinery selection problem and scientific decision

In 2016, a farmers was 367.9 thousand hectares area sowed, which consists of 315.4 9 thousand hectares of cereals, 11.2 9 thousand hectares of potatoes, 5.0 thousand hectares of vegetables, 28.1 thousand hectares of fodder crops. A cultivation technology for grain crop production in soil and climate condition Mongolia related to region, were should dominate a conservation and zero tillage version of cultivation technology.

According to medium-term reform program in 2016-2020 of grain crop production in Mongolia a farmers should have machinery set that may be finished grain crop seeding 10-14 days and harvesting 21-28 days, as well cultivation for fallow 7-10 days.

Therefore, selecting the proper power level of tractor, self-propelled combine and optimum width of field machines is a most involved problem of farmers. A professors of MULS engaged with machinery selection problem and a preparing a

recommendation paper to Ministry of Food, Agriculture and light Industry, as well and to farmer.

To be determine optimum machinery set for given farm size should perform a next procedures:

1. Establish cropping practice and the expected grain crops yield per hectare and values
2. Establish the required machine field operations and secure real or representative data for energy and labor requirements
3. Computer calculation and evaluate analysis for tractor and machines parameters
4. Select a optimum parameters of tractor and machine and find the permissible range in implement sizes.

A new recommendation on the suitable parameters of tractor and other machines which got from results of research work in 2014-2016 sows in table 3.

Table 3.  
Recommended parameters of machinery set for grain crops depending on the farm field size

Set of machinery	Field size, ha			
	400-800	1000-1500	2000-3000	More 3000
tractor	130-175 HP. (1)	180 -275 HP (1)	275-335 HP (1)	About 350 HP
Field cultivator	4-6 m	4-6 m (2-3)	10 m	10-15m
Seeder and drill	2 m (2-3)	2 m (5-6)	10 -12 m (air seeder)	10-15 m (air seeder)
Self-propelled combine harvester	150-210 HP (1)	150-210 HP (2-3)	230-270 HP 6.0-7.5 m (2-3)	230-270 HP. 6.0-8.5 m
Field sprayer	-	15 M	18-24 M	18-24 M

### In the field of scientific solution on the farm machinery application:

Economic farm management requires a careful matching of tractor capability to the farm's power need depending on the soil condition, number of expected grain crop yield and other special feature of the region. There are five agricultural region in Mongolia. In other side, a crop farming in

Mongolia makes on gross size of field (plot) up to 200 hectare with furrow length 1000-2000 m.

Therefore, machine field efficiency is most important information item needed by farm machinery manager and researchers of MULS are conducted the field experiences joint with farmers.



Figure 3. A measuring facilities and a field testing of tractor for drawbar power

For example, large companies are used John Deere (430 HP) and New Holland (425 HP) tractors attached with Air seeder 15 m and they have been a



Figure 4. JD 9430 tractor and Air seeder MAXIM II with the tank 7240 in operation

According to testing of small size tractor defined that approximately operation width of mower is 194.2 cm instead of 2 m, working speed 3.39

field capacity per hour 10 hectare and a fuel consumption 5.67 litre per hectare (fug.4).



Figure 5. Testing process of tractor BJ-200 (China) for hay cutting

km/hour and fuel consumption is 3.19 l/ha. Field testing of large machine shows, a field capacity and fuel consumption is depended on the furrow length of field that

as length of field is increased will rise capacity of machine per hour and fuel consumption is decreased quite the reverse. For example, the correlation coefficient between the field capacity and

field length is 0.89 for combine harvester John Deere 1076 in direct cutting of wheat (fig.6). In fig.6 the vertical line shows a field capacity (ha/8 hour) and in horizontal line shows a length of field (meter).

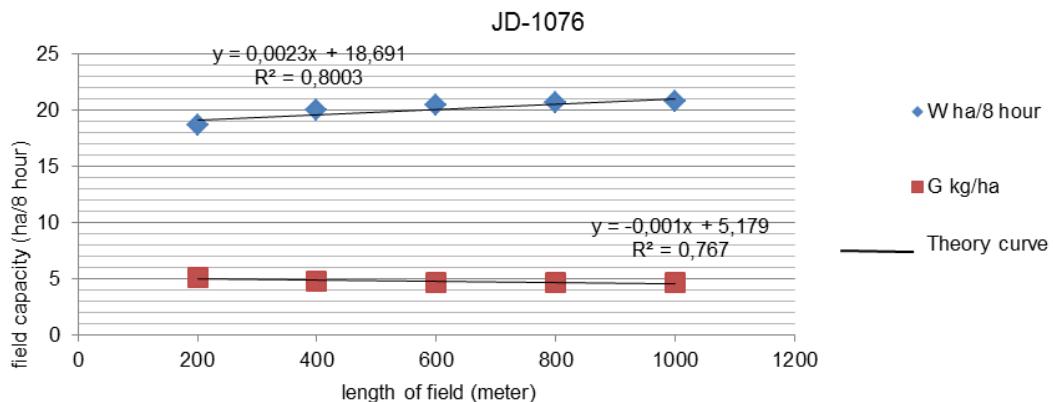


Figure 6. A dependence between a field capacity of combine harvester John Deere 1076 and field length.

#### In the field of Biotechnology development:

Biochar as a soil amendment to enhance plant growth is higher. For example, after application a biochar on the potato planted field the yield per hectare increased 23,5 percent, 2014.

Waste of cooking oil (vegetable oil and fat from animals) is one of the economical sources for diesel fuel fabrication. Therefore, research team of Engineering and Technological School is focusing on developing process to obtain biodiesel from waste of sunflower and fat cooking oil. The methanol is used in the

application of recycled vegetable oil. Biodiesel production is completed through the transesterification process, which consists of three consecutive and reversible reactions. Due to transesterification of fats or vegetable oil with alcohols to form biodiesel esters and glycerol. The properties of petroleum based diesel, biodiesel from pure sunflower oil and biodiesel derived from sunflower cooking oil are given in table 4. It can be seen clearly that B100 had very low sulphur content compared with petroleum diesel. The cloud point of the various methyl esters ranged from +50 to +90C.

Table 4.

Compared properties of petroleum diesel with biodiesel derived waste cooking oil

specifications	unit	Diesel fuel petroleum	Biodiesel from pure sunflower oil	Biodiesel from waste cooking oil
Density	Kg/m <sup>3</sup>	814	865	888
Viscosity	mm <sup>2</sup> /s	2.331	4.862	8.432
Cetane index	-	47	59	49
Pour point	°C	-35	-6	-3
Cloud point	°C	-5	+5	+9

Next, application of biodiesel on the diesel engine was tested for fuel consumption. The results of the experiment show fuel consumption of biodiesel is increased by 6.5 % in the 20 % blend biodiesel to compare with petroleum diesel and by 32.6 % in the 100 % biodiesel. The Cetane number of biodiesel from waste oil was 49 unit it was higher by 2 unit than petroleum fuel. It may reduce a fuel burned

completely and increase amount of toxic gases.

#### In the field of Animal and Husbandry farm mechanization

An around of large cities and UB located cow milk farms, a number of them is 1554 and meat production farms of 351 in 2014.

Farmers in the rural areas are generally small and cannot as individuals afford for

farm machinery to mechanize their farms. At the same time, they do not like to come together to form cooperatives and put their resources to invest. Because of their individualistic approach, they are unable to have access to credit facilities from commercial houses or government.

The MULS is the leading center of animal farm process mechanization. Some of the research results can be summarized given below:

1. Optimization of the farming technology is necessary for exploiting the genetic potentials of dairy cows.
2. Mathematic modeling of the effects of variables such as level of mechanization, water and feed supply, breeds of dairy cattle, labor requirement per cow and microclimate of the barns revealed that the feed supply and the level of mechanization have strong influences on the lactation yield.



*Figure 7. Milking machine*



*Figure 8. Automatic scraper*



*Figure 9. TMR mixing machine*



*Figure 10. Maize harvester*

3. Increasing the level of mechanization results in reducing the work load, saving energy, and reducing risks caused by human activities.
4. The energy efficiency is compared by the different version of milk farm mechanization and technologies.
5. The application of milking machines at small cow farm;



*Figure 11. Bucket milking machine*

6. Development of free-stall housing system;
7. A comparative economic assessment of mechanization in dairy farms with different housing systems;
8. Reduction of production cost by mechanization;
9. Utilization of renewable energy sources;

## In the field of Agricultural Electrification and Automation of farm process

At department of Electrification and Electronic has done research on debugging of insects by high voltage electric field using solar energy. New method has been successfully tested in 2012 at “Nart” training and research center of MULS in Tuv province. The solar equipment has been successfully working until now. Approximately, from 2 to 3 kg insects were killed per day and these insects were prepared for chicken feed. Capacity of equipment determined is 1 to 3 ha. The last 10 days of June to first 10 days of July is the most spreading time for insects. As such there is need for a research on insects depending on the landscape.

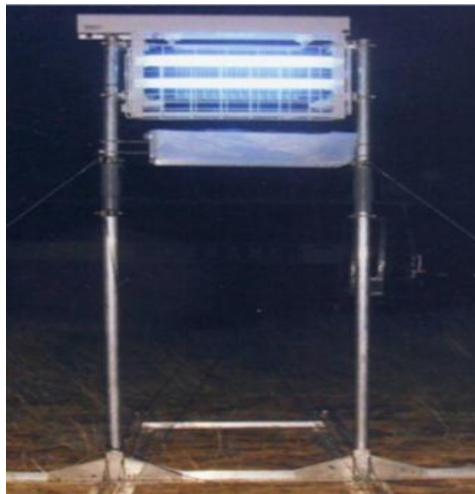


Figure 12. High voltage light traps at field



Figure 13. Types of destroyed insects by light trap system

There are tested a influence of Low-Temperature Plasma on Seed Germination Characteristics of *Lotusc orniculatus*. The low temperature plasma (LTP) technology uses for pre-sowing seed treatments. In this experiment researchers used the new LTP technology equipment “low-temperature plasma modified instrument” and applied different doses in LTP technology to explore its effect on seed

germination and other related characteristics on *Lotusc orniculatus* crop seeds. The maximum *Lotusc orniculatus* seed germination percentage and germination vigor percentage were recorded at 120W followed by 260W LTP treatment, while maximum plant height and root length were recorded at 260W LTP dose.

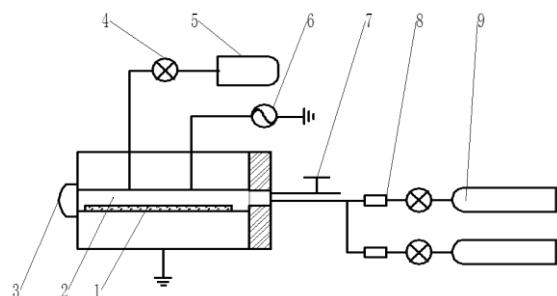


Figure 14. Structure diagram of low-temperature plasma modified instrument

1. Sample tray
2. The vacuum chamber
3. The vacuum chamber door
4. Cut-off valve
5. Pump
6. RF power
7. Vent valve
8. Gas flow meter
9. Helium tank

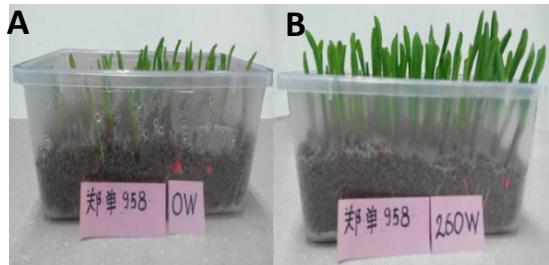
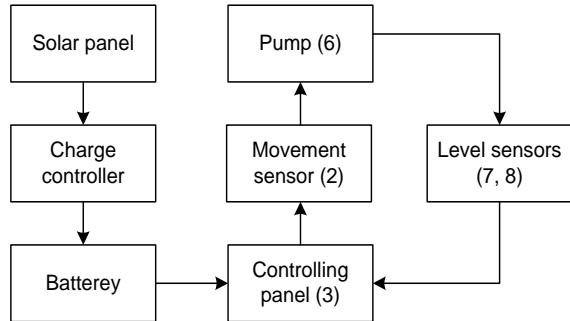


Figure 15. Experiment of seed germination

- A. Treatment dose is 0W (untreatment)
- B. Treatment dose is 260W

Mongolia has mainly nomadic in the countryside. Therefore we aim to make the water supply system with automate controlling to save manpower, money and time. Automated controlling block is fixed to ATMEGA 32 board and programmed by SI system. System operation information is transferred to LCD display. Movement sensor and water levels sensors are send the information to controlling board through relay and will control the pump. The system worked reliable during the experiment time and the researchers are focusing to develop the innovation now.



*Figure 16. General layout of instrument of automation of well pump*



*Figure 17. Locating the automate operated irrigating system to well*



*Figure 18. laboratory for testing diesel and petroleum engine*

Since the SET of MULS is leading scientific center of Mongolia a scope of research activity is widely and trend of engineering science includes:

- To expand research activity of establishing a nature of wearing process in the IC engine and working elements (share, blade and parts which operated under abrasive wearing) of soil cultivation machines,
- To come out a leader's role for definition a engineering police in agriculture,
- To develop a research activity in uncultivated pasturing Animal husbandry

## RESEARCH PROBLEMS OF ENGINEERING SCIENCE

At the present time at SET implements a fundamental research project << A study of abrasive wearing process of soil cultivation machines shares>> and such four projects for Innovation, as <<New version of machinery service management>> and <<A redesigning and manufacturing of sweep cultivator share >> and etc.

A last year SET was equipped with new research laboratories for testing diesel and petroleum engine, for analyzing of metal wearing process in the dry and liquid surround, for determining mechanical and chemistry compositions and for analyzing properties of fuel and lubricating materials.



*Figure 19. laboratory of Tribology*

to be replace human labor and to improve life standard of herders and rural labors,

- To strengthen a research participations in machinery management and service at farm joint with dealers companies,
- To increase amount of assembly of farm machine and equipment's for mechanization hand make labor and modification of imported machines,
- To increase a adaptation scope of oversee suitable technology and machines in Mongolian condition,
- To develop a activity and laboratories potential purposed for tribology, Nano and bio technology engineering.

## REFERENCES

1. Byambadorj Ch., "Implement Policy of Crop Sector Machine and Technologies and Method of Improvement", Mongolian Journal of Agricultural Sciences, vol.15, pp.3-10, 2015.
2. Baldangombo B., Nyamgerel B., "Equipment of Livestock", UlaanBaatar, 2014.

3. Buuveibaatar R., Koichi Takeda, Amgalanzul J. and Tuya B. "Ecologically Pure Solar Equipment for the Insecticide" Academia Journal of Scientific Research vol.4, No.6, pp.132-135, June, 2016.
4. Baatarkhuu D., Amgalanzul J. and Ganbold D. "Research of Instruments for Automation of Well Pumps" Journal of Eurasian Union of Scientists, vol.4, No. 25, pp. 6-11, May, 2016.

## DYNAMIC MODEL OF SOLAR PHOTOVOLTAIC SYSTEMS

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### ABSTRACT

*The paper deals with the simulation of the solar photovoltaic system in the Simulink program. The main purpose of the model is to analyze the dynamic operating modes. Much attention is paid to the simulation models of the battery and controller whose function is the distribution of energy flows. The paper describes consistency criteria of energy flows. The energy excess and energy deficit parameters are used as the evaluation criteria of coherence of energy flows. Graphical illustrations of simulation results are presented in the paper.*

**KEYWORDS:** Photovoltaic system, simulation model of the battery, charge controller simulation model.

### 1. INTRODUCTION

Optimization of operation modes and parameters of solar energy systems is one of the most important tasks when designing and implementing these systems in practice. Adapting systems to the specific climatic conditions, geographical location and requirements of

the energy consumer sets a complex analysis task that is solved, as a rule, in terms of multivariate analysis methods. However the application of multivariate analysis methods requires a model that has a range of contradictory properties. Obviously, the model should accurately

show the main processes in the system, but, on the other hand, be simple enough

## 2. MATERIALS AND METHODS

A formal approach to simulating allows you to resolve the contradiction between the requirements for accuracy and model complexity.

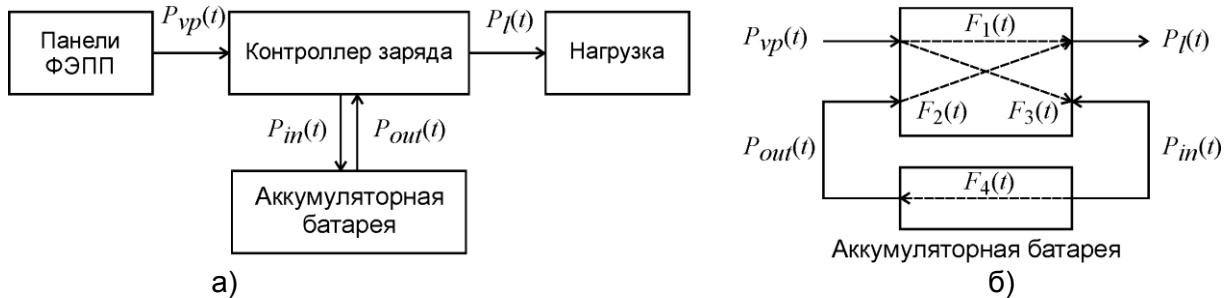


Figure 1. A structure of a typical SPVS: a) an original block scheme; b) a modified block scheme.

The block scheme includes the following elements (Fig. 1 a). Panels of photovoltaic semiconductor converters (PVSC), energy storage presents a chemical battery, management of power is carried out by a charge controller, and energy consumer is marked through the power load.

Flow capacity balance is made up according to the SPVS structure shown in fig. 1b.:

$$P_l(t) = F_1(t)P_{vp}(t) + F_2(t)P_{out}(t), \quad (1)$$

$$P_{in}(t) = F_3(t)P_{vp}(t), \quad (2)$$

$$P_{out}(t) = F_4(t)P_{in}(t), \quad (3)$$

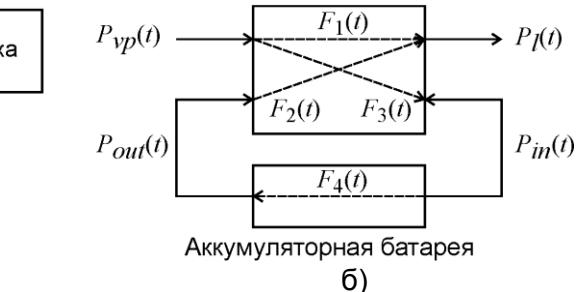
where:  $P_l(t)$  – power required for load;  $P_{vp}(t)$  – power generated by solar panels;  $P_{in}(t)$  – power spent on the battery charge;  $P_{out}(t)$  – power transferred from the accumulator in the load; functions  $F_1(t)$ ,  $F_2(t)$ ,  $F_3(t)$  and  $F_4(t)$  show different aspects of the relationship of energy flows.

The flow of energy generated by solar panels while simulating, can be determined by one of the known methods, for example [1], but it is necessary to note that both astronomical model and the model for consideration weather

for the possibility of multiple runs while searching for the best solutions.

The example of simulating a typical structure of the solar photovoltaic system (SPVS) is shown in fig. 1a. In order to build the model a block scheme is modified to the scheme shown in fig. 1 b.

Контроллер заряда



б)

conditions in the place of SPV installation are required for the accurate reproduction of insolation.

The functions of interconnections of flows are built on the basis of analysis of the system operation  $F_1(t)=1$  if  $P_{vp}(t) \leq P_l(t)$ , otherwise  $F_1(t)=P_l(t)/P_{vp}(t)$ , the difference of energy flows is directed via channel  $F_3(t)$  into the flow battery  $P_{in}(t)$ . Function  $F_3(t)$  must also take into account the final speed of battery charge and  $F_3(t)=0$ , if the battery is fully charged.

Function  $F_2(t)=0$  if  $P_{vp}(t) \geq P_l(t)$ , at  $P_{vp}(t) > P_l(t)$   $F_2(t)=1$ , and  $P_{out}(t)=P_l(t)-P_{vp}(t)$ . Function  $F_2(t)$  must take into account a final rate of discharge, and  $F_2(t)=0$  when it reaches the lower border of the battery charge level.

Function  $F_4(t)$  presents a formal battery model:

$$F_4(t) = E_0 + \int_0^t (\eta_1 P_{in}(\tau) - \eta_2 P_{out}(\tau) - p) d\tau, \quad (4)$$

where:  $\eta_1$  - parameter, taking into account the energy losses at a charge;  $\eta_2$  - parameter, taking into account the energy losses at a discharge;  $p$  – battery self-

charge constant;  $E_0$  – the amount of energy in the battery at  $t=0$ .

Implementation of the controller model in the Simulink is shown in fig. 2. Areas covering elements that implement

the connection functions  $F_2(t)$  and  $F_3(t)$  are highlighted for illustrative purposes. Function  $F_1(t)$  is implemented without computation.

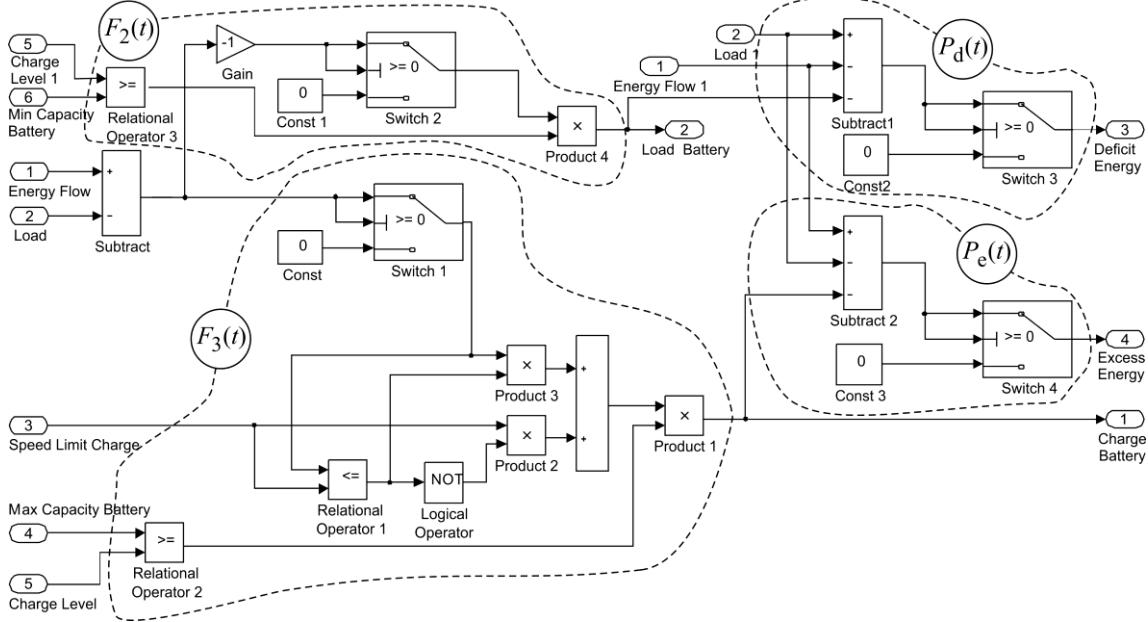


Figure 2. Implementation of a controller model in Simulink.

In addition to the above functions  $F_2(t)$  and  $F_3(t)$ , connecting the energy flows, additional computational parameters are introduced in the controller model which represent the following equations

$$P_d(t) = k_1(P_l(t) - P_{vp}(t) - P_{out}(t)) \text{ и}$$

$$P_e(t) = k_2(P_{vp}(t) - P_l(t) - P_{in}(t)),$$

where:  $k_1 = 1$  if  $P_l(t) - P_{vp}(t) - P_{out}(t) \geq 0$

otherwise  $k_1 = 0$ ;  $k_2 = 1$  if

$P_{vp}(t) - P_l(t) - P_{in}(t) \geq 0$  otherwise  $k_2 = 0$ .

In the first case the time function  $P_d(t)$  of deficit energy is computed, in the second case, the time function  $P_e(t)$  of excess energy is computed.

The implementation of the battery model in Simulink which is based on formula (4) is shown in fig. 3. Due to the high complexity of the exact battery model the simpler version is used.

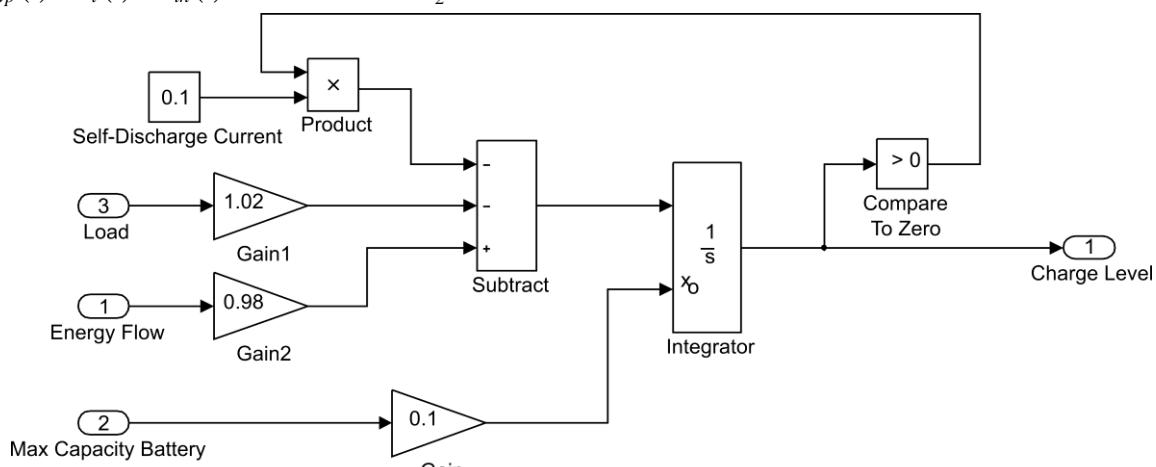


Figure 3. Implementation of a battery model in Simulink.

While building the model the following parameter points are taken in formula (4):  $E_0 = 0.1E_{\max}$ , where  $E_{\max}$  – is the maximum capacity of the battery; losses during battery charge and discharge are considered equal to 2 %, then  $\eta_1 = 0.98$ , and  $\eta_2 = 1.02$ ; self-discharge constant is  $p = 0.1$ .

The assumptions in the model: the battery power is not dependent on the level of charge, the influence of temperature on the battery and solar panel is not taken into account; the efficiency of

the charge controller is considered equal to one.

The implementation of the general model is shown in figure 4, the following processes are visualized (Scope 1): the flow of energy generated by solar panels –  $P_{vp}(t)$ ; required flow of energy load –  $P_l(t)$ ; the function of energy deficit –  $P_d(t)$ ; the function of excess energy –  $P_e(t)$ ; in some coordinate system the charge level of the battery –  $E_4(t)$  is displayed.

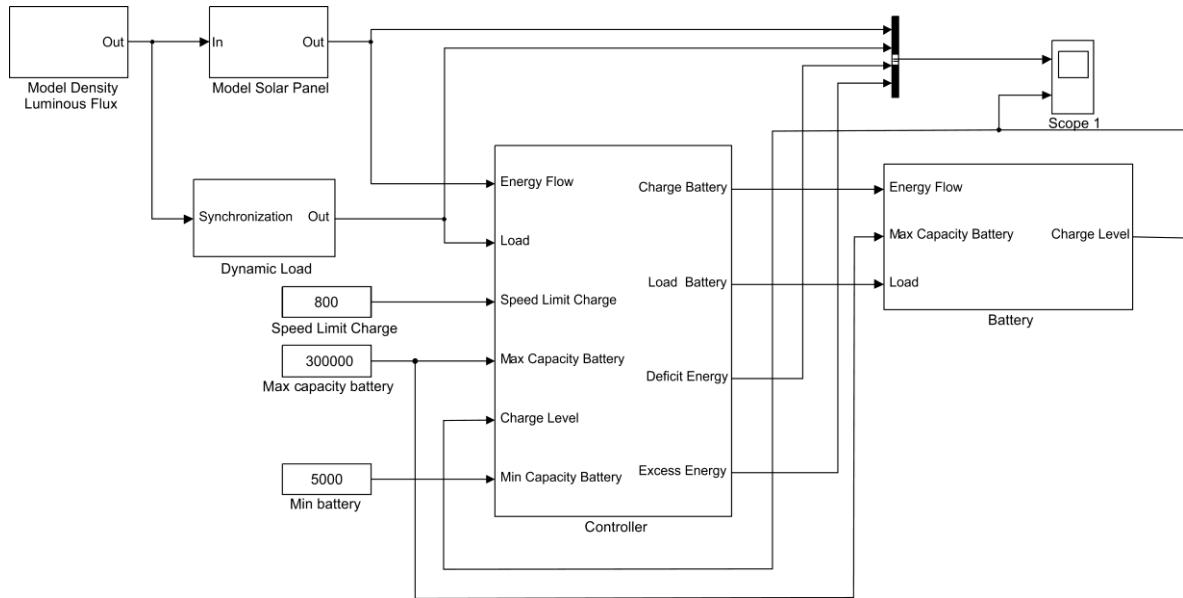


Figure 4. Implementation of a system general model in Simulink

### 3. RESULTS AND DISCUSSION

System simulating is carried out with the following parameters: the total area of solar batteries –  $S = 5 m^2$ ; SPVP efficiency –  $\eta_{vp} = 0.15$ ; solar constant (density luminous flux)  $I = 1500 W/m^2$ ; maximum battery capacit  $W_{vp \max} = SI\eta_{vp}$ ,  $W_{vp \max} = 1125 Bm$ ; accumulator capacit

$100 A/h$ , voltage  $12 V$ ,  $V$  is converted into Joule  $E_{\max} = 4.32 MJ$ ; minimum battery charge level  $E_{\min} = 0.15E_{\max} = 648 KJ$ ; self-charge parameter  $p = 360 J/h$ .

The simulation results for the case of excess energy flow and low flow (deficit energy) is shown in figure 5 and figure 6.

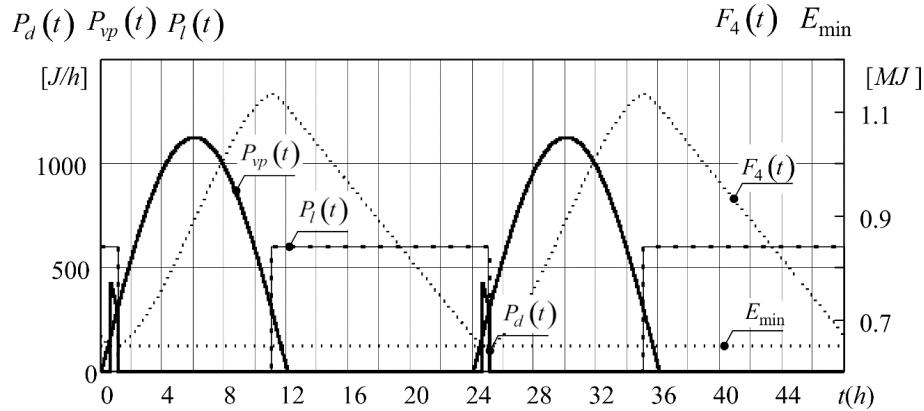


Figure 5. Simulation results for the case of excess energy flow.

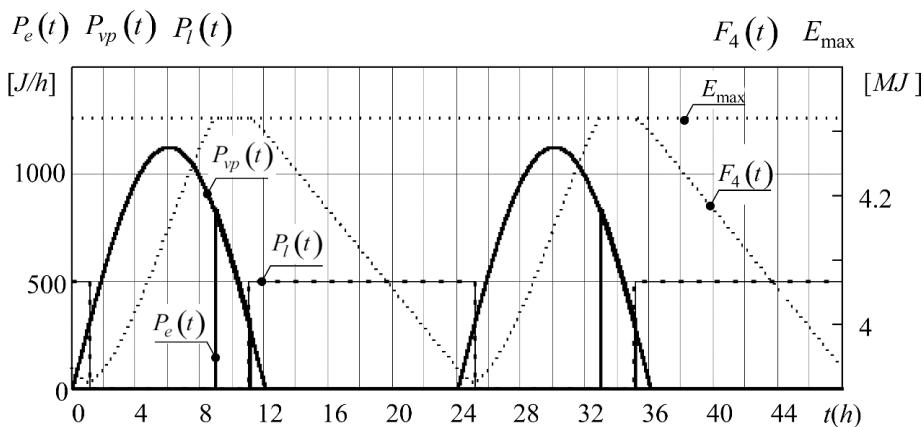


Figure 6. Simulation results for the case of deficit energy flow.

#### 4. CONCLUSIONS

The developed model allows for analysis of dynamic processes which occur in the system, comparison of energy

flows by level and evaluation of losses due to their inconsistency.

#### REFERENCES

Falayi E. O., Rabiu A. B. Solar Radiation Models and Information for Renewable Energy Applications // Solar radiation. – 2012. – pp. 111-130.

Peter W. et al. Physics of Solar Cells: From Principles to New Concepts. – John Wiley & Sons, 2008. – 198 p.

## **ROLE OF CROP PRODUCTION FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN KYRGYZSTAN.**

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### **ABSTRACT**

*Agriculture is the backbone of the Kyrgyz Republic's rural economy engaging 30 percent of the labor force and accounting for 15 percent of gross domestic product. Wheat, potato, bean, sugar beet, cotton and tobacco are the most important crops. The aim of this study was to evaluate crop production level of the country and to make plan for sustainable development in agricultural sector.*

**KEYWORDS:** Sustainable development, crop production, Kyrgyzstan.

### **INTRODUCTION**

Kyrgyzstan is one of the smallest countries in Central Asia. Population of Kyrgyzstan makes up 6.08 million. Sixty-five percent of the country is consisted of mountainous areas. The climate is the same throughout all the continent, with hot and dry summers and cold winters and great local variations depending on altitude. Agriculture in Kyrgyzstan is a significant sector of the economy and it comprises 15% of the total GDP. The agricultural sector provides employment for over 30% of the population [5,9]. More than half Kyrgyz population live in rural areas and directly faced with agriculture. Due to the many mountains of Kyrgyzstan, crop production and animal husbandry remains a significant part of the

agricultural economy. Agriculture has great reserve for sustainable development of the economy and for achieving or ensuring food security [4,8].

Total land area of Kyrgyzstan, 56,2% is classified as agricultural land and only 1.185 million ha as arable land, of which 835 thousand ha or nearly 75% is irrigated. Of the total agricultural land, 87% is grassland. Only 6.8% of the total land area is used for crop cultivation [4,6]. The most important agricultural area is the Fergana Valley, and the Chui and Talas Provinces. Kyrgyzstan has a great potential to develop organic farming in other word, chemical free crop production.

During the period of a centrally planned economy, almost entire

agricultural production came from either state or collective agricultural enterprises, but with the breakup of the former Soviet Union and privatization of land, three types of agricultural production units have recently emerged, comprising households, private farms, and agricultural enterprises [8].

## MATERIALS AND METHODS

The data used in this study were obtained from Kyrgyz Statistic Committee [1,3,5]. Tables and figures were created from the obtained data. Total agricultural area, numbers of agricultural enterprises,

## RESULTS

Agricultural production facilitated by three types of agricultural enterprises, which are mostly owned by farmers. In 2015, 401350 farms (households, private farms, state farms and collective) were registered in total (Table 1). In Table 1, Chui has the biggest arable agricultural land among of all, but nevertheless it does not have most of the agricultural

By 2008 ninety one agricultural cultivated plant species including 617 varieties and hybrids were registered in the list of State Variety Register of Kyrgyz Republic. The main cultivated crops are wheat, barley, corn, rice, sugar-beet, cotton, tobacco, oilseed, potato, grape, fruits and vegetables[10].

yields of plants were given in the data. Sustainable Agricultural development and its potential of Kyrgyz Republic were evaluated and discussed in this study.

enterprises. Almost 26% of agricultural enterprises takes place in Osh province but when it compared with other agricultural facilities, average land area per enterprise is quite low. As described before, Chui holds leadership from the point of average land area. This could be the key factor for achieving great crop production.

Table 1.

Numbers of agricultural area and enterprises (2015)					
Provinces	Arable land (ha)	Percent of total(%)	Number of agricultural enterprises	Percent of total (%)	Average land area for enterprise (ha)
Jalal-Abad	149000	0,125642972	95012	0,236731033	1,568222961
Yssyk-Kol	179700	0,151530483	35040	0,087305344	5,128424658
Narin	104100	0,087781432	40338	0,100505793	2,580693143
Talas	104300	0,08795008	24895	0,062028155	4,189596304
Osh	175900	0,148326166	104929	0,26144014	1,676371642
Batken	61700	0,052027996	38037	0,094772642	1,622104793
Chui	410300	0,345981955	63099	0,157216893	6,502480229
<b>Kyrgyzstan</b>	<b>1185900</b>	<b>1</b>	<b>401350</b>	<b>1</b>	<b>2,954777626</b>

As seen from Figure 1, Both crop and livestock production tends great potential in terms of economical contribution to the Kyrgyzstan. This

increase curve will most probably stable because of the growth potential of Kyrgyzstan agriculture.

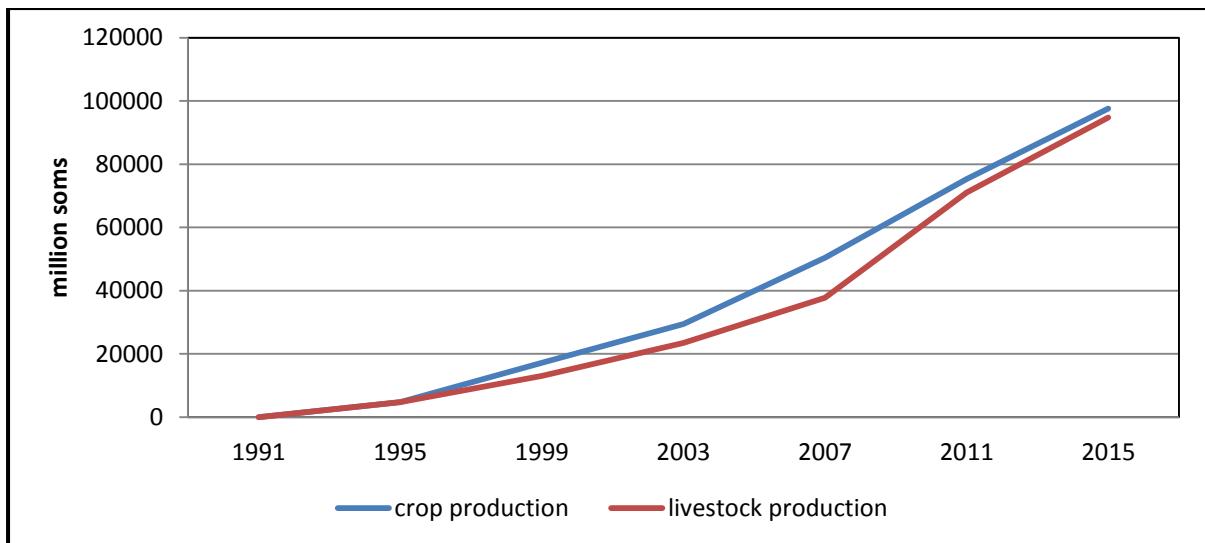


Figure 1. Agricultural value added by crop and livestock production

The most cultivated crops in Kyrgyzstan are wheat, corn, cotton, potato and vegetables. Wheat is produced all regions of country. Total wheat production was estimated 704600 tones in 2015. In general, farmer plant winter wheat varieties, but non-irrigated agricultural lands each year covered by spring wheat varieties. Production of barley in 2015 was estimated 370200 tons; corn 641900 tons; rice 30200 tons; bean 96700 tons; sugar beet 183200 tons; oilseeds 49000 tons; tobacco 1400 tons; vegetables 1052100 tons; fruits 209200; grapes 5700 tons. Cotton is one of the important industrial plant, has great potential to export to different countries. In 2015 total production of cotton was 44100 tons. South of the Kyrgyzstan has suitable climate condition for cotton production. In last years over 3 thousand hectare cotton areas registered as organic production in Osh and Jalal-Abad Provinces. Potato

grow all provinces of country, but mainly has big production in Yssyk-Kol Province. Sugar-beet was main crop that growing hole North region, especially in Chui, but after break up of the Soviet Union, farmers stopped feeding sugar beet crop and factories has closed. But last 5 years, farms again turned to grow sugar beet in Chui region. In 2015, sugar beet production was 183200 tons.

After potato, world widely most popular and most productive three crop are wheat, rice and corn. Due to the climatic reasons as explained throughout all the continent, wheat and corn, especially wheat is very suitable for planting (Table 2). Sugar beet shows the highest yields from per area in comparison with other crops and bean is the lowest one. This table may be explaining the suitable planting pattern of which plant prefer for better production.

Table 2.

Crop production in Kyrgyzstan (2015)			
Crops Common Name	Cultivated area (thousand ha)	Total Yield (thousand tones)	Yield (centner from 1 ha)
Wheat	293,3	704,6	23,7
Barley	173,9	370,2	21,3
Corn	102,3	641,9	61,6
Rice	8,6	30,2	34,7
Bean	57,3	96,7	16,8
Sugar beet	5	183,2	363,0

Oilseeds	42,9	49,0	11,1
Cotton	14,3	44,1	30,9
Tobacco	0,6	1,4	23,5
Potato	84,5	1416,4	165,1
Vegetables	51,5	1052,1	192,3
Fruits	49,6	209,2	42,5
Grapes	6,4	5,7	10,1

Combined all the datalies from explained figures and tables, expected results from Figure 2 is verifiyig itself. Except for potato, Chui is the incontestable leader ship of Kyrgyzstan

agriculture comparing other province. Grain and legumes, vegetable and fruits, weed crops mostly are cultivated in this province.

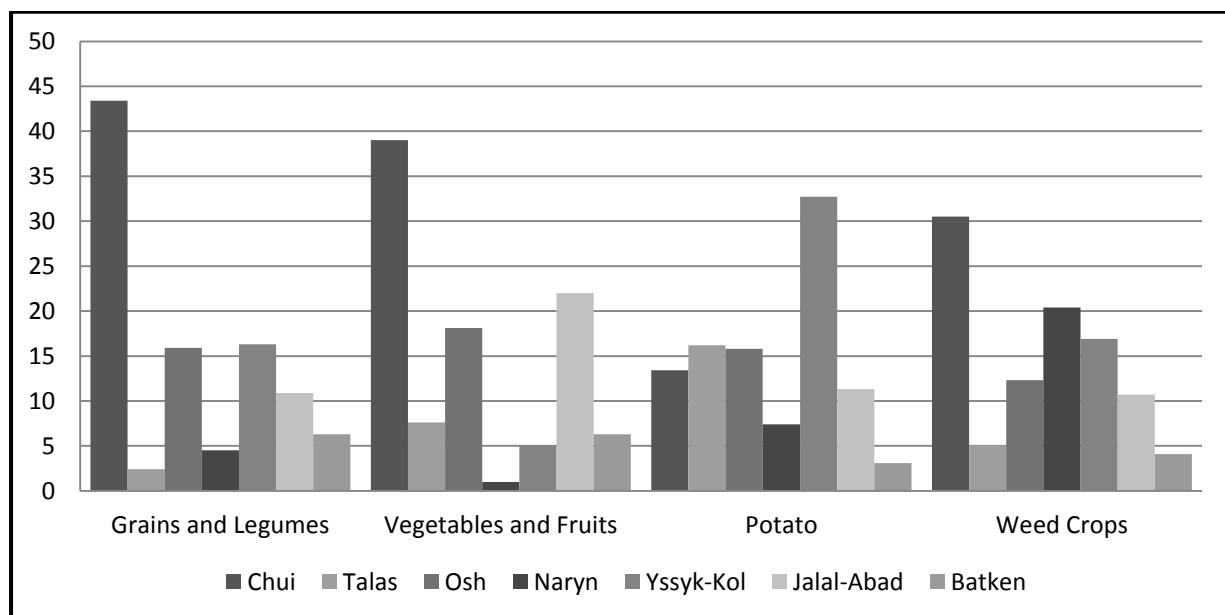


Figure 2. Distribution of crop production by provinces (2015)

## CONCLUSIONS

Agricultural sector performance has a huge impact on Kyrgyzstan's economic performance, because of its large portion of GDP and major share of employment. Agricultural growth is key factor for sustainable economic growth and continued poverty reduction. Continued productivity of crop production is essential for the sustainability of future agricultural growth. This requires modern market opportunities and improvement in export of traditional export products.

Despite good achieves in the past years, there is much scope for further productivity increases through the

adoption of improved technology, including beter seed varieties, fertilizers and crop protection techniques. Improved seeds, beter varieties, increased fertilizer use, more efficient use of irrigation water and holding modern agricultural machinery make more intensive crop productivity, develop rural incomes and employment.

## REFERENCES

- [1] Anonymous, 2004. The First National Agricultural Census of Kyrgyz Republic. 464p. Bishkek.
- [2] Anonymous, 2004. Fruit and Vegetable Processing Industry in Kyrgyzstan. HELVETAS Swiss Intercorporation, 23p. Bishkek.
- [3] Anonymous, 2011. Agriculture of Kyrgyzstan between 2006-2010. 80p. Bishkek
- [4] Anonymous, 2013. Kyrgyz Republic Data Collection Survey on Dairy Industry. Japan International Cooperation Agency (JICA). 178p.
- [5] Anonymous, 2016. Agriculture of Kyrgyzstan between 2011-2015. 89p. Bishkek
- [6] B. Sahmshiev. 2004. Kyrgyz Republic Agricultural Policy Update. Document of the World Bank. 99p.
- [7] D. Abdulhamidov, T. Abdurakhmanov, P. Monneveux. 2015. Potato in Kyrgyzstan: The Second Bread. Manas Journal of Agriculture and Life Science. 5:1.
- [8] E. Ryazanov. 2007. Adding Value in Agriculture. HELVETAS Publication. 49p.
- [9] Mogilevskii, Roman et al. (2017). The outcomes of 25 years of agricultural reforms in Kyrgyzstan, Discussion Paper, Leibniz Institute of Agricultural development on Transition Economies, 40.162
- [10] M. Dzunusova. 2008. National Report on the State of Plant Genetic Resources for food and Agriculture in Kyrgyzstan. 49p.

## A STUDY OF CORROSION OF PETROLEUM STORAGE TANK

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### ABSTRACT

*Oil products storage observed by Electron microscope analysis (SEM) small crystalline particles approximately 1 $\mu$ m thickness and width 3-4 $\mu$ m disc-shaped in addition from a variety larger size crystals on samples from the bottom of the tank storage inside corrosion. These large and small crystals consist of iron and sulfur elements. On the sample of corrosion x-ray diffraction analysis (XRD) is established that compounds goethite ( $Fe^{3+}OH$ ), iron hydroxide ( $FeO_2H$ ).*

**KEYWORDS:** Petroleum product, storage tank, corrosion, crystals structure, goethite, iron hydroxide

### INTRODUCTION

The component Mongolian leading fuel and energy sector is part of a storage tank for petroleum products. In recent years the number of warehouses oil production increase more than 130 m<sup>3</sup> and total warehouse capacity of petroleum products was approximately 400,000m<sup>3</sup> in our country. The average aging 25-30 years of these storage tank and most are used obsolete tank more than 30 years. The main issue is usage of safety oil products storage tank, because it is dangerous object for fire and boom [1].

The potential for economic savings to bate expenses of metal by increasing the

useful life of the tank. Most scientists and researchers consider, that products are stored the vertical steel tanks lifetime depends on the rate of inside wall corrosion in the tank [2].

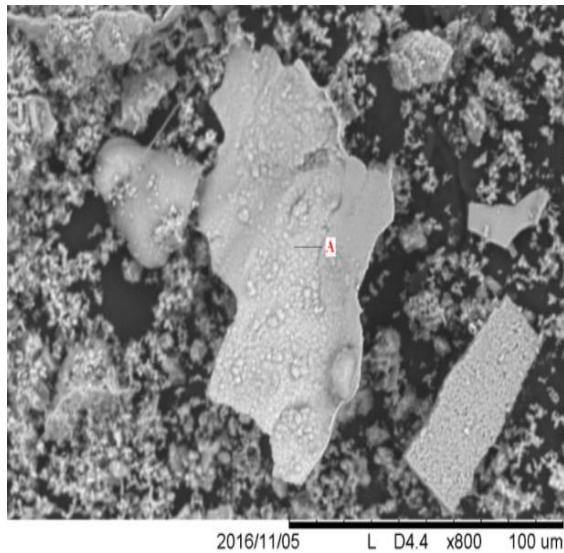
An external walls protected from corrosion but often used without proofing inside wall of the tank [3]. The purpose of this study is by electron microscope and X-ray diffraction method crystal structure in the bottom formed corrosion of fuel storage vertical steel tank related on the above issues and to describe the mechanism formation of corrosion[4].

### THE RESULTS OF THE EXPERIMENTS

This sample is consisted of samples which are consisted of small orange crystalline powder there are formed inside bottom of the vertical tank.

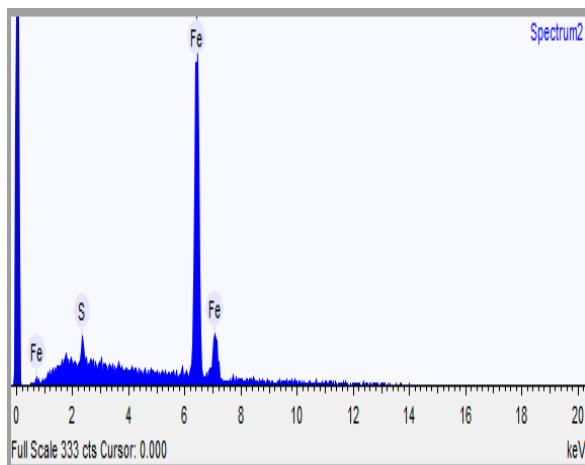
A. Samples of study measured electron microscope (Energy dispersive x-ray spectroscopy (EDX)). The results of the

measurements are shown on Figures 1, 2, 3, 4.



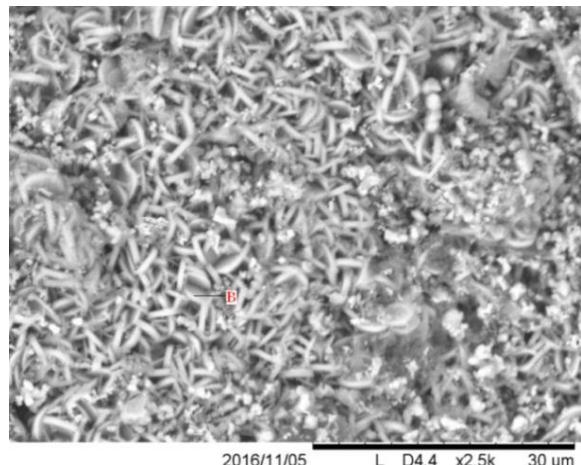
*Figure 1. The micro image of corrosion via electron microscope (SEM) (image raised 100mkm)*

In figure.1 observed a variety of irregular larger size crystals in addition mainly part of small crystals. The analysis at point A on large crystal in Figure 1 revealed the following chemicals. The results are shown on Figure 2.



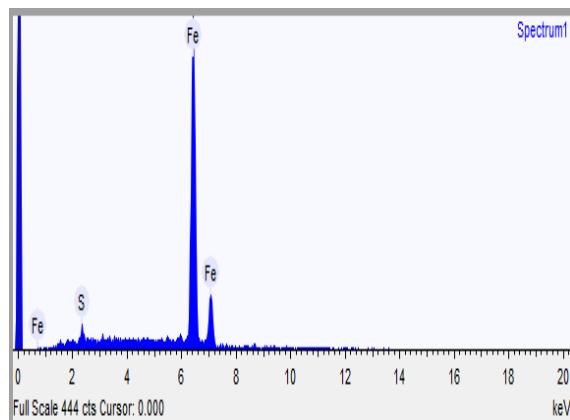
*Figure 2. The results of elements performed at point A on large crystal*

Figure 1 shows that the large crystals (point A) consist the elements of Fe (99.2 mass. %) and S (0.8 mass. %).



*Figure 3. The micro image of corrosion via electron microscope (SEM) (image raised 30 mkm)*

In figure 3 observed of disc-shaped crystal particles of thickness 1μm, width 3-4μm. The analysis B letter marked sections in Figure 3 revealed the following chemicals. The results are shown on Figure 4.



*Figure 4. The results of elements performed at point B on disc-shaped crystal partical*

Figure 4 shows that the equal disc-shaped crystal partical (point B) consist the elements of Fe (98.8 mass.%) and S (1.2 mass.%)

The powder XRD measurements conducted by transition of division angel 0.05<sup>0</sup> in the dispersion angle 2θ<sub>0</sub>=13÷80<sup>0</sup> using anodized CuK<sub>α</sub>=1.54Å in the <Enraf Nonius Delft Diffractis 583> of X-ray diffraction analysis and at room temperature by 2 seconds point each transition. The phase analysis derived measurements obtained from X-ray diffraction spectrum used to program of "Match! Crystal Impact" and results of processing are shown on Figure 5. [5]

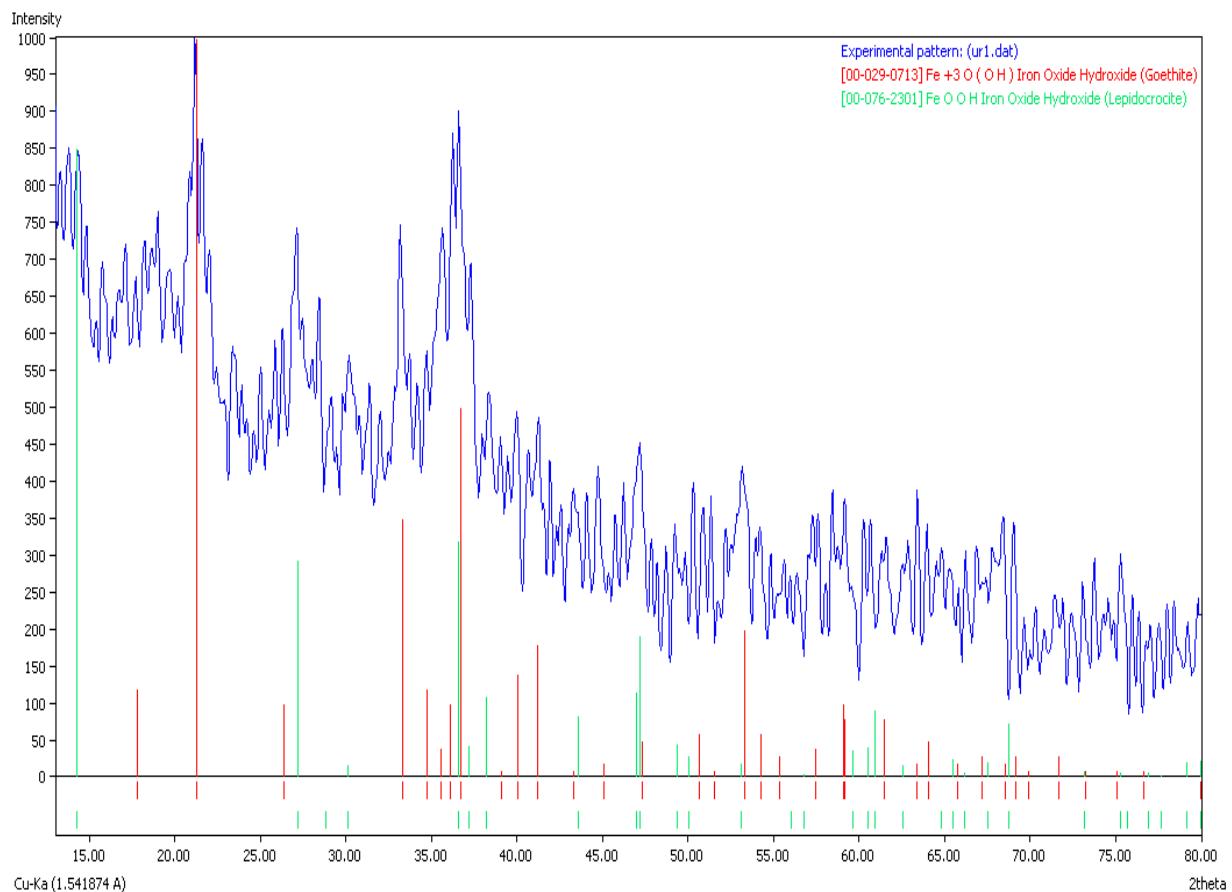


Figure 5. The sample of corruptions X-ray diffraction analysis (x-ray pattern)

Figure 5 shows to correspond X-ray intensity on the vertical axis, an angle of the X-ray energy dispersion on the horizontal axis. The phase analysis derived measurements obtained from X-ray diffraction spectrum (x-ray diffraction pattern) used to international standard program of "Match! Crystal Impact" and results of processing are shown on Table 1. Using the formula (1):

$$2\sin\Theta = n \lambda \quad (1)$$

Measured experimental data from X-ray diffraction analysis defined between atoms flat spaces ( $d$ , Å) and compared with  $d$ -values in international data (ICSD, PDF-4) and determined risk type and numbers (Table 1).

Table 1.

No	$d$ , Å	Mineral title	Chemical formula	The crystal symmetry and cell parameters (Å)
1	4.19	Goethite	$\text{Fe}^{3+}\text{OH}$ (60.07, wt.%)	Orthorombic, Pbnm, $a=4.60$ , $b=9.95$ , $c=3.02$
2	3.28	Iron Oxide Hydroxide (Lepidocrocite)	$\text{FeO}_2\text{H}$ (39.93%, wt.%)	Orthorhombic, Amax, $a=3.87$ , $b=12.40$ , $c=3.06$
3	2.68		$\text{Fe}^{3+}\text{OH}$	
4	2.47		$\text{Fe}^{3+}\text{OH}$	
5	2.45		$\text{FeO}_2\text{H}$	

**d- space between the atoms flat.**

Table 1 shows that samples of corrosion consist compounds such as goethite ( $\text{Fe}_3 + \text{OH}$ ) orthorhombic symmetry 60.07%, iron oxide hydroxide ( $\text{FeO}_2\text{H}$ ) orthorhombic symmetry 39.93%. But did not appear on any phase containing sulfur X-ray diffraction analysis. On samples of corrosion detected small amounts of sulfur according to electron microscopy studies, but the phase analysis results of X-ray, they did not appear crystalline phases present in the capacity of the sorting method. Generally, iron chemical corrosion process will be explained as follows: The following

## CONCLUSION

Oil products storage observed by Electron microscope analysis (SEM) small crystalline particles approximately  $1\mu\text{m}$  thickness and width  $3\text{-}4\mu\text{m}$ .

1. Disc-shaped in addition from a variety larger size crystals on samples from the bottom of the tank storage inside corrosion.
2. These large and small crystals consist the elements of iron and sulfur (Fe 99.2 mass. % and S 0.8 mass. %).

The samples of corrosion X-ray diffraction are determined compounds such as goethite ( $\text{Fe}_3 + \text{OH}$ ) orthorhombic symmetry 60.07%, iron oxide hydroxide ( $\text{FeO}_2\text{H}$ ) orthorhombic symmetry 39.93%. But did not appear on

reactions are in the dry anaerobic:  $4\text{Fe} + 3\text{O}_2 + 6\text{H}_2\text{O} = 4\text{Fe(OH)}_3$ . Formats  $\text{Fe(OH)}_3$  phase depends on the specific temperature values and will take following reactions:  $\text{Fe(OH)}_3 \rightarrow \text{H}_2\text{O} + \text{FeO}_2\text{H}$ . The compounds  $\text{FeO}_2\text{H}$  formats from reaction is called corrosion. But  $\text{Fe}^{3+}$  cat ion formats by the following reaction:  $4\text{Fe}^{2+} + \text{O}_2 \rightarrow 4\text{Fe}^{3+} + 2\text{O}^{2-}$ . Thus, described  $\text{Fe}^{3+}\text{OH}$  and  $\text{FeO}_2\text{H}$  phases X-ray diffraction analysis method are established formation with iron compounds from the chemical corrosion process.

any phase containing sulfur by X-ray diffraction analysis

3. Also  $\text{Fe}^{3+}\text{OH}$  and  $\text{FeO}_2\text{H}$  phases are established formation with iron compounds from the chemical corrosion process.
4. On samples of corrosion detected small amounts of sulfur according to electron microscopy studies, but the phase analysis results of X-ray, they did not appear crystalline phases present in the capacity of the sorting method.

## REFERENCES:

1. P. Cawley, M. J. S. Lowe, et al. Practical long range guided wave testing application to pipe and rail, Material Evaluation, Vol.61, No.1 (2003), pp. 66-74.
2. J. Pei, M. I. Yousuf, F. L. Degertekin, B. V. Honein and B. T. Khuri-Yakub, Lamb wave tomography and its application in pipe erosion/corrosion monitoring, Research in Nondestructive Evaluation, Vol.8, No.4 (1996), pp. 189-197.
3. D.Urgamalsuvd, L.Orosoo "The analysis of mechanical characteristics of vertical storage tanks of oil products", Oil and gas-2016 Ulaanbaatar, Mongolia, pp. 127-136
4. D'Orazio, T., Dukan, J. M. and Bell, R. A. (1989), "Distortion of steel tank due to settlement of their walls". Journal of the Geotechnical Engineering Division, ASCE, Vol. 115 (6), 871-890.
5. "Match Crystal Impact" program

## **REPAIRS AND REFURBISHMENT OF AGRICULTURAL MACHINERY DETAILS WITH COLD SPRAY TECHNOLOGY**

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### **ABSTRACT**

*Cold Spray (CS) is a relatively recent spray technology that belongs to the larger group of spray processes including thermal spray, plasma spray, etc., There are different approaches that can be named as: Cold Gas Dynamic Spraying, Kinetic Spraying, High Velocity Particle Consolidation (HVPC), High Velocity Powder Deposition and Supersonic Particle/Powder Deposition (SPD). But the generally known term for that is Cold Spray or CS.*

*The basic principle of the cold spray process is very simple: A high velocity (300 to 1200 m/s) gas jet, formed using a de Laval nozzle (BTW, the same type of nozzle is installed on space crafts) or similar converging/diverging nozzle, is used to accelerate powder particles (1 to 50 µm) and deposit them onto a substrate, located approximately 25 mm from the exit of the nozzle where they impact and form a coating. The kinetic energy of the particles rather than high temperature helps these particles to plastically deform on impact and form splats, which bond together producing layers and thereby avoids or minimizes many deleterious shortcomings of traditional thermal spray methods such as high-temperature oxidation, thermic deformation of precise details, evaporation, melting, crystallization, residual stresses, harmful gas release. In this process, powder particles are accelerated by the supersonic gas jet at a temperature that is always lower than the melting point of the sprayed powder, resulting in coating formation from particles in the solid state giving the effect of micro-welding, and therefore no melting and solidification process is experienced by the powders like in traditional thermal spray process. Further this technique is used for filling scratches, cracks and craters as well as corrosion protection of metal parts and other troubles that occur on machinery in agriculture.*

**KEYWORDS:** Repairs, Machinery parts, Cold spray, Thermal spray, Supersonic gas

### **I. INTRODUCTION**

During operations on machinery some parts will inevitably wear and break. The right solution here is replacement of the worn/broken detail. But sometimes details aren't sold separately but only as whole units in assembly that is too expensive – maintenance and repairs

should be as cheap as possible, otherwise total cost rise and price of production won't be competitive. Other issue with new parts replacement is availability of the required details in local dealer shop – average period of supply is from two weeks to several months (delivery, custom

clearance for parts from abroad, etc.) that is quite unacceptable for agriculture where most of works are in the strict span and can never be delayed. That is why it is better and cheaper in general to restore instead of buying new parts.

## II. Technologies of repairs

At large there are different technologies of restoring of agricultural machinery parts. For instance, if we're talking about hydraulic cylinder rod repair (fill up scratches and wears in central part of it) normally old coating is machined up to flat surface and then new coating is anodized. For small scratches and rust

craters welding may be used as well but machining is required again. Those ways of repairing have in common such major imperfections as complexity and labor input and long duration of process (as usual 3-5 days that is unacceptable in agriculture especially in periods of sowing or harvesting).

Other example is rupture of head cylinder partition that is too thin to repair with the help of argon welding. In order to repair it we need to use some alternative technology.

## III. Cold Gas Dynamic Spray

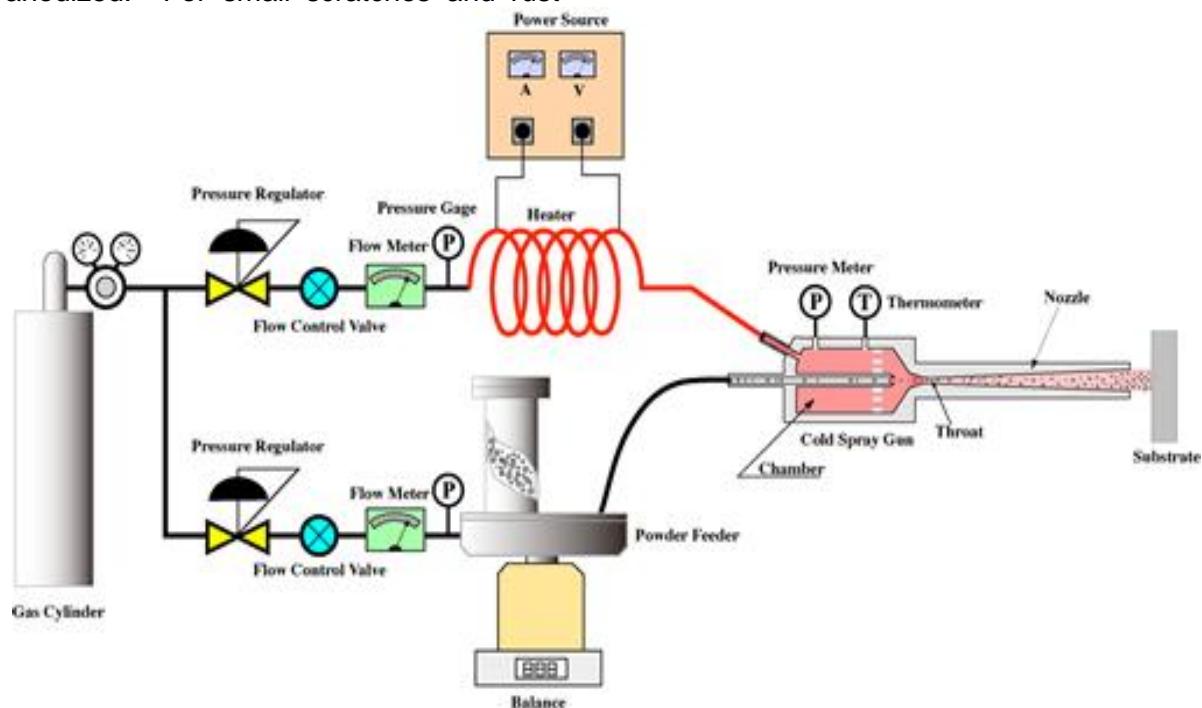


Figure 1.

Having analyzed those technologies we decided to use the Cold Spray Technology that is supposed to resolve the above mentioned issues. Apart from the technological advances, the other main goals are large reductions in cost and lead-time. To achieve these reductions, our intentions are to, first, modify the shape of nozzle ejector to reduce inner turbulence – this is expected to let us operate with lower air/nitro pressure (now this is approx. 7 bar, the goal is 5 bar with equal parameters); and,

Via process peculiarities the footprint of the cold spray beam is very narrow typically around 5 mm diameter due to small size of the nozzle (10-15

second, design a unit for collecting the over sprayed powder and reprocess these expensive raw materials. Depending of the purpose of spray powder can contain activated metals, gold, silver, aluminum, aluminum-bronze, copper, monel, nickel chrome, nickel, stainless steel, tin, titanium, zinc, cermet, brazing material, and solder; bi-metal powders, matrix powders, etc.

Moreover, it is very important to collect over sprayed powder to avoid contamination of environment.

sq.mm) and spray distance (5-25 mm), yielding a high-density particle beam, resulting in precise control over the area of deposition over the substrate surface. This

process is similar to a micro shot peening and hence the coatings are produced with compressive stresses, rather than tensile stresses, which results in dense and ultra-thick (5-50 mm) coatings without adhesion failure. The low temperature formation of

Cold spray technology also makes it possible to create the protective coating by bombarding the solid phase material at supersonic speed, without melting or vaporizing it, with the substrate using inert

But nowadays a serious problem exists – not all sprayed powder is deposited onto substrate, efficiency is only 60-80%. In other words nearly one third part of expensive powder is not used for its purpose contaminating environment making spraying operation harmful and damage for the operator. To resolve the problem a new stand with aspiration

coating leads to oxides and other inclusions -free coatings with wrought-like microstructure. It means that CS is suitable for repairs of highly precise details as hydraulic elements, engine parts, etc.

gases. Generally in CS we can use nitrogen or helium, but depending on type of powder compressed air can also be used that is very convenient for repairs in local shops on farms.

system is required. To be able to reuse that collected powder 2 stage filtration can be installed consisting of cyclone and cartridge.

So for now our primary goal is to design a complex with Cold Spray unit, aspiration and filtration systems and find versatile contents of powder to make repairs as cheap and quick as possible.

## **RESULTS OF INVESTIGATION OF INJECTION PRESSURE FOR DIESEL SMOKE PM**

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### **ABSTRACT**

*One important element of the power supply system of diesel engines technical condition which changes during operation are injectors. Changing the injection pressure nozzles directly affects the emissions. We investigated the effect of the change in injection pressure nozzle on the toxicity of Grace diesel minibus widely used in passenger transport suburbs of capital city.*

**KEYWORDS:** Nozzle , technical condition , smoke, fuel injection pressure

### **I. INTRODUCTION**

The fuel system has a special place in the consideration of the formation of toxic substances in the engine cylinder. The normal functioning of the fuel system provides a relatively stable emissions of nitrogen oxides, hydrocarbons, CO, PM (soot) and the level of fuel efficiency.

Conditions of combustion in the cylinder is dependent upon factors such as air excess, its turbulence and quality of the fuel injection feed points, and many other factors. In turn, these factors determine the one hand on the physical-chemical conditions of the preparation of ignition, on the other hand the duration of the processes of cold flame ignition delay period, the third value of the fuel cycle. The stability of the fuel cycle depends on the fine filter and coarse fuel from fuel contamination, wear and tear of fuel equipment of their problems, the state of the sprayer.

Spray quality dependent on the magnitude of the pressure increase start injection nozzle spray condition, fuel equipment wear and tear, lacquer deposits on the nozzle needle, and other factors. There may be a fuel injection, instability of injection fuel supply interruption and bruise fuel through nozzles during injection.

Characteristics and quality of injection fuel atomization conditions affect local air ratio in the cylinder affects the duration of the ignition delay, on the law of heat in the cylinder.

Through increasing the temperature of the law, the law of heat can determine the level of emissions of harmful substances in exhaust gases.

Reduction of CO, CH, NOx and soot due to the more complete combustion. Diesel engines with normal fine filter, coarse filter, a worn-out low pressure fuel pump, high pressure fuel pump when the sprayer

without sludge and varnish, fuel equipment

adjusted work more economically.

## II. CONDUCTED EXPERIMENT

### A. Objects of research:

Objects of experiment were "Grace" diesel engine with normal technical condition , 16 nozzles with modified fuel injection pressure .

### B. Objective:

To determine the effect of varying the injection pressure nozzle by the amount of soot emission from exhaust gases.

### C. Experiment:

The experiments were conducted at the diagnostic center "Songino Khairkhan" area.



Figure 1. The Course of the Experiment

In Table1 show the average values of measurements and process these data were obtained relationship between the

- Were selected nozzles with normal technical conditions and were modified injection pressure Alignment with tightening springs injectors using the device KM562. ( $R_{vpr} = 120 \text{ kg/cm}^2, 140 \text{ kg/cm}^2, 160 \text{ kg/cm}^2, 180 \text{ kg/cm}^2$ )
- On the engine minivan alternately rearranging nozzles with different values and tightening springs for each pressure under different engine operating modes were measured opacity data.



Figure 2. The Course of the Experiment

injection pressure and the size of the PM (carbon black) in different modes of operation.

Table.1.

	Engine speed	Injection Pressure $p_{inj}$ , kg/cm <sup>2</sup>			
		120 kg/cm <sup>2</sup>	140 kg/cm <sup>2</sup>	160 kg/cm <sup>2</sup>	180 kg/cm <sup>2</sup>
1	1000 min <sup>-1</sup>	17,12	15,22	11,87	4,92
2	2000 min <sup>-1</sup>	24,45	21,22	19,22	17,22
3	3000 min <sup>-1</sup>	34,37	30,33	28,3	24,57
4	4000 min <sup>-1</sup>	48,6	46,2	44,3	42,1

Table.2.

Results of measurements at under free acceleration

N	Injection Pressure $p_{inj}$ , kg/cm <sup>2</sup>	Averaged Values of PM (soot)%
1	120 kg/cm <sup>2</sup>	48.6
2	140 kg/cm <sup>2</sup>	46.2
3	160 kg/cm <sup>2</sup>	44.3
4	180 kg/cm <sup>2</sup>	42.1

## II. REGRESSION ANALYSIS OF "PRESSURE INJECTION NOZZLES" ON DIESEL SMOKE

Using the data of experience as one of the factors to smoke or soot values were made using regression analysis

subroutine "Regression" package "Microsoft Excel".  
The results are shown in box "Regression" in tab.3-5

Table.3.

The results of calculation of the regression statistics

	H	I
5	SUMMARY OUTPUT	
7	Regression Statistics	
8	Multiple R	0,925091382
9	R Square	0,855794065
10	Adjusted R Square	0,847782624
11	Standard Error	1,103967592
12	Observations	20

Table.4.

The results of analysis of variance

	H	I	J	K	L	M
14	ANOVA					
15		df	SS	MS	F	SIGNIFICANCE F
16	Regression	1	130,1881	130,188	106,821	5,36224E-09
17	Residual	18	21,9374	1,2187		
18	Total	19	152,1255			

Table.5.

The value of the regression coefficient and statistical evaluation

	H	I	J	K	L	M
20		Coefficients	Standard Error	t Stat	P-value	Lower 95%
21	Intercept	62,18	1,67424	37,1390	1,822E-18	58,662531
22	X Variable1	-0,1141	0,01103	-10,335	5,362E-09	-0,137293

Using data obtained by calculating the equation of dependence of soot and injection pressure.

$$Y=62.18-0.1141 \cdot X_1 \quad (1)$$

The equation shows a decrease in injection pressure at 1 kg/cm<sup>2</sup> would increase the opacity at 0.114 %.

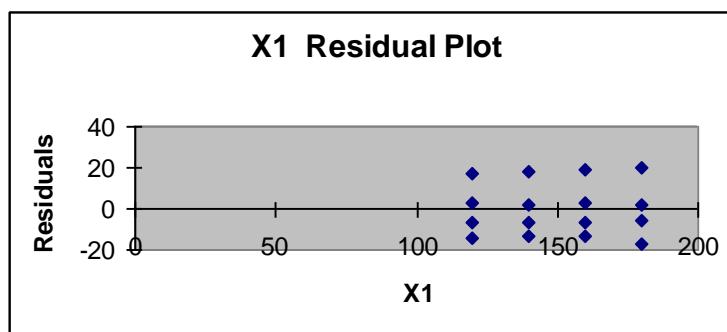


Figure 3.The dependence of the difference of the "Y" model and experiment by a factor X1

## CONCLUSIONS

1. There is a relationship between opacity and injection pressure. It is expressed by a linear equation inverse regression dependence.
3. The value of the coefficient of determination  $R^2 = 0,855$  shows 85.5% of the variation sheathe indicators expressed variation factor  $X_1$ .
4. In a diesel engine with normal technical condition at crankshaft speed  $n = 1000 \text{ min}^{-1}$  injection nozzle pressure drop of  $180 \text{ kg / cm}^2$  to  $120 \text{ kg / cm}^2$  leads to an increase in the value of soot from 4.2 .... 19.1. This is due to the deterioration of mixing due to poor fuel atomization in the combustion chamber of the engine and is explained by the incomplete combustion of physical.
5. Under free acceleration where possible the highest emissions of soot under reduced pressure injection nozzle from  $180 \text{ kg / cm}^2$  to  $120 \text{ kg / cm}^2$ , the amount of soot discharge increased from 42.1 .... 48.6 or 15.4 %.

## REFERENCES

- [1] B. Bayarsuren, "Systematic analysis of the factors influencing the exhaust gas of diesel engines" MUST, Ulaanbaatar, Mongolia, 2006.
- [2] Луканин В.Н., Трофименко Ю.В. Экологические воздействия автомобильных двигателей на окружающую среду // ВНИТИ. Итоги науки и техники. Серия. Автомобильный и городской транспорт.-Moscow, 1993, E.17. Pp. 1-136.
- [3] Annual inspection report of transportation in Mongolia, 2009.
- [4] Alin Dj.K., Work process feature and the ways improving KamAZ engine characteristics in high mountain regions. Dissertation of PhD.L.:LTSU, 1991.-19p. (in Russian)
- [5] B.Bayarsuren. Ecological estimation of quality of the diesel fuel. Academic publication of MUST, 2004, No. 5/67 (in Mongolian)
- [6] B.Bayarsuren. Research on PM of engine emission of microbus. Academic publication of MUST, 2002, No. 2/48 (in Mongolian) Proceedings of the Eastern Asia Society for Transportation Studies, Vol.8, 2011
- [7] B.Bayarsuren. Using system analisis for determining PM of diesel engine. Science and technology, 2004, No. 2. (in Mongolian)
- [8] B.Bayarsuren. N.Odbileg, B.Bayarsaihan, Factors Affecting To Automotive Exhaust PM Emissions. Academic publication of The Third International Forum on Strategic Technologies. Novosibirsk-Tomsk, Russia June 23-29, 2008.

# ON THE USE OF COAL WASTE OF ULAN-UDE CHPP-1 IN AGRICULTURE

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## ABSTRACT

*The analysis of waste utilization of Ulan-Ude CHPP-1 in agriculture was carried out: irrigation and fertilization of agricultural crops. The chemical composition of wastewater and ash of Ulan-Ude CHPP-1 is given.*

**KEY WORDS:** Sewage, irrigation of agricultural crops, ash dump, ash, slag.

## INTRODUCTION

Energy, which is the driving factor in the development of many industries and agriculture, has the highest rates of development and scale of production. In this regard, a very significant share in the pollution of the environment-waste of the energy industry - including sewage water.

Ulan-Ude CHPP-1 was put into operation in 1936, being a source of energy for residential and industrial facilities in Ulan-Ude. Part of the sewage of CHPP-1 is discharged into the Udu River. This is basically the regenerative and washing water of the water supply system, the blowing water of the boilers, the cooling water of the electrolysis plant equipment, the water from the circulation system, and the rain melt water. Discharge of sewage p. Udu leads to chemical contamination of the Lake Baikal basin [2].

The use of sewage for irrigation of crops is one of the rational ways of their utilization. Irrigation of agricultural crops with these wastewater is particularly important in connection with the

termination of discharges of polluting substances that can enter lakes, rivers and other water bodies.

Wastewater from CHPP-I is heterogeneous and consists of: 1) sewage re-used in the plant's technological cycle (2624 thousand m<sup>3</sup> / year); 2) sewage discharged into the Udu river; 3) wastewater used in the system of hydro-ash-slag removal; 4) rain and thawed waters; 5) domestic wastewater.

For agricultural use, the greatest interest is represented by wastewater discharged into the Udu river after treatment and sewage accumulated in the ash dump, from which partially excess water is diverted through the terrain in the Udu River.

Wastewater from CHPP-I, discharged in the Udu river, consists mainly of regenerative and washing waters of the water treatment plant, purge waters of the cooling water boilers of the electrolysis plant equipment.

These drains, together with rain and thawed water, are diverted to the commercial waste water treatment facilities, where after purification some of the sewage is reused in the technological cycle, and the other part is discharged into the Udu River by open discharge. The volume of sewage entering the machine shops is 335 m<sup>3</sup> / hour, and discharged into the river Udu - 95 m<sup>3</sup> / hour.

The treated wastewater recycled in the technological cycle is partially used for later use in wet ash collectors and for the hydrotransport of ash and slag [3].

The chemical composition of wastewater is presented in Table 1. The total mineralization of waste water of the old gold mine is 1331.7 mg / l, which makes it possible to classify them as slightly saline.

The reaction of water is slightly alkaline - pH 7.65-7.8. The content of hydrocarbonates is low and amounts to 61-75 mg / l. With respect to sulphates, these wastewater does not pose a threat to soil contamination and plant oppression, since the content of the SO<sub>4</sub> ion is up to 278.2 mg / l with a maximum permissible concentration of 500 mg / l, i.e. one and a half to two times less than the maximum permissible concentrations.

The chloride content in the wastewater is 318-482 mg / l. In terms of chloride content, irrigation water can pose a certain threat. Chlorides are toxic, highly mobile, the soil is not absorbed and can be washed into deeper horizons

In the cation composition of wastewater of CHPP-I of the old and new zoo, sodium predominates, the content of which is 198.2-205 mg / l, which causes a not very favorable ratio between mono- and divalent cations. The latter can determine the threat of soil alkalinization.

It should be noted and a high content of potassium - 120 mg / l, due, apparently, by dissolving nearby slags. Water-soluble potassium is the most available for plants. In soil, potassium can be fixed and transferred to an unchanged state.

The content of divalent cations is: calcium 110 mg / l. is half that of Na, and magnesium is 72 mg / l.

The beneficial value of these waters is low in the content of various forms of nitrogen (N gross 1.7 mg / l, NO<sub>3</sub> - 2.6 mg / L, NO<sub>2</sub> - 0.13 mg / L) and is significant in the content of the potassium ion (120-132.5 mg / l).

The amount of polluting specific substances is: petroleum products 0.04-0.08 mg / l phenols 0.3 mg / l. If we take into account that the MPC of petroleum products for reservoirs of domestic and drinking water use is 0.1-0.3 mg / l, in our samples they do not exceed the maximum allowable concentrations.

Such quantities of pollutants that do not exceed the MPC do not pose any hazard for soil and plant contamination during irrigation.

Table 1.

Ingredients	Place and time of selection		MPC for discharge into the tributaries of the lake. Baikal
	Old ash dump	The new ash dump	
pH	7,8	7,65	
K	120,0	131,0	5
Na	205,0	198,	120
Ca	110,0	112,4	120
Mg	72	65,1	50
HCO <sub>3</sub>	61,0	75	
SO <sub>4</sub>	278,2	209	100
Cl	482,5	318	300
NO <sub>3</sub>	2,6	2,5	5
NO <sub>2</sub>	0,13	0,09	0,02
Dry residue	1140	1110	
N <sub>o</sub> gross	1,75	n/o	
K gross	132,5	Ho	
Petroleum products	0,037	0,08	

The waters of the new and old ash dump contain a certain amount of trace

elements and heavy metals, however, no special differences in the elements are observed.

It can be noted that the content of nickel, copper, vanadium, titanium, manganese is somewhat higher in the waters of the new ash dump, and the content of strontium and lithium is higher in the waters of the old ash dump. For all other investigated ingredients (cobalt, zinc, chromium), the quantitative content of these elements is identical.

The main pollutants among heavy metals and the most toxic are copper, zinc, chromium, nickel, cobalt. Co. As shown by the results of the studies (Table 3.2), the concentration of these elements is much lower than the MPC. This is a positive fact. Practically, the content of heavy metals in the waters of new and old goldfish does not limit the possibility of using them for irrigation of agricultural crops.

Table 2.

Results of spectral analysis of wastewater

Indicators	The new ash dump	Old ash dump
Fe	0,9	0,59
Ni	<0,002	0,014
Co	<0,002	0,002
Cu	0,014	0,011
V	0,027	0,007
Mo	not detected	not detected
Ti	0,043	<0,005
Pb	0,012	H.o
Mn	0,280	0,210
Zn	0,020	0,022
Cr	0,002	0,002
Sr	2,2	3,4
Li	0,35	0,060
Ag, Ga, Te, Sb, Cd, Bi, Sn, Be not detected		

From the above, it can be concluded that the waste water of the old and new ash dumps at Ulan-Ude CHPP-1 are characterized by a total mineralization of up to 1.3 g / l, a weak alkali reaction (pH 7.8), sulfates of 278 mg / l, hydro carbonates 61-75 mg / l, chlorides 318-480 mg / l, calcium 112 mg / l, sodium 198-205 mg / l, potassium 120-131 mg / l. According to the chemical composition and irrigation assessment, sewage can be used for irrigation of crops.

The content of heavy metals in the waters of new and old ash dumps does not exceed the established MPC when used for irrigation of agricultural crops.

In the case of land reclamation by sewage, it is necessary to have a clear idea of how it can change the nutrient and water-salt regimes of irrigated soil, and also to provide for environmental changes in this area.

In connection with this, studies were carried out on the changes in the soil, the natural environment, on possible changes in the soil under the influence of melioration. Otherwise, increasing the

yield during reclamation in the first years, it is possible to reduce the fertility of lands with improper use of sewage (in the particular case of sewage lake in the new ash dump).

As a result of the research, it was found that irrigation by sewage of CHPP-I did not have a negative influence on the nutrient and salt regimes of irrigated soil in comparison with the non-poured virgin land. Irrigation led to a slight increase in the content of humus and ammonia nitrogen. There is a tendency to increase the salt accumulation in the irrigated area. The content of water-soluble salts in the soil of the irrigated area is small and does not pose a danger to agricultural crops. cultures [1].

The waste of the Ulan-Ude CHP is also the slag formed after burning coal. At the present time, a shortage of free capacity for storage of ash and slurry and high quality pulp deposits is very acute on the old ash-and-slag-pit. The ash dump is overcrowded and for the subsequent storing at the old ash-and-slag-pit it is necessary to exceed the limits of about 50

thousand m<sup>3</sup> of ash and slag. The new ash-and-slag-pit is of ravine type, unfiltered. The project area is 102 ha, the filling volume is 8 mln.m<sup>3</sup>. Thus, both at the old and the new ash dumps, there has been accumulated a lot of ash and slag materials. In this connection, the issue of efficient use of ash (if possible, slag) from two ash dumps [4].

Ash is a mineral residue formed by burning coal and is a phosphorus-potassium fertilizer. The soil contains also various trace elements, chlorine is absent. Potassium in the ash is in the form of a carbonate salt ( $K_2CO_3$ ) - potassium. This form of potassium is good for all crops, and for plants sensitive to chlorine (potatoes, buckwheat, tobacco, lupine, vine, etc.), it is better than raw salt-potassium potassium salts and often exceeds potassium chloride.

The amount of potassium in the ashes of different coals is somewhat different, but does not exceed 1%. Phosphorus in ash is lower compared to potassium, but it is assimilated by plants no worse than from precipitate and thomaslag, and unlike superphosphate it is not subject to strong binding in acidic soils to compounds that are difficult to reach.

The chemical composition of slag ash is presented in Table 3. The ash of slag from CHPP-1 of old and new gold mines contains an insignificant amount of total nitrogen 0.023-0.035%, phosphorus 0.22-0.27% (or 220-265.6 mg per 100 g of ash) and potassium 0.7-1% (or 672-1020 mg per 100 g of ash).

The sol contains also mobile Ca, Mg, and Na. The sodium content is negligible and amounts to 0.16-0.4 mg-eq per 100 g of ash. Magnesium in the ashes of slag is small, its content does not exceed 2.5 mg-eq per 100 g. However, the

presence of a low amount of magnesium in the ash slag will play an important role necessary for the normal growth of plants. Magnesium is a part of chlorophyll and takes a direct part in photosynthesis. With a lack of magnesium in the soil, the chlorophyll content in the green parts of the plant decreases, oxidation processes increase, peroxidase activity increases, the sugar and ascorbic acid content decreases.

Calcium in the ash is heavier and its content varies depending on the site of selection (from 10 to 17.5 meq per 100 g of substance). The content of lime in the ash ( $CaCO_3$ ) in combination with potash ( $K_2CO_3$ ) eliminates the negative effect of the latter on the soil structure. Therefore, the content of calcium in the sol is a valuable component.

Calcium is necessary for the normal development of the aboveground organisms and plant roots. With a lack of this element, their development slows down. The role of calcium in plants is closely related to photosynthesis. When there is a lack of calcium, leaf growth stops, the leaves die. It enhances the metabolism in plants, plays an important role in the movement of carbohydrates, affects the transformation of nitrogenous substances, is essential for the construction of normal cell membranes and for establishing favorable acid-base balance in plants.

Thus, the content of potassium, phosphorus and calcium in the ash is subject to fluctuations depending on the site of selection (old and new goldfish), as well as the time of selection (autumn, summer, spring).

A valuable component of ash are trace elements (up to 0.06%), manganese and others.

Table 3.

Chemical composition of ash slag

Place of selection	Gross,% mg per 100 g of substance			Movable, mg / 100 g		Exchange, meq / 100 g		
	Азот N	$P_2O_5$	K	$P_2O_5$	K	Ca	Mg	Na
Old ash dump	0,035	0,22/220,0	1,02/1020	36,75	85,2	17,5	2,5	0,47
The new ash dump	0,023	0,27/265,6	0,67/671,9	7,6	67,5	10,0	2,5	0,16

At present, there is a real danger of soil contamination with heavy metals. One of the pollutants of the soil are agrochemicals (fertilizers, pesticides and other substances). When high doses of mineral fertilizers are applied, a large number of ballast substances containing trace elements and heavy metals in addition to those necessary for agricultural plants are introduced into the soil.

Due to the fact that ash is considered in the long term as a potassium phosphate fertilizer, it seems to us necessary to analyze the ashes for heavy metals and metalloids, the content of heavy metals and metalloids in the slag ash of CHPP-1 is shown in Table 4.

Table 4.

The content of heavy metals and metalloids in the slag ash of CHPP-1, (item 10-3%)

Element	Old ash dump	The new ash dump
Ba	150	150
Be	0.4	0.2
Pb	1.5	1.5
Sn	0.25	0.2
Ti	400	320
W	0.8	0.5
Mn	120	150
Na	1.5	1.5
Ca	1.2	1.2
Cn	8	8
Ni	3.2	2.5
Bi	0.1	0.1
Co	2.5	2.0
Mo	2.5	1.2
Cu	5	3.2
Zn	10	8
Zr	32	20
Cd	0.4	0.4
V	2.5	2
La	2	2
Ce	3.2	3.2
P	120	100
Sr	80	63
Sc	2.5	1.5
Hg	1	1
As	6.3	6.3

The obtained data on the content of microelements and heavy metals in slags showed that there were no characteristic differences in the quantitative and qualitative composition of the selection on the old gold mine.

Thus, despite some differences in the elements in the ashes of the old and

new ash dump, it is necessary to ascertain the fact that the quantitative content of heavy metals and metalloids in the slag ash of CHPP-1 is small and does not pose a danger to soil contamination, with the introduction of slags.

## REFERENCES

1. Borisenko LV, Semenova TL Hydrogeological and meliorative conditions of central Buryatia (on the example of the Gusinoozero depression). In the book Hydrogeological meliorative conditions of the Western Transbaikalia. Ulan-Ude, 1983.
2. Dambiev Ts.TS. Improvement of technical and economic and environmental performance of Ulan-Ude CHPP-1 based on energy audit results / Dambiev Ts.TS. [and others] // Energetik.: M. No. 2. 2015. P. 27-28.
3. Dambiev Ts.TS. Environmental indicators of Ulan-Ude CHPP-1 based on energy audit / Dambiev Ts.TS. [and others] // Energy: efficiency, reliability, security. Proceedings of the XIX All-Russian scientific and technical conference with international participation, 12/6/2013 S. 194-197.
4. Tyskineeva I.E. Ecological and Economic Aspects of Energy in Buryatia: Analytical Review / Tyskineeva IE, Dambiev TS.// Fundamental Research .. № 9-2. 2014. P. 252-255.

## YIELD MAPPING OF A CITRUS ORCHARD

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### ABSTRACT

*In this study yield mapping was plotted for an automatic yield monitoring system. Two kinds of yield mapping were plotted in this paper: 1) Yield mapping for early yield monitoring, 2) Yield mapping prior to harvest. The citrus field, which is located in Gwangnyeong 1-ri, Aewol-eup of Jeju Island was used for developing a yield mapping system in citrus fruits. A total of 21 sample tree images were taken during the months of May, and November by camera in the citrus field. Two different sets of data were used in the yield mapping for the 21 sample trees: a) Yield estimation data by the total number of flowers, which was developed in [13], b) Yield estimation data by the total number of citrus fruits, which was composed in [17].*

**KEY WORDS:** Yield Mapping, Citrus Fruits, Yield Monitoring, Computer Vision, Image Processing

### 1. INTRODUCTION

Precision agriculture, sometimes called site-specific agriculture is a management philosophy that responds to spatial variability, found on agricultural landscapes. Steps involving precision agriculture include determining yield variability in a field, determining its cause, deciding on possible solutions based on economic justification, implementing new techniques and repeating the procedure using a cyclical approach. Yield mapping

is foremost step in precision agriculture to implement site-specific crop management on a specific field. Yield mapping can provide valuable information for forecasting yields, planning harvest schedules and generating alternate bearing year prescription maps and other management practices. As noted, an early prediction of expected yields has always been a major challenge in agriculture.

A large number of yield mapping systems

have been investigated and developed for various fruits and crops including blueberries, cereals, grains and cottons, crops, almonds, peanuts, sugarcanes, coffee and citrus [1-13] over the last two decades.

Yield mapping for citrus has been conducted prior to harvesting time [1, 3, 4, 6, 8, 10, 17], during or after harvesting time [2, 4, 5], or in the early season, when citrus flowers are blooming [11-13].

Jeju is main citrus producing province in South Korea. Survey research in citrus yield monitoring has been investigated by the Jeju Citrus Commission and the Jeju Special Self-Governing Province Agricultural Research & Extension Services every year for three times during the months of May, August, and November [14-16]. For example, in 2013, for 15 days from the 6th of May onwards an agricultural research survey was carried-out in 458 locations on Jeju Island by 112 researchers and 224 assistants [15]. During this survey research a representative sampling of tree flowers were counted, not all tree flowers. Up to now, on Jeju Island, citrus yield monitoring operations have been conducted only through human vision.

## 2. OBJECTIVES AND METHODOLOGY

A specific objective of this study is to plot yield mapping for an automatic yield monitoring system. Two kinds of yield mapping were plotted in this study.

1. Yield mapping for early yield monitoring

2. Yield mapping prior to harvest

For developing a yield mapping system in citrus fruits, the citrus field, which is located in Gwangnyeong 1-ri, Aewol-eup of Jeju Island. A total of 21 sample tree images were taken during the months of May, and November by camera in the citrus field.

Two different sets of data were used in the yield mapping for the 21 sample trees:

- a. Yield estimation data by the total number of flowers, which was developed in [13]
- b. Yield estimation data by the total number of citrus fruits, which was composed in [17]

Color detection, counting algorithm of the tangerine (citrus) flowers under various

The main drawbacks of manual surveys using human vision are the large in number labourers needed, the intensity of labour involved, the amount of time required and high capital outlays. As well, a margin of error may also be evident due to the limited number of trees included in such research as well as other factors including the incidence of natural calamities.

In order to overcome tangible disadvantages of vision based research, including inaccuracy, inefficiency, time intensity, and financial expenditures, an automated yield mapping system in citrus fruits is hereby proposed in this paper. The main goal of this paper, which is in line with our previous research [10-13] is to work towards the development of an automated yield mapping system by using color component information of citrus flowers, and fruits.

This paper is arranged as follows: Chapter 2 explains the objectives and newly proposed methodology in detail. Chapter 3 presents performance evaluations and discussions on the experimental results. In chapter 4 the conclusions are presented.

natural lighting conditions and estimate yield of fruits was developed in [13]. As a result, total of 1340 sub images of tangerine flowers were detected by the newly introduced algorithm from a sample of 21 tangerine trees during blooming season. A Gaussian filter was used to reduce noise and illumination adjustment as much as possible for better clarity to identify exactly the tangerine flowers.

An effective, simple, aptly computer vision algorithm to detect and count citrus on the trees using hybrid-watershed transform, to estimate the yield was composed in [17] and compared the yield estimation results obtained through several methods. This citrus recognition and counting algorithm was utilized the color features (or schemes) to present an estimate of the citrus yield, and the corresponding models are developed to provide an early estimation of the citrus yield. The counting algorithm were tested on 84 images which were collected from 21 trees. The citrus

counting algorithm consisted of the following steps: convert RGB image to HSV, thresholding, orange color detection, noise removal, watershed segmentation, and counting. Distance transform and marker-controlled watershed algorithms were evaluated for automated watershed segmentation in citrus fruits to obtain good result.

Prior to yield mapping, data were grouped for each case as per the following rules: Table 1 illustrates the rule for yield estimation data by the total number of flowers, which were presented in [13]. The rule for yield estimation data by the total number of citrus fruits, which were developed in [17] is shown in Table 2.

Table 1.

The rule for yield estimation data by the total number of flowers

Color Mark	Limits for Number of Flowers	Group
	2500 ≤ Flowers	5
	2000 ≤ Flowers < 2500	4
	1500 ≤ Flowers < 2000	3
	1000 ≤ Flowers < 1500	2
	Flowers < 1000	1

Table 2.

The rule for yield estimation data by the total number of citrus fruits

Color Mark	Limits for Number of Citrus Fruits	Group
	1000 ≤ Fruits	5
	900 ≤ Fruits <1000	4
	800 ≤ Fruits <900	3
	700 ≤ Fruits <800	2
	Fruits<700	1

### 3. RESULTS AND DISCUSSION

There two kinds of yield mapping in citrus fruits were plotted in this research. Table 3

provides the grouped data used in this paper.

Table 3.

Data Using for the Yield Mapping

Tree Number	by Citrus Fruit Counting Algorithm Result [17]			by Flower Counting Algorithm Result [13]		
	Number of Citrus Fruit	Color Mark of the Group	Group	Number of Flowers	Color Mark of the Group	Group
1	904		4	3381		5
2	788		2	1934		3
3	577		1	774		1
4	592		1	1315		2
5	646		1	1436		2
6	921		4	3552		5
7	868		3	2203		4
8	612		1	1329		2
9	676		1	1449		2
10	759		2	1768		3
11	902		4	2852		5
12	738		2	1664		3
13	839		3	2120		4
14	893		3	2581		5
15	801		3	2073		4

16	874		3	2379		4
17	891		3	2480		4
18	626		1	1435		2
19	723		2	1616		3
20	1214		5	4657		5
21	875		3	2418		4

Two kinds of yield mapping were plotted by yield estimation data from results in [13, 17]. Figures 1 and 2 provide the illustrated plots of the yield mapping.

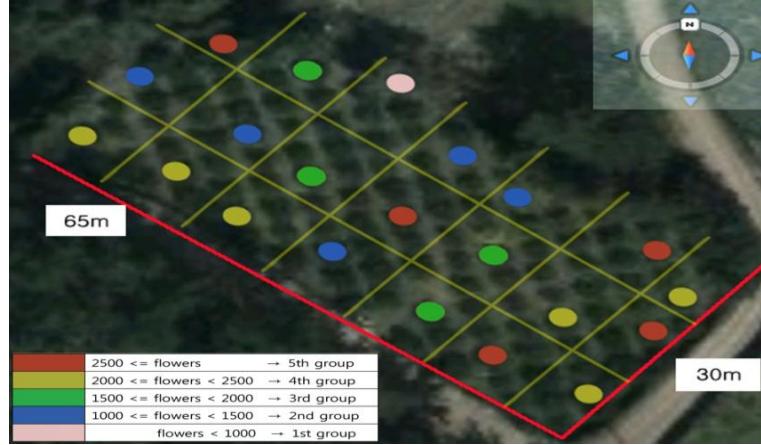


Figure 1. Yield Mapping Using Data of the Total Number of Flowers (As Presented in [13])

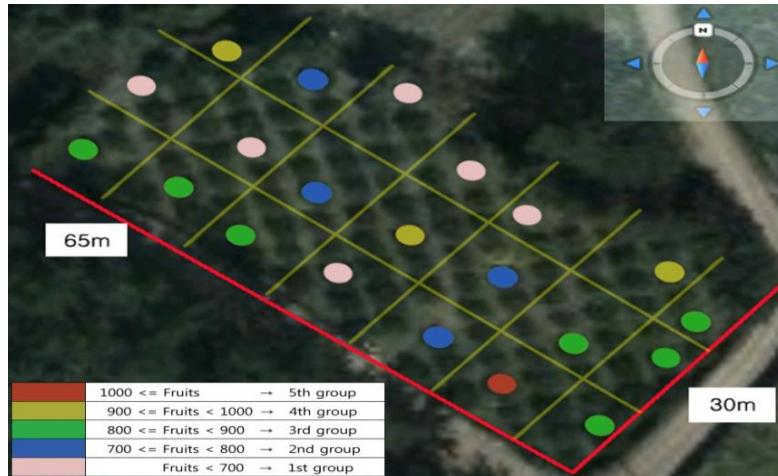


Figure 2. Yield Mapping Using Data of the Total Number of Citrus Fruit (As Presented in [17])

#### 4. CONCLUSIONS

In this study two kinds of yield mapping for an automatic yield monitoring system were plotted by using two different data sets for the 21 sample trees: 1) Yield mapping for early yield monitoring, and 2) Yield mapping prior to harvest.

If there are too many flowers blooming on a single tree, it is not suitable for a high quality yield, because citrus may end being too small for the market. As well, if the total harvest is too high prices may drop since the market for citrus fruit in

Korea is limited. Therefore yield monitoring in a timely fashion is both highly justified and relevant.

## 5. ACKNOWLEDGMENTS

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## REFERENCES

1. Schueller, J. K., J. D. Whitney, T. A. Wheaton, W. M. Miller, and A. E. Tunner. 1999. Low-cost automatic yield mapping in hand-harvested citrus. In Computers and Electronics in Agriculture 23(2): 145-153.
2. J.D.Whitney, Q.Ling, W.M.Miller, T.A.Wheaton. A DGPS Yield Monitoring System for Florida Citrus. Applied Engineering in Agriculture. Vol.17 (2): 115-119, 2001.
3. Palaniappan Annamalai,. Won Suk Lee.: Citrus Yield Mapping System Using Machine Vision. An ASAE Meeting Paper. 2003. Paper No 031002.
4. Palaniappan Annamalai.: Citrus Yield Mapping System Using Machine Vision, A Thesis Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Master of Science. 2004
5. Tony Grift, Reza Ehsani, Kentaro Nishiwaki, Catherine Crespi, Min Min. Development of a Yield Monitor for Citrus Fruits. An ASABE Meeting Presentation, Paper Number: 061192, UIUL Number: 2006
6. Donald, K. MacArthur., John, K. Schueller., Won Suk Lee., Carl, D. Crane., Erica, Z. MacArthur., Lawrence, R. Parsons.: Remotely-Piloted Helicopter Citrus Yield Map Estimation. An ASAE Meeting Paper. 2006. Paper No 063096. [18]
7. Chinchuluun.R., Won Suk Lee.: Citrus Yield Mapping System in Natural Outdoor Scenes using the Watershed Transform. An ASAE Meeting Paper. 2006. Paper No 063010. [26]
8. Chinchuluun.R, Won Suk Lee., Reza Ehsani.: Citrus Yield Mapping System on a Canopy Shake and Catch Harvester. An ASAE Meeting Paper. 2007. Paper No 073050.
9. Chinchuluun, R., Machine Vision Based Citrus Yield Mapping System on a Continuous Canopy Shake and Catch Harvester, A thesis for the degree of Master, University of Florida, 2007.
10. Ulzii-Orshikh Dorj, Malrey Lee, S. Han, "A Comparative Study on Citrus Detection, Counting and Yield Estimation Algorithm", International Journal of Security and Its Applications, Vol. 7, No.3, 2013, pp. 405–412.
11. U.-O. Dorj, M. Lee, D. ul Imaan., "A New Method for Citrus Tree Flower Recognition", Computer Applications for Bio-technology, Multimedia, and Ubiquitous City, 353 (2012) of the series Communications in Computer and Information Science, pp 49-56, Proceedings of International Conferences MulGraB, BSBT and IUrC 2012 Held as Part of the Future Generation Information Technology Conference, FGIT 2012, Gangneug, Korea, December 16-19, 2012.
12. Ulzii-Orshikh Dorj, Keun-kwang Lee, Malrey Lee. A computer Vision Algorithm for Tangerine Yield Estimation, International Journal of Bio-Science and Bio-Technology Vol.5 No.5 October 2013, pp.101-110.
13. Ulzii-Orshikh Dorj, Malrey Lee, K.-K. Lee, G. Jeong, "A Novel Technique for Tangerine Yield Prediction Using Flower Detection Algorithm", International Journal of Pattern Recognition and Artificial Intelligence", Vol. 27, No.5, 2013, pp. 1354007 (1-25).
14. Agricultural Advisory Service Report, Tech. rep., "Jeju Special Self-Governing Province", Agricultural Research & Extension Services, 2015.
15. Agricultural Extension Services Report, Jeju-do Agricultural Research and Extension Services, 2013, [www.agri.jeju.kr](http://www.agri.jeju.kr) (제주특별자치도농업기술원, 농촌지도사업보고서, 2011년도, [www.agri.jeju.kr](http://www.agri.jeju.kr))
16. Survey investigation result in outdoor growing citrus. Jeju-do Agricultural Research and Extension Services, 2011, [www.agri.jeju.kr](http://www.agri.jeju.kr) (제주특별자치도농업기술원, 2011년 노지감귤 관측조사 위원회 운영, [www.agri.jeju.kr](http://www.agri.jeju.kr))
17. Ulzii-Orshikh Dorj, Malrey Lee. "An Yield Estimation in Citrus Orchards via Fruit Detection and Counting using Image Processing", Computers and Electronics in Agriculture, 2017.5.19, DOI:10.1016/j.compag.2017.05.019

# **ARCHITECTURE AND STRATEGY FOR MANAGING THE SMART HOME SYSTEM FOR A RURAL HOUSE**

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## **ABSTRACT**

*The article summarizes the first experience of the practical construction of the Smart Home system, which takes into account the peculiarities of the operation of residential buildings in rural areas. The basic functional modules of the "Smart home" system of a modern rural house are substantiated and the architecture of the system is developed, which allows ensuring reliable exchange of information and its safety. The developed management strategy is based on the principle of "compulsory centralization". The main principle embodied in the proposed strategy, ensuring maximum reliability of the system in the event of failure in power supply and telecommunications systems. On the example of two functional modules (a street light control and a weather station), the principle of constructing the hardware part of the device using modern systems on a chip and the protocol of their interaction with the managing server are shown.*

**KEYWORDS:** Smart house, Smart home, automation.

## **INTRODUCTION**

Technical progress offers many new technologies that somehow change the world around them. One of the typical examples can be considered the development of automation systems in everyday life of a person, in his home. To be more precise, attempts at automation have been made for a long time, not only household appliances, but also more

complex systems, such as climate control in the room, lighting control, security systems and others. The current stage of development is characterized by the introduction of new technologies that allow to unite various systems into a single information field and make available hardware with large computing resources (microcontrollers, systems on a chip, etc.).

## **FORMULATION OF THE PROBLEM**

The author's analysis of the market for manufactured products for "Smart home" systems shows that most of the tasks for which they are directed can be attributed to one of the categories:

- Control of access to the premises (security systems);

- Climate and lighting control (comfort systems);
- Management of household appliances.

This set of tasks is fully justified when building a "Smart home" system for a city apartment, and is clearly not enough when

building automation systems for a rural manor.

Consider what the main differences are.

First, it is the presence in the rural home of complex engineering systems: water supply system, heat generation and distribution system, hot water supply system, sewerage system, power supply system. Unlike a city apartment, where these same systems are built on other principles and are serviced by external organizations, they are operated and serviced independently in a rural house, and they should be the primary object of automation.

Secondly, as a rule, this is the availability, homestead farming. Automation

of this type of activity in a rural mansion is also of great interest, both in terms of reducing labor costs for farming, and improving the quality of management and productivity.

Other important factors that need to be considered when building Smart Home systems for a rural manor are:

- Low reliability of power supply;
- Spatial distribution of automation objects;
- Harsh climatic conditions in the operation of automation devices.

The totality of the differences presented in the work allows us to formulate the main principles of building the "Smart home" systems for a rural manor in the future.

## THE ARCHITECTURE OF THE "SMART HOME" SYSTEM FOR A RURAL MANOR

The architecture of the "Smart home" system for a rural manor is shown in Fig. 1. As the communication channels of the system modules with the central server, the use of the Wi-Fi standard is suggested. This solution is due to the availability on the market of inexpensive systems on the ESP8266 chip, which have built-in support

for this standard and the ability to use widespread equipment for Wi-Fi networks. As servers of the system, you can use inexpensive single-board computers, for example, Raspberry Pi, which do not require the use of noisy cooling systems and consume a small amount of electricity.



Figure 1. The architecture of the "Smart home" system for a rural manor

To reserve data and obtain information from the system via the Internet, the architecture provides for the use of cloud services. Modern services of this kind allow not only to accumulate data, but also

organize feedback to the system, have tools for analyzing and visualizing the information received.

The interface part of the system is traditionally built using smartphones, tablets

or workstations. The software issue can be solved in a variety of ways, for example, writing your own programs, using free software or using cloud services.

Critical automation sites can have additional operational communication channels with the user using 3G technology. For example, the module for monitoring the

water temperature in a street water pipe while fixing the minimum permissible temperature can promptly transmit information to the user on the phone in the form of SMS or a call to the number. In this example, the cost of efficiency is justified, because A further decrease in temperature will lead to a disruption of the water supply.

## MANAGEMENT STRATEGY IN THE "SMART HOME" SYSTEM FOR A RURAL MANOR.

The introductory part of this work was devoted to the need to ensure increased reliability of the system operation, in a number of cases it is responsible for critical processes in the engineering networks of a rural manor. In the developed control strategy, mutual control is supposed between the system modules and the server. Let us consider this principle in more detail.

Each module of the system has an autonomous control algorithm, however in normal operation mode the module periodically checks its parameters with parameters defined on the central server of the system. In the event that the module

does not receive a response from the central server, it switches to an autonomous control algorithm, periodically accessing the server to verify its operability, and in the event of a server response, again goes to centralized management (the principle of "forced centralization"). In the modules responsible for critical processes in engineering networks, devices are being built to organize an operational communication channel using 3G technology.

In turn, the server monitors the operation of all modules of the system, and in cases of detection of problems, transmits information to the user.

## AN EXAMPLE OF CONSTRUCTION AND INTERACTION OF TWO MODULES OF THE SYSTEM

Let's consider an example of building modules of the system "Smart home" for the automatic control of street lighting and weather stations. The lighting control module has a simple task of switching the lighting device on and off depending on the

natural light, but in addition to this function, the device has the ability to detect a malfunction in the power circuit, for example, the failure of the lighting device. The block diagram of the device is shown in Figure. 2.

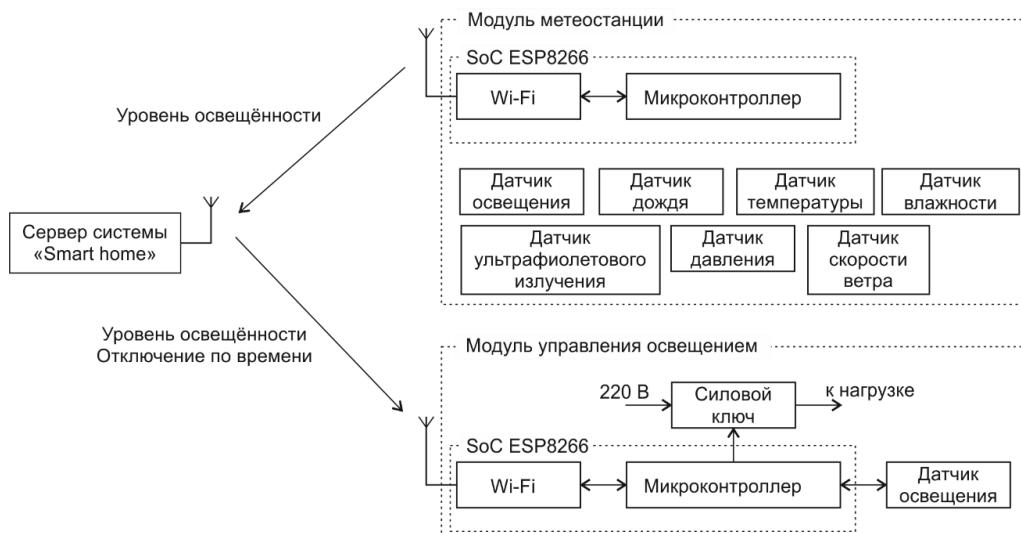


Figure 2. Example of building two modules of the system

The module is implemented on the basis of a system on a chip (SoC) ESP8266 and a digital light sensor BH1750. The design features of this module do not always allow you to get the exact value of natural light. In this case, it is possible to use the illumination values obtained with the measurements made by the weather station.

The weather station module has a large number of sensors (Figure 2),

including an illumination sensor that measures the light flux directly from a given direction of the sky. The information is transmitted to the server of the system, where a decision is made to turn the lighting on or off. During daylight hours, the light module is put into sleep mode. In the event that the lighting module does not detect a running server, it goes to the built-in algorithm of operation.

## CONCLUSION

The paper outlines the characteristic features of building "Smart home" systems for a rural manor, suggests the architecture of building such a system and gives an example of the construction and interaction of two modules. Currently, the first version of the system is under trial and the server software is updated.

## **APPLICATION OF AUTOMATED SYSTEMS FOR ACCOUNTING ELECTRIC ENERGY IN THE RESIDENTIAL SECTOR OF RUSSIA**

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### **ABSTRACT**

*The article compares the effectiveness of the application of automated metering systems of three Russian manufacturers; the calculation uses the methodology for calculating the economic efficiency of introducing automated metering systems for electricity in the municipal sector.*

**KEYWORDS:** Automated electricity metering systems, economic efficiency, tariffs, electricity metering devices.

### **INTRODUCTION**

After the elimination of the existing cross subsidization in Russia and bringing tariffs for electricity from household consumers to the level of production costs, their share in the balance of revenues of marketing companies significantly increases. At the same time, the problems of non-payments and theft of electric power are exacerbated.

World experience shows the necessity of applying special measures to increase the level of collection of payments from the

population; such as, for example, the organization of remote automated readings from meters; automation of billing, etc. In many countries with a developed market economy, similar problems of energy sales organizations are also solved by the introduction of automated systems for accounting for electrical energy (ASUE). In the world practice, similar systems have the designation "AMR systems" (Automatic meter reading (AMR) - automatic meter reading system).

### **FORMULATION OF THE PROBLEM**

The use of ASUE in the residential sector of Russia is most expedient for the construction of new residential buildings. More than a dozen Russian manufacturing plants produce electronic energy meters

and other equipment needed to build the ASUE [1].

The range of output of these plants is so great that at present it is difficult for a consumer to decide not only with the manufacturer of ASUE, but with the option

of constructing a structure for the collection and transmission of information. Only a qualitative technical and economic comparison of several options can help to find the optimal balance between price and quality.

When introducing one of the types of automated metering system in the municipal sector (multi-apartment houses, rural

dwellings, cottages, etc.), the losses of electricity are significantly reduced due to accurate accounting and control, the costs associated with the theft of electricity are drastically reduced, as well as the labor costs for the controlling functions of organizations that carry out electricity supply are reduced.

## METHOD OF CALCULATION

The methodology for calculating the economic efficiency of the introduction of automated systems for the accounting of electrical energy in the public utility sector is as follows:

1) Investments in the electricity metering system are determined, rub:

$$KASUE = KOB + KM + CRC, \quad (1)$$

Where KOB - the cost of equipment, rubles; KM - installation costs, rubles; CRC - other costs, rub.

The cost of a set of equipment is determined depending on the manufacturer. Let's make calculations of economic efficiency of three variants of ASUE: "Energomera"; Beltelekart-M (Belarus); Smart IMS Matrix (Intellect LLC, Korolev, Moscow Region). The initial information on the cost of equipment is presented in Tables 1-3.

Table 1.

Cost of ASUE "Energomera"

Name of equipment	Amount	Cost per unit, rub.	Total cost, rub.
CE-101, 230B 5-60A	120	1400	168000
CE-303-S7, 380B 5-60A	3	5000	15000
Splitter RS-485	60	612	36720
УСПД 164-01М	8	2340	18720
GSM-modem Siemens MC35i	1	4990	4990
Cable RS485	432	25	10800

Table 2.

Cost of the equipment of ASUE Beltelekart-M

Name of equipment	Amount	Cost per unit, rub.	Total cost, rub.
Counter CTK1-10.BU1t	120	1800	216000
Counter CTC-565/5-400	3	3850	11550
Interface splitter РИ-485П	80	380	30400
Adapter-multiplexer УСПД 32.485	1	1676	1676
GSM-modem Siemens MC35i	2	5160	10320
Cable НВПЭ 4x2x0,52 5e	4320	11,5	49680

Table 3.

The cost of the equipment of the ASUE Smart IMS (Matrix)

Name of equipment	Amount	Cost per unit, rub.	Total cost, rub.
Counter -NP523.20D 220V,5-60 A	80	3700	296000
Counter -NP 545	3	6000	18000
Router RTR-512	1	620	620

The installation costs are determined by the local estimate. To simplify the calculations, CMs are taken equal to 10% of the cost of equipment, and other costs are taken equal to 5% of the cost of equipment. Annual operating costs for ASUE are determined by the formula, rubles / year:

$$И = IAM + ИТР + ИОТ + ИПР, \quad (2)$$

Where IAM - depreciation, rubles / year; ITR - deductions for current repairs, rubles / year; IOT - costs of labor payment, rubles / year; IPR - other deductions (take 5% of the amount of IA, ITR and IOT), rubles / year.

Depreciation deductions take into account the compensation of fixed assets in the process of wear and tear of equipment and determined by the formula:

$$IAM = KACУЭ · α, \text{ rubles / year}, \quad (3)$$

Where  $α$  is the depreciation rate,  $α = 5\%$ .

The deductions for current repair and maintenance are determined by the formula:

$$MFI = KASUE · αTP, \text{ rubles / year}, \quad (4)$$

Where atr - norm of deductions for current repairs,  $αTP = 10\%$ .

Costs for labor payment are determined by the formula:

$$ИОТ = TC · t · k1 · k2 · k3, \text{ rubles / year} \quad (5)$$

Where TC - the tariff rate of the electrician serving the ASUE, rubles / hour; t - fund of working hours necessary for maintenance of ASUE, h / year; k1 - the northern coefficient,  $k1 = 1,3$ ; k2 - rayon coefficient;  $k3 = 1,3$ ; k3 - the coefficient, taking into account the deductions for social needs,  $k2 = 1,3$ .

Other deductions are determined by the expression:

$$IPR = (IAM + ITR + IOT) · 0.05, \text{ rubles / year}. \quad (6)$$

The annual energy consumption by subscribers of residential houses will be:

$$EGROD = WKB · n, \text{ kWh}, \quad (7)$$

Where  $WKB$  is the average annual electricity consumption per apartment, kWh;  $n$  is the number of apartments, pcs.

Possible reduction of energy losses in the electrical network of 0.38 kV is:

$$ESTETI = KPOT · EGOD, \text{ kWh}, \quad (8)$$

Where  $KPOT$  is the coefficient of possible reduction of electric energy losses in the 0.38 kV network.

The cost of covering the costs for consumed electricity for the year will be:

$$IGOD = EGROD · T, \text{ rubles / year}, \quad (9)$$

Where  $T$  - tariff for electricity, rubles / kW · h;

The expected additional income due to improved accounting and control over electricity consumption will be:

$$IEC = ESTETI · T, \text{ rubles / year}. \quad (10)$$

The economic efficiency of ASCS will be determined:

$$E = ISP + REC, \text{ rubles / year}, \quad (11)$$

Where  $IZP$  - Wages of the controller of the sales organization, rubles / year.

The payback period of the ASUE is determined by the expression:

$$CURRENT = KASUER / (EI) \square TINV, \text{ year}, \quad (12)$$

Where  $TINV$  - payback period, taking into account the normative coefficient  $EH = 0.2$ , is 5 years.

The main parameters for calculating the economic efficiency of introducing accounting systems of three types are given in Table 4.

Baseline data for calculating the economic efficiency of ASUE

Depreciation rate, $α$ , %	5
Norm of deductions for current repairs, $α_{TP}$ , %	10
Norm of deductions for current repairs, TC, rubles./ hour	66
Fund of working hours necessary for maintenance of ASUE, t, hour / year	10
Average annual electricity consumption per apartment, $W_{KB}$ , kW · h / year	3000
Number of apartments, $n$ , шт.	150
Annual energy consumption by residential users, $W_{KB}$ , kWh · h / year	450000
Tariff for electricity, $T$ , rubles / kW · h	0,92
Coefficient of reduction of energy losses, $KPOT$	0,1

Based on the above procedure, the results shown in Table 5 were obtained.

Table 5.

## Technical and economic comparison of the implementation of ASUE

Indicators	"Energomera"	Beltelekart-M	Smart IMS (Matrix)
Cost of ASUE, $K_{ОБ}$ , rubles	254230,0	319626,0	314620,0
Cost of installation, $K_M$ , rubles	25423,0	31962,6	31462,0
Other costs, $K_{ПР}$ , rubles	12711,5	15981,3	15731,0
Investments, $K_{ASUE}$ , rubles	292364,5	367569,9	361813,0
Depreciation deductions, $\mathcal{N}_{AM}$ , rubles / year	14618,2	18378,5	18090,7
Deductions for current repairs, $\mathcal{N}_{TP}$ , rubles / year	29236,5	36757,0	36181,3
Labor costs, $\mathcal{N}_{OT}$ , rubles / year	2175,0	2175,0	2175,0
Other deductions, $\mathcal{N}_{PP}$ , rubles / year	2301,5	2865,5	2822,3
Annual operating costs, $\mathcal{N}$ , rubles / year	48331,2	60176,0	59269,3
Savings on payment for electricity $\mathcal{N}_{ЭК}$ , rubles / year	62100,0	62100,0	62100,0
Salary of the controller of the sales organization, attributable to the houses serviced by ASUE, $\mathcal{N}_{зп}$ , rubles / year	85000,0	85000,0	85000,0
Economic effect, $\mathcal{E}$ , rubles / year	147100,0	147100,0	147100,0
Payback period, $T_{OK}$ , rubles	3,0	4,2	4,1

**CONCLUSION**

Thus, when comparing three automated metering systems from different manufacturers, the Energomera Concern system is most effective, with a payback period of 3 years. In the context of minimizing costs, the introduction of IT technologies makes it possible to reduce some calculations to a minimum, and sometimes to accelerate them. Therefore, the production, implementation and use of such systems as ASUE is considered topical and in demand. Such systems help to optimize energy costs and achieve the necessary savings for all energy users, both suppliers and consumers.

**REFERENCES**

1. Khusnudinova EA Application of AIIS KUE for various types of agricultural consumers: dis. Master of Science / EA Khusnudinova; Irkutsk State University. - Irkutsk, 2015 - 87 p.

## ELECTRO PHYSICAL CHARACTERISTICS OF MECHANICALLY ACTIVATED CEREALS

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### ABSTRACT

*The electro physical parameters of mechanically activated disperse media have been studied using the example of grains with different particle dispersions. Dependence of dielectric, electrical and temperature properties on particle size distribution was revealed. Studies were carried out for samples of fine wheat, barley and oats. A correlation is established between the dielectric permittivity of grains, the dielectric loss angle tangent and the total conductivity with the value of grain fractions. The specific surface area of the fine-dispersed systems studied influences the electro physical properties of the investigated samples of wheat, barley and oats. Reducing the size of the fraction of the grain samples under investigation leads to an increase in the dielectric constant of the substance and the loss tangent. The frequency dependence of the permittivity and loss tangent, most pronounced at low frequencies, is investigated.*

**KEY WORDS:** Dispersion, mechanically activation, dielectric, electro physical properties, dielectric permittivity, grain.

### GENERAL INFORMATION.

Investigation of the electro physical properties of grain crops, including fine particles with a surface saturated with grinding, electrically active particles, is one of the urgent problems of modern science and, including, nanotechnology. Finely dispersed electrically active media can be attributed to the most promising class of modern materials. The mechanical and electro physical properties of such finely dispersed media make it possible to create qualitatively new materials whose characteristics depend on the particle size and chemical composition. In particular, the use of crushed grain crops as a food base

for the national economy makes it possible to increase their energy value. The energy properties of cereals, as studies show, will depend significantly on the structure of the substance and the degree of dispersion of the particles. The current scientific interest in the study of the nature of finely dispersed media is not accidental, since information can be used, among other things, to obtain information about the structure of local defects in matter and its dielectric characteristics, which is directly related to its energy properties. The new physical properties of mechanically activated grains are associated with a change in the

structure of the grain upon its grinding and the formation of an ordered orientation of molecules that are in direct contact with the ground surface of the sample under investigation [1].

The aim of this work is to study the electro physical properties of electrically

active fine-dispersed systems based on mechanically activated grains of grain crops of wheat, barley and oats, caused by the appearance of an electrical interfacial interaction between charges on the surface of a solid.

## THE METHOD OF DATA COMPARISON.

Dispersed systems have a rather complex structure, which is explained by the presence of local inhomogeneities that appear after mechanically activation and which affect the transfer of electric charge and the very structure of the energy spectra. A distinctive feature of finely dispersed samples of oats, barley and wheat is the significant size of the specific surface, the fine particles of which have great hygroscopicity and have many electrically active centers. Dielectric spectroscopy is the most accurate method of studying the structure. In order to study the electrophysical properties of cereals, the method of dielectrometry is used in the work. Experimental measurements of the dielectric properties of grains were carried out in the frequency range 25 - 106 Hz using the digital immittance meter E7-20 (error of 0.2 pF capacitance measurement and 1 pS conductivity) [1]. Using an analog-to-digital converter, the experimental data entered the personal computer. The results of the studies were processed using standard statistical methods.

To study the electro physical properties, the grain samples underwent mechanically activation in the "Pulverisette 5" plant, by means of which disperse

systems with particle sizes in the ranges from 50  $\mu\text{m}$  to 1000  $\mu\text{m}$  were obtained. Analysis and study of the properties of samples obtained by grinding, studying the structural properties of dispersed cereal crops is of great importance, since wheat, barley and oats are some of the products most used in the food industry and agriculture. The electro physical characteristics of the grain-water polar matrix interface play an important role in the processes of polarization and electro transport. With mechanically activation, the smallest grain particles have electrical uncompensated charges on the surface, formed during the grinding process. The surface of the crushed grain crops becomes adsorption ally active to polar molecules of water, forming water films around the particles of mineral matter, and retains moisture well. Along with the adsorption of water molecules, there is a change in the conductivity and polarization of samples of crushed grain. The dielectric method for studying the structure of grain crops and intermolecular interactions is interrelated with the consideration of the processes of polarization of substances under the action of an external electric field [2, 3].

## RESULTS

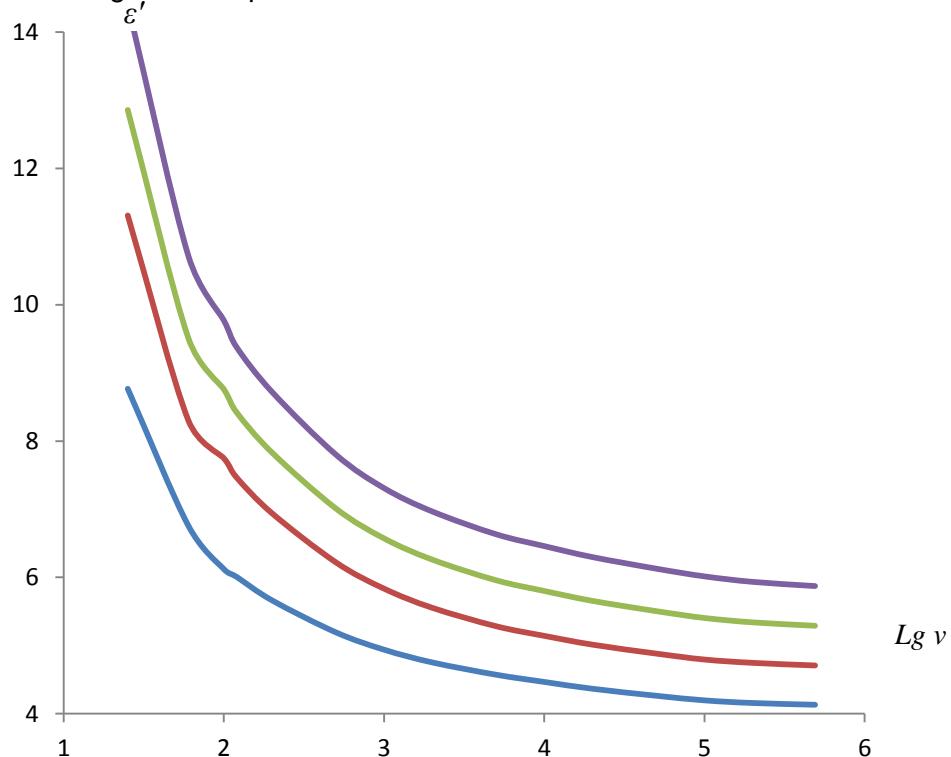
As a result of the experiment it was established that mechanically activation of grain samples leads to changes in their dielectric properties. In Fig. 1 shows the frequency dependence of the dielectric constant. Samples of finely dispersed grain crops of 50 and 100  $\mu\text{m}$  are characterized by the maximum values of the real component of the permittivity in the frequency dependence. Thus, at a frequency of 25 Hz, the permittivity for a sample of 1000  $\mu\text{m}$  averages 8.8, and for a sample with a dispersion of 50  $\mu\text{m}$  and less

than 14.4, respectively, which is associated with considerable electrical activity of the surface of the fine-particle sample 4. An increase in  $\epsilon'$  at all frequencies under consideration approximately equal to and reaches an average of 50%, so at a frequency of 1000 Hz for the above samples,  $\epsilon'$  is 4.6 and 6.6, respectively.

Analysis of the tangent of the dielectric loss angle also shows a clearly expressed dependence on the dispersity of small-sized wheat samples. So at a frequency of 25 Hz,  $\text{tg}\delta$  for a sample with a

dispersion of 1000  $\mu\text{m}$  averages 0.3, and for a sample with a particle size of 50  $\mu\text{m}$ , 0.44, respectively. For a frequency of 1000 Hz, these parameters are 0.07 and 0.09, respectively. Thus, at high frequencies there is also a change in the dielectric characteristics. The higher electrical activity of finely dispersed samples is less than 100  $\mu\text{m}$  due to the fact that they are characterized by greater electrical activity and are able to adsorb water films of greater thickness as compared to samples of the larger part. Dispersed samples of wheat at room temperature are saturated with water, the concentration of which increases with decreasing particle sizes, due to an increase in their specific active surface. The main sources of losses in finely dispersed mechanically activated grain samples are

stratification cavities of various sizes characterized by the presence of film water [4]. Under the action of an external electric field, the electric charges are redistributed, forming macro dipoles, the polarization of which leads to a sufficiently appreciable increase in the permittivity in a wide frequency range. Water films, enveloping the particles of the investigated fine-dispersed medium, are able to unite into extended surface clusters. Interphase boundaries of adsorbed water layers under the action of the internal electric field of the investigated mechanically activated grains of wheat, barley and oats, interlayer polarization occurs, which is accompanied by the appearance of a significant absorption capacity of the samples [4, 5].

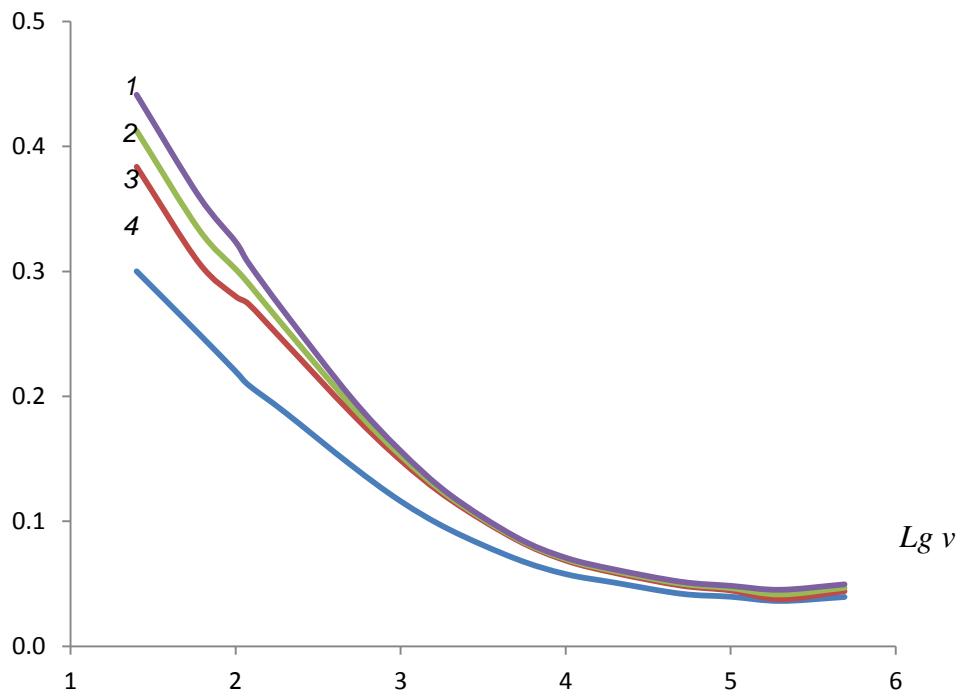


*Figure 1. Frequency dependence of the permittivity  $\epsilon'$  of samples of mechanically activated wheat (room temperature) on the size of fractions: sample 1 - dispersion less than 50  $\mu\text{m}$ ; sample 2 - dispersity 51-250  $\mu\text{m}$ ; sample 3 - dispersion 251-500  $\mu\text{m}$ ; sample 4 dispersity 501-1000 microns.*

Thus, it has been established that the dielectric constant in the low-frequency region for smaller disperse media increases with the increase in the specific surface area of the mechanically activated particles of the investigated samples of grain crops. The decrease in the real component of the dielectric constant  $\epsilon'$  and the dielectric loss tangent  $\tan \delta$  with increasing frequency of the external electric field is associated with degeneracy of the dipole-orientation

polarization in the disordered systems of mechanically activated fine grains of wheat, barley, and oats [4, 5].

Thus, the study of the electro physical properties of samples of fine-grained wheat made it possible to detect the effect of a pronounced dependence of the dielectric constant, the dielectric loss tangent, the electrical capacitance, and the total conductivity on the granulometric composition.



*Figure 2. Frequency dependence of the tangent of the dielectric loss angle  $\text{tg}\delta$  mechanically activated wheat: sample 1-dispersion less than 50  $\mu\text{m}$ ; sample 2 - dispersity 51-250  $\mu\text{m}$ ; sample 3 - dispersion 251- 500  $\mu\text{m}$ ; sample 4 dispersity 501-1000 microns.*

## CONCLUSION

In the relaxation processes of finely dispersed systems (with the example of mechanically activated grains of wheat, barley and oats, along with the structural elements of the grains themselves, water films contribute to the increase in the

Small grain samples show non-uniform physical properties, depending on their electrical activity and the specific

The tangent of the angle  $\text{tg}\delta$  of dielectric losses increases with decreasing particle sizes of the studied samples. The decrease in the particle size of the samples of mechanically activated grain crops promotes a significant increase in the real part of the dielectric permittivity, which can increase to 1.5-2 times at room temperature for samples with a particle size of less than 100 microns, which leads to an increase in the energy value of the substance.

relaxation characteristics of the investigated fine-dispersed systems and make a significant contribution to the values of the basic electro physical parameters: dielectric permittivity and tangent of the dielectric loss angle.

surface area that affects the electro physical properties of mechanically activated test samples.

## **REFERENCES**

- 1 Transfer of electret charges in nonequilibrium fine-dispersed systems under the action of an internal field / M.Yu. Buzunova, Sh.B. Tsydipov, L.A. Shcherbachenko et al. // Bulletin of the Buryat State University. - 2015. - No. 3. - P. 75 - 80.
- 2 Tareyev BM Physics of Dielectric Materials. Tareyev. - M., Energoizdat. 1982. - 320 s.
- 3 Gorokhovatsky Yu.A. Thermal activation current spectroscopy of high-resistance semiconductors and dielectrics / Yu.A. Gorokhovatsky, G.A. Bordovsky. - M., Science. 1991. - 189 p.
- 4 Relaxation processes in heterogeneous fine-dispersed systems / Ya.V. Bezrukov, L.A. Shcherbachenko, M.Yu. Buzunova et al. // Bulletin of the Buryat State University. - 2015. - No. 3. - P. 101 - 103.
- 5 Analysis of the structural interaction of electrically active heterogeneous fine-dispersed systems at the interface between the solid and liquid phases. Shcherbachenko, N.T. Maksimova, S.D. Marchuk et al. // Physics of the Solid State. - 2011. - No. 7. - P. 1417 - 1422.

## **MODEL FOR PREDICTING THE SAFETY RISK AND ESTIMATING THE REMAINING LIFE OF THE ELEMENTS OF THE ELECTRICAL INSTALLATION**

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### **ABSTRACT**

*The article examines the stages of the risk analysis of the hazard in the electrical installation. It is suggested that the risk analysis should be considered as a hazard identification procedure and proceed to a quantitative risk assessment. One of the main tasks of the analysis is to obtain information on the state of insulation of electrical installations for establishing their residual life and predicting the service life. The stages of electro traumatic prediction are described with a description of the mathematical model. An analysis of the change in the index of the electrical safety level revealed a rather low tendency to a gradual decrease in the number of electric trauma.*

**KEYWORDS:** Electrical installation, risk, risk management, accident, fire, electric injury, damage, wiring, analysis, forecasting, electrical safety.

### **INTRODUCTION**

As a result of many years of underestimation of the safety of electrical installations, the current structure of measures for occupational safety and health does not meet modern requirements for the reliable operation of electrical equipment and electrical installations.

Application of the risk management framework electrical installations and analysis of identification of hazards associated with the occurrence of accidents, injuries, fires, makes it possible to obtain the data necessary for assessing the effectiveness of organizational and technical measures and predicting the level of electrical

safety.

The procedure for analyzing the risk of electrical safety must be considered in two interrelated stages:

- forecasting and comparative risk assessment;
- Management of individual (or cumulative) risk.

The purpose of the first stage is to predict the magnitude of the total risk of electro-injury, taking into account the possible damage from each individual injury and comparing the magnitude of the risk with an acceptable value. The purpose of the second is to develop recommendations to reduce the likelihood of electric trauma and possible damage

from them, aimed at achieving an acceptable risk with limited economic costs.

Risk analysis is the conduct of a hazard identification procedure and the definition of a risk assessment for humans and the environment. One of the main tasks of the analysis is to obtain objective information about the state of insulation of an electrical installation with the aim of establishing a residual resource and predicting the service life. It is known that the most dangerous element of the electrical installation is electrical wiring. Annually at the facilities of the country's economy, up to 20% of the electrical wiring of buildings and structures breaks down [1].

The solution of this problem is based on scientifically based principles, the development of which will require implementation of such general issues as: substantiation of the service life of the electrical wiring and improvement of the safety assessment criteria; collection and investigation of information on cases of damage, the development of accidents, the occurrence of injuries and fires, an analysis of their main causes; studying

the degradation of physical and mechanical properties of solid insulation of wires and cables and the mechanism for changing their characteristics under operating conditions; calculation forecasting of the durability of electrical wiring in production facilities, as well as residential and public buildings in settlements; creation and introduction in engineering practice of a package of computational programs for probabilistic estimates of the occurrence of defects in electrical wiring leading to hazardous consequences and the calculation of potential damage from them.

The above forms a single interconnected complex (Figure 1), which includes blocks of scientific and methodological and regulatory support, implementation of organizational and technical measures.

An important factor is the solution of the problem associated with determining the optimum service life of the electrical installation, because the desire to increase the service life, on the one hand, saves material resources, and on the other - increases the likelihood of damage, accidents, etc.

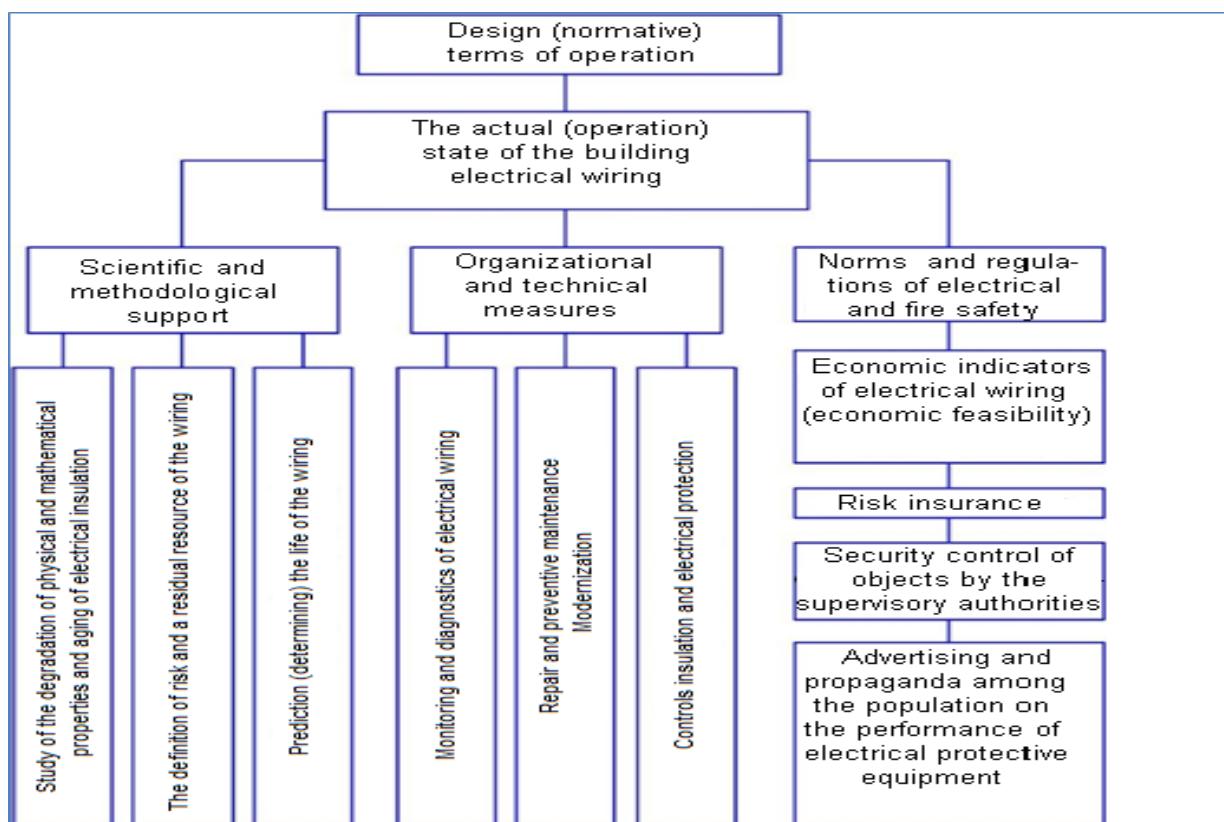
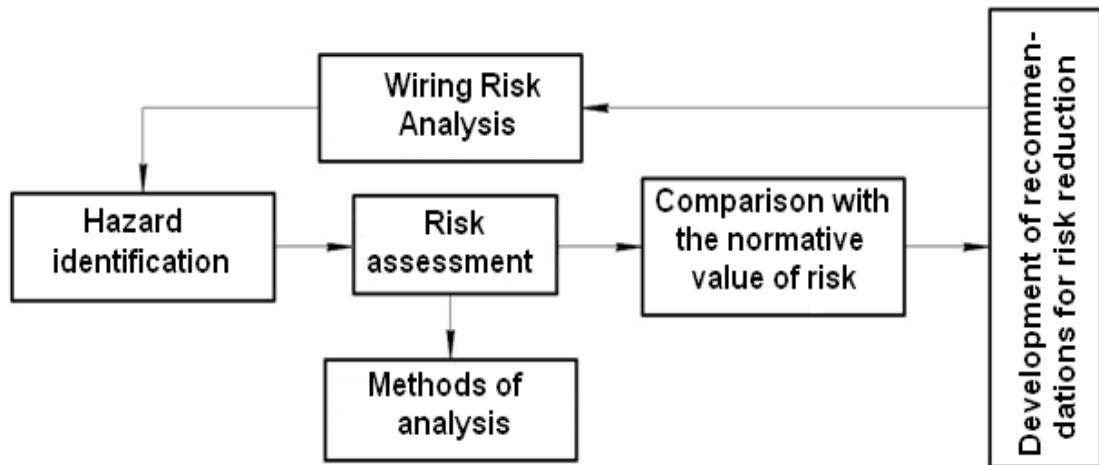


Figure 1. Model of residual life and service life

The rationale for the optimal period involves, firstly, conducting a diagnosis of the technical condition of the wiring by equipping the facility with automatic insulation monitoring devices (protective cut-off devices), and secondly determining the quantitative risk assessment, and comparing it with the normative value. The latter is reduced to the procedure for implementing methodical and practical

measures for risk management (Figure 2). Note that here one should give preference to methods of quantitative analysis, which is reduced to the calculation of risk indicators by multiplying the probability of a dangerous event (accident, injury, fire) by the mathematical expectation of the damage (material losses) caused by this event.



*Figure 2. Block diagram of risk management*

In general, the forecasting system can include mathematical, logical and heuristic elements [2]. At the entrance of the system comes the available information about the predictable phenomenon of electro-injury; at the output - data are given about the future parameters of the phenomenon, i.e. forecast. A block diagram of the predictive electrotraumatic system is shown in Fig. 3.

In accordance with the block diagram in question, the first step in forecasting is the collection and analysis of the necessary background information on accidents. Here it is possible to obtain statistical data both by using retrospective data and using an automated system for collecting and analyzing data on electro-traumatic stress. Moreover, the data transmitted through the two channels should not be contradictory, but should confirm the reliability of the information received.

The second stage of forecasting is to create a mathematical model of

traumatic situations and their outcomes (event and outcome trees), as well as a methodological tool for determining unknown parameters of the model. It should be noted that when creating models, one must proceed from the goals and tasks of forecasting and take into account the so-called preemptive interval, during which a statistical database on electrotraumatic activity is formed.

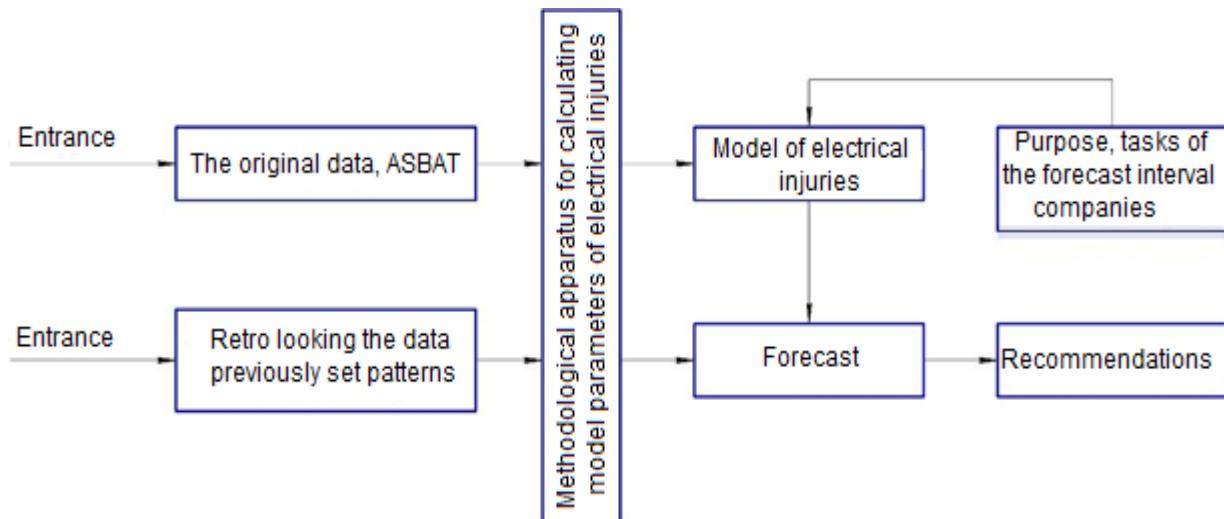
The third stage is the necessary calculations and visualization of their results.

At the fourth stage, the adequacy of the model is assessed for real phenomena and the reliability of the predicted situations obtained.

At present, various forecasting methods are widely used, based on mathematical and heuristic models [3]. Mathematical models, in turn, can be divided into deterministic and probabilistic ones. The first are based on the establishment of functional dependencies between the primary safety criteria and the parameters of the

human-machine system. These dependencies can be expressed in analytical, graphical or tabular forms. Probabilistic models take into account the stochastic nature of the parameters

that characterize the source of electrical danger, as well as the processes of formation and outcome of traumatic situations.



*Figure 3. Block diagram of the prediction of electro-injury*

To a variety of probabilistic models for predicting traumatic situations, one should include the extrapolation method, which, on the basis of statistical data on electro-traumatic stress, evaluates the parameters of interest to us over a certain time interval. This method can find application, for example, in the prediction of electrotraumatic injury with different outcomes. As a predictable parameter, there can be both macro-indicators, for example, the integral risk of electrotravism of a region or industry, including social, material and economic damage expressed in a single monetary equivalent, and micro-indicators - differentiated characteristics that determine the outcomes of electric trauma.

The most objective indicator that can be used for a statistical assessment of the level of electrical safety in any industry, in our opinion, is the amount of electric trauma.

As an example, Figure 4 shows the dynamics of the change in the indicator  $M(EP)_i$  (the mathematical expectation of the number of electric

traumas) at industrial enterprises of the Baikal region for the period from 2005 to 2015. [3]. "Smoothing" of the statistical curve of the change in the average annual number of accidents, carried out by the method of least squares, made it possible to establish the character of the regression dependence, which has the following form:

$$M(EP)_i \square 1,5 \square 1,8e^{0,2i}, \quad (1)$$

Where  $i = 1, 2 \dots n$  is the time during which the statistical data on electrotraumatic injury were obtained.

As follows from the graph, a characteristic feature of the period under consideration was a clearly expressed tendency to a gradual decrease in the number of electric trauma. The reason for this is the creation in Russia of a regulatory legal framework in the field of labor protection, as well as the introduction of a complex of effective organizational and technical measures regulating safe operation in electrical installations up to 1000V. At the same time, we should note a rather low unsatisfactory front decrease in the

indicator M (EP) i. Extrapolation of this indicator confirms the low level of electrical safety in the industry, which will persist in the future, until the state

takes effective measures in this direction.

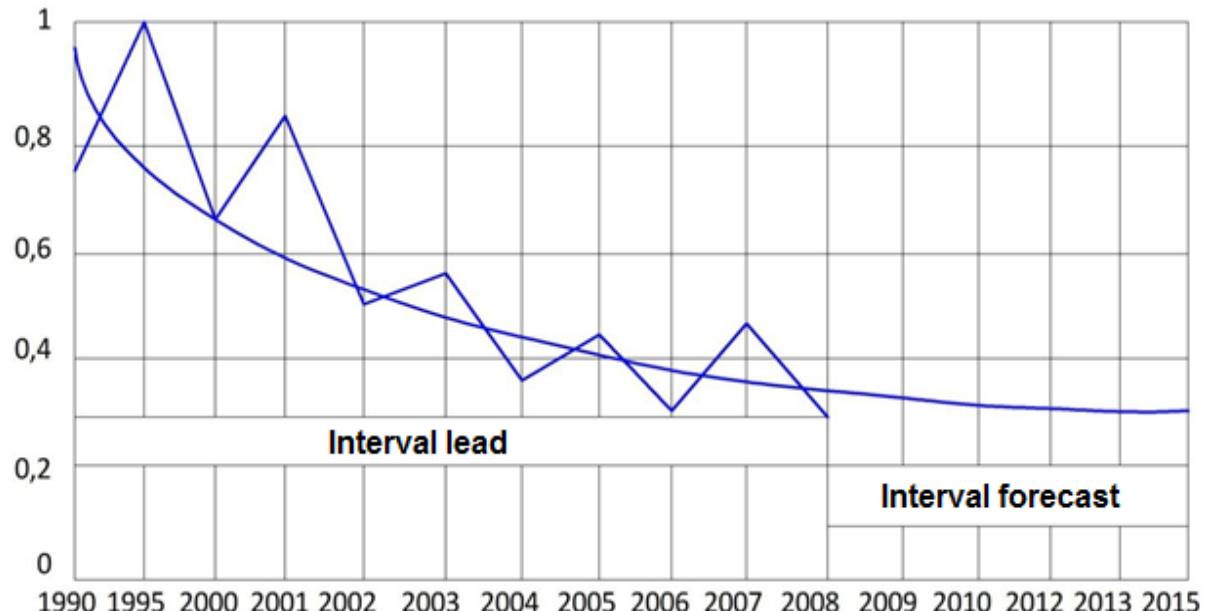


Figure 4. Dynamics of the change in the indicator M (EP) i

The "bursts" and "dips" in the values of the M (EP) i indicator on the curve (Figure 4) confirm the hypothesis of the accidental occurrence of these events. Despite the fact that each electric trauma in this flow is caused by specific "own" reasons, it can be assumed that the entire flow of electric trauma as rare events obeys discrete distributions of the binomial type [4]. The most suitable for describing the frequency of electric trauma is the Poisson distribution.

$$f_n = a^n \exp(-a), \quad (2)$$

where  $n = 0, 1, 2, \dots$  is the number of electric trauma, and  $a$  is the distribution parameter.

The mathematical expectation and variance for the Poisson distribution are, respectively, the following:

$$M\{n\} = \sum_{n=0}^{\infty} n f_n = a, \quad (3)$$

$$D\{n\} = M\{(n-a)^2\} - (a)^2 = a \quad (4)$$

$n \geq 0$

On the basis of the Bernoulli theorem, the average frequency of the events under consideration (electric injury), equal to  $a / n$ , with infinite growth

of  $n$  tends to the probability of electrotraumatic P (ET):

$$\lim_{n \rightarrow \infty} \frac{1}{n} = P_{ET}, \quad \dots \quad (5)$$

Then  $f_n$  can be represented as

$$f_n = \frac{1}{n} (nP_{ET})^n \exp(-nP_{ET}), \quad (6)$$

Moreover, P (ET) should not exceed the value of the upper permissible (normalized) level of risk.

Along with mathematical methods for predicting electrotravism, heuristic, in particular, the Delphi method [5], can be used, the essence of which is to conduct expert forecasting by organizing a system for gathering expert estimates and their statistical processing. Despite the share of subjectivism contained in it, which is the intuitive opinion of individual expert experts, this method, in combination with the analytical one, not only gives reliable and qualitative forecast results, but allows you to make possible scenarios for the future. The heuristic method is free from formalized mathematical descriptions and allows you to predict the event for the next 10-15 years, taking into account the possible

"Interference" of external factors, socio-economic and political nature.

## **CONCLUSION**

1. At present, there are no effective methods for determining the safety lifetime of electrical installations (wirings) of buildings and structures. Therefore, in order to increase the efficiency and safe operation of electrical equipment and electrical installations at any facilities, it seems promising to create a system for the technical diagnostics of the state of wiring, to

estimate and predict the residual resource and to extend the life of their operation.

2. A systematic approach to the analysis and prediction of electrotraumatic activity represents the general methodological basis for a comprehensive solution to the problem of increasing the safety of electrical installations used at economic facilities.

## **REFERENCES**

1. Polukhin OV, Soshnikov AA Investigation of electric arc arson over electric wiring // Mechanization and electrification of agriculture, 2009. -№5. - P.17-19
2. Gmoshinsky V.G. Engineering Forecasting. - Moscow: Energoatomizdat, 1982. - 208s.
3. Working conditions, industrial injuries / / Russian Statistical Yearbook. M .: Statistics, 2006-2016
4. Gmurman V.E. Theory of Probability and Mathematical Statistics. - Moscow: Higher School, 1988. - 688 p.
5. Baid D. Scientific and technical forecasting for industry and government agencies. - Moscow: Progress, 1972. - 497 p.
6. Eremina Tamara Vladimirovna, Doctor of Technical Sciences, Professor of the Department of Ecology and Life Safety, FGBOU VO SAGGUTU, t.e.vsgutu@mail.ru, 670033, Republic of Buryatia Ulan-Ude, ul. Shumyatsky, house 10 sq. M. 59. Tel. 8-924-656-68-65
7. Kushnaryov Sergey Nikolaevich, Senior Lecturer, "Electrification and Automation of Agriculture", FGBOU VO "Buryat State Agricultural Academy named after V.R. Filippova ", s\_kushnarev@inbox.ru, 670045, Ulan-Ude, ul. Shevchenko, 49 Tel. 8-9021-63-65-88

## **THE INFLUENCE OF MODES OF PROCESSING VEGETABLE'S OIL THE STRUCTURE OF BARLEY GRAIN**

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### **ABSTRACT**

*The influence of the modes vegetableoil treatment on the structure of barley. Industry contributes to the change of microstructure, structural-mechanical properties of grain. Shell be less associated with the core, can be easily separated from the endosperm and crushed. This significantly reduces the process.*

**KEYWORDS:** Blagodarova processing, microstructure, endosperm, shell

### **INTRODUCTION**

As you know, a basic method to convert the technological properties of grain in its processing is the hydrothermal treatment, implemented in the form of various methods of influence. Blagodarova processing (WTO), which consists in moistening the grain, its otrajenii and heat treatment, as studies have shown, is an effective method of processing wheat and barley into flour, cereals and feeds [1,2]. Studies have shown the possibility of using this technique to obtain fast food products and do not require cooking. Thus the production process is significantly reduced, increasing the yield and significantly to 20-30% reduced energy consumption. This technique can be

implemented in the processing of cereal crops, rye and wheat.

Intracellular and intercellular interaction in the WTO are moving into diverse processes spanning all tissues of barley and wheat. The inclusion of water in biological metabolism in the cell tissues of the weevil in combination with high temperature treatment leads to changes in physico-chemical, biochemical and technological properties of grain.

Studies of the structure, the grains are of great importance, because communications that occur between the components of the system, their state provides a certain structure and properties that contribute to the technological advantages of the product.

## MATERIALS AND METHODS STUDIES

Objects of research were samples of wheat and barley. Blagodarova processing used for grain processing included hydration, otvalivalas and heat treatment. The study of the microstructure of grain

held in the Center of collective using "Progress" of ESSUTM on the electronic scanning microscope brand Jed JSM-6510LV (Japan) [3].

## RESEARCH PROCESSING AND RESULTS

Vegetable processing of barley and wheat was carried out under process conditions that provide the possibility of obtaining a wholemeal flour with a high content of dietary fiber and minerals. The results obtained by visualization of change

of grain shown in Fig. 1-6, if you increase 700. It is established that in the endosperm of control samples of barley and wheat starch granules are Packed in a continuous protein matrix (Fig. 1, 2)

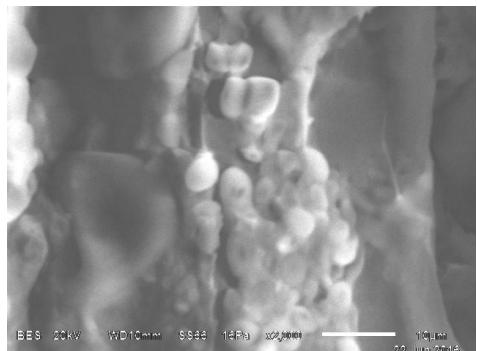


Figure 1. Control (700) of barley

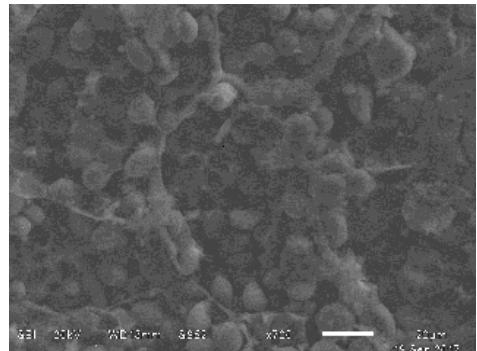


Figure 2. Control (700) of wheat

When vegetableoil treatment there is an increase in the volume of grains, loosening of the endosperm as a result of intensive evaporation, resulting in a breakdown of communication between the shell and the endosperm. Markedly the microstructure of the endosperm. Hydration of the grain and otvalivalas before heat treatment to activate the enzymes which, as studies have shown, a

certain influence on the microstructure. Starch granules swell, there is a softening of the protein matrix and the hydrolysis of part of the starch granules, rice.3 and 4. It should be noted that a more intense development of hydrolysis of the starch granules of barley (Fig.3) compared to wheat (Fig.4) owing to the apparently greater activity of amylases of barley.

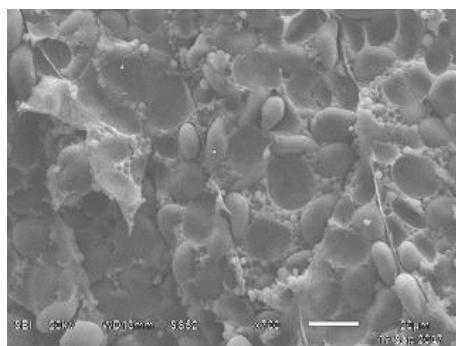


Figure 3. Sample 1 (700) of barley

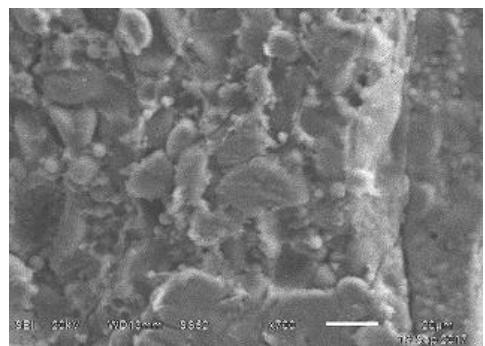


Figure 4. Sample 1 (700) of wheat

Subsequent heat treatment causes changes in the shape and size of starch granules (Fig. 5, 6).

Grain processing at temperatures of 200-2200C contributes to the development of a deep domestic transformation with the decompression of cellular structures to the

porous state of degradation of the large starch granules and denaturation of proteins with the formation of filamentary strands. Develop processes dextrinization and gelatinization of starch granules, resulting in the loss of characteristic shape

and almost their degradation (Fig.5,6). Biochemical analyses established a significant increase in barley grain and wheat to the WTO content of dextrans from 0.7 to 3.0 and 2.4 %, respectively

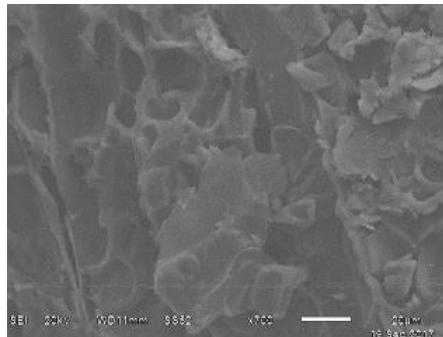


Figure 5. Sample 2 (700) of barley

The data obtained indicate that the depth of microstructure changes in barley and wheat, the transformation of the starch granules and protein substances is determined vegetable oil processing of grain before milling. Industry contributes to the change of structural-mechanical

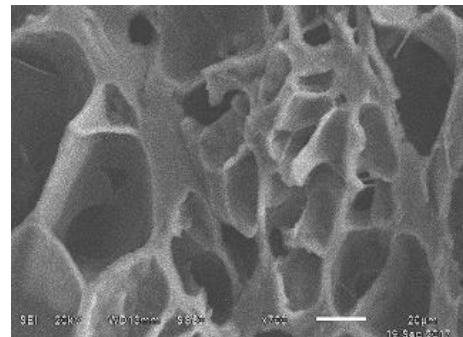


Figure 6. Sample 2 (700) of wheat

properties of grain. Shell be less associated with the core, can be easily separated from the endosperm and crushed. This significantly reduces technological process, reduce the energy consumption for the production of flour and cereals.

## CONCLUSIONS

The data obtained indicate that the depth of microstructure changes in barley and wheat, the transformation of the starch granules and protein substances is determined vegetable oil processing of grain before milling. Industry contributes to the change of structural-mechanical

properties of grain. Shell be less associated with the core, can be easily separated from the endosperm and crushed. This significantly reduces technological process, reduce the energy consumption for the production of flour and cereals.

## REFERENCES

1. Tsybikova G.Ts., Kozlova T. S., Snovickaja L.V. Development of resource-saving technologies of processing of barley for food pur. // Magazine "Storage and processing agricultural raw materials" №8, 2003.
2. Egorova E. Yu., Obrezkova M. V. Grain and nanoprodukty. Book 1. Grain, flour, cereals. Technology and quality assessment. Educational-methodical manual.-Biysk.: Ed. Altai state technical University, 2013-182c.

## TECHNOLOGICAL CALCULATION AND MACHINERY OF SMALL FEED WORKSHOP

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### ABSTRACT

*When Mongolia has entered the free market economy, dairy farms which were established in the socialist economic system divided into small and medium farms newly. Attributable to it collapsed past dairy farms. Instead of them had built middle sized farms. In order to supply these cattle farms with adequate and quality feeding we need to formulate new techniques, technology and should introduce new ideas into these farms. Depending on it, we formulated basis settlement of midget sized feeding stuff workshop technique and technical figuration to small sized dairy farms.*

**KEY WORDS:** *Dairy farm, feed, feed production efficiency, technique, technological assessment, calculations, small feed shop, collecting cars*

### INTRODUCTION

One of the effective ways of using feed raw materials is connected, first of all, with rational technical methods of its processing. When establishing adequate manufacturing of the machines of the feedstuff production line, it is necessary to make a full calculation of the productivity of livestock, the juiciness and nutritional value of the feed, and the efficiency of using the machines. Below are the formulas for calculating a mathematical model for establishing the acquisition of adequate machines for the technological line of the dairy farm's forage workshop. A. Theoretical basis

Establishing a sufficient complex machine, following formula determines the annual cost effective production line of option z, in the objective function:

$$\varTheta_{T_z} = \varTheta_{T_z} - (\Pi_z + Y_z) \quad (1)$$

$\varTheta_{T_z}$  - Annual economic efficiency of

the production line

$\varTheta_{T_z}$  - Annual technological efficiency

of the production line

$\Pi_z$  - Annual transferred flow of production line

$Y_z$  - The annual loss due to unreliable work of the production line

Technological efficiency is determined by the profit from quality, the growth of livestock products and the saving of feed

$$\varTheta_{T_z} = Q_T \cdot \Delta K_{OZ} [a \cdot v \cdot L_{mc} + (1-a)L_{ke}] \quad (2)$$

$Q_T$  - the volume (quantity) of feed that is produced per year in the feed shop, tn;

$\Delta K_{OZ}$  - The growth of nutritional of forages of a technological line of variant z of a forage workshop;

$v$  - the productivity of livestock in a unit of feed;

$U_{ke}$  - unit cost of one feed;

$U_{\mathcal{K}}$  - the cost of a unit of livestock;

$\alpha$  - percent, in which the additional product of cattle breeding, obtained from the increase in feed nutrient density, is calculated.

$$a = (1 - \eta \cdot K_{EH} / M_c \cdot \Delta K_o) T_{\Gamma\Delta} = D \cdot T \cdot K_p \quad (3)$$

$K_{EH}$  - nutritional daily dose, corresponding to zoo technical requirements;

$\eta$  - The percentage of provision of complementary feeding of livestock feed.

The following formula determines the amount of feed that are produced in a year:

$$Q_T = Q_{T_p} \cdot T_{\Gamma\Delta} \cdot K_{H\Phi} \quad (4)$$

$Q_{T_p}$  - The productivity that is required in the food shop;

$T_{\Gamma\Delta}$  - the performance that is required in the feed shop;

$K_{H\Phi}$  - percentage of the use of the fund of working time. The annual fund of working time is;

$$T_{\Gamma\Delta} = D \cdot T \cdot K_p \quad (5)$$

$D$  - the length of time for the unremitting care of livestock;

$T$  - term of one-time preparation of forages;

$K_p$  - number of cattle feeding per day.

The production that is required in the feed shop is

$$Q_{T_p} = (H_F \cdot M_C) / (T \cdot K_p \cdot K_{H\Phi}) \quad (6)$$

$H_F$  - number of cattle farms

From this comes the first constraint, namely  $Q_{T_z} \geq Q_{T_p}$ .

$Q_{T_z}$  - The theoretical efficiency of the production line of version  $z$  in the fodder plant.

The following formula gives increased nutritive value

$$\Delta K_{OZ} = K_{\mathcal{O}_i} \cdot \sum_i^L K_{\mathcal{O}_i} \cdot K_{Kei} \cdot K_{u_i} - \sum_i^L K_{Kei} \cdot K_{u_i} \quad (7)$$

$K_{\mathcal{O}_i}$  - percent efficiency of processing feed mixtures in the production line  $i$ ;

$K_{Kei} \cdot K_{u_i}$  - nutritious feed and the share of the weight in it;

$L$  - The number of the production line fodder plant Following translated flow is defined by the formula

$$\Pi_z = S_{OB_z} [(h+1)E + he_1 + e_2] + z + M \quad (8)$$

$S_{OB_z}$  - Equipment's cost balance of option  $z$  production line, of the fodder plant;

$E$  - the standard efficiency of investment,  $E = 0.15$

$e_1, e_2$  - The rate of contributions set of machines, equipments, technical service, repair, construction of the fodder plant and the total percentage of depreciation deductions;

$h$  - the cost of construction and the average relationship of technological equipment;

$z$  - the annual budget of the earnings in the feed shop;

$M$  - the expression of the value of the annual expenditure of means of labor. Table 1 shows the percentages of effectiveness of different feed processing methods, defined on the basis of zootechnical norm.

Table 1.

Type of feed	Processing methods	Efficiency ratio $K_{\mathcal{O}_i}$
A mixture of feed	Preparing the feed mixture of full ingredient	1.12
Straw	Processing thermal chemistry	1.36
Straw	Fermentation	1.57
Concentrated feed	Processing scraping with moisture and heat	1.14
Concentrated feed	Fermentation	1.16

The impairment loss of productivity due to unsafe working cattle feed plant can be determined by following:

$$Y_z = \varphi(1/k_{T_z} - 1) \cdot H_F \cdot D \cdot U_{\mathcal{K}} \quad (9)$$

$\varphi$  - An indicator of loss of productivity due to the unsafe working cattle feed plant,  
 $\varphi = 0.88$

$k_{T_z}$  - Production line percentage of option z in the fodder plant.

Limitation of the mathematical model is determined adequate relation of equipment and technology for fodder plant.

This is determined by the second limitation of the mathematical model

$$P_H \leq P_Z \leq P_B \quad (10)$$

$P_Z$  - Production line technological relationship of option z;

$P_H, P_B$  - maximum, minimum (high and low limits) of the efficiency and power of machines in the feed plant.

Figure 1 shows the diagram of the feed shop

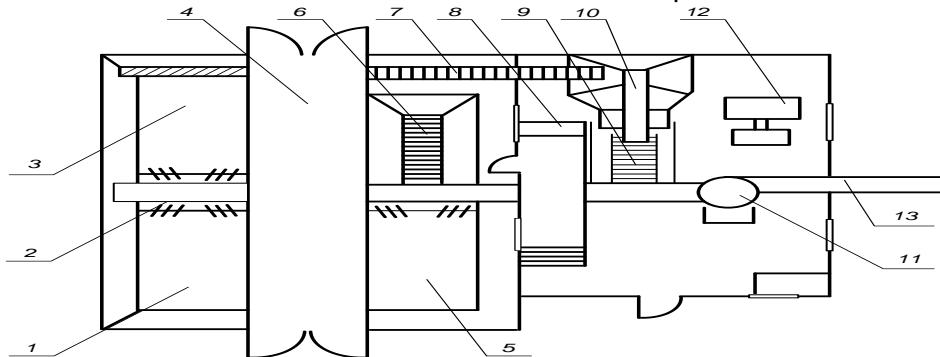


Figure 1. Fodder shop of a dairy farm designed for 50-100 cows

1,3,5 – weighing bunker, coarse, juicy, edible roots feed; 2, 7 – lines carrying feed TK-5; 4 – insulator; 6 – forage cutter, succulent feed; 8 – Remote Control; 9 – crusher succulent feed; 10 – crusher pungent fodder; 11 – fodder mixer; 12 – loader feeds.

Table 2  
Shows the acquisition of machinery forage dairy plant intended for 50-100 cows

№	Workflow	Make machines	Required	
			Power (kw)	effectiveness (kg/h)
1	Shredder of coarse, succulent feed	СР-2; СР-60	0.6	60-100
2	crusher succulent feed	ДЗК-1; ЭКР-1	1.1	300-800
3	crusher pungent fodder	ДЗ-Т-1; ЭЗД-Т-1	1.6	40-100
4	fodder mixer	СМ-1.7	2-5	100-1000

## CONCLUSION

- Developed the formula for calculating the mathematical model for calculating and determining the sufficient machine shop feed dairy farm in small sizes.
- Fodder plant dairy farm in small size of production line designed for harvesting

forage mixtures with the full gross, juicy and concentrated feed.

- It can be suggested that the portable fodder plant can use machine with a power of 0.5-5 kW and a capacity of 40-1000 kg/h feed.

## REFERENCE

- Baldangombo B. "Mechanical equipment for feed production". UB. 2006
- Мельников С. В. "Механизация и автоматизация животноводческих ферм". М. 1978.
- Сыроватка В. И. "Механизация приготовления кормов". М. 1985.
- Nyamtseren G. "The question of optimal technical and technological solutions for mixed feed preparation". UB. MUST. 2002
- Nyamtseren G. "Substantiation of optimal sets of machines for preparing fodder for dairy farms". UB. MUST. 2006

## **SMART AGRICULTURE AND ICT INNOVATION —PROGRESS AND INNOVATION IN INTELLIGENT AGRICULTURE—**

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### **ABSTRACT**

*ICT-based Smart farming is an innovative method of agriculture in which each phase, from production to marketing, is integrated and improved upon by taking advantage of existing knowledge and techniques in information and communication technology (ICT), as well as by creating and testing new ICT tools and frameworks within which such tools are implemented. The ultimate goal of the approach is to achieve low-input, sustainable agriculture comprised of high productivity, cost reduction and efficiency, and improvements in food and labor safety.*

*Smart-farming is made possible by drawing upon both ICT and human wisdom. Fortunately, we live in an age in which platforms for highly advanced ICT systems are well-established and in which cloud computing environments and multifaceted analyses of Big Data are becoming more readily available. With ease of accessibility to technology and complex data, it is now possible for any of us to understand and implement Smart-Farming techniques. As such, high expectations exist for this powerful approach, and it is apparent that there is a significant need for ICT-based systematization of vast information and the creative development of algorithms for the production of biological systems. This study show the several case of intelligent and smart agriculture.*

**KEYWORDS:** Smart-agriculture, Big-data, System innovation, AI-Farming

### **INTRODUCTION**

1. **To make something** “smart” in information technology means to develop a system, which possesses advanced abilities for the processing and control of its component modules and yields optimal behavior. The electronic toll collection systems implemented in transportation, and hybrid vehicles with a system that optimizes the use of an on-board battery and engine are a couple of examples.

Innovation has been achieved by removing boundaries created by existing

frameworks or systems of representing information, whereby a “framework” may be defined as a relationship resulting from the interaction between two entities such as that between motor and engine, between one local area and another or between one enterprise and another. The abstraction of underlying relationships that comprise different frameworks and the integration of these abstractions are ideas that lead to innovation. A prominent example is an automated car driving

system, in which information processed by each component system, i.e., various sensors, image processing and electronic

mapping and driving control, is iteratively and recursively integrated so as to yield real-time optimization.

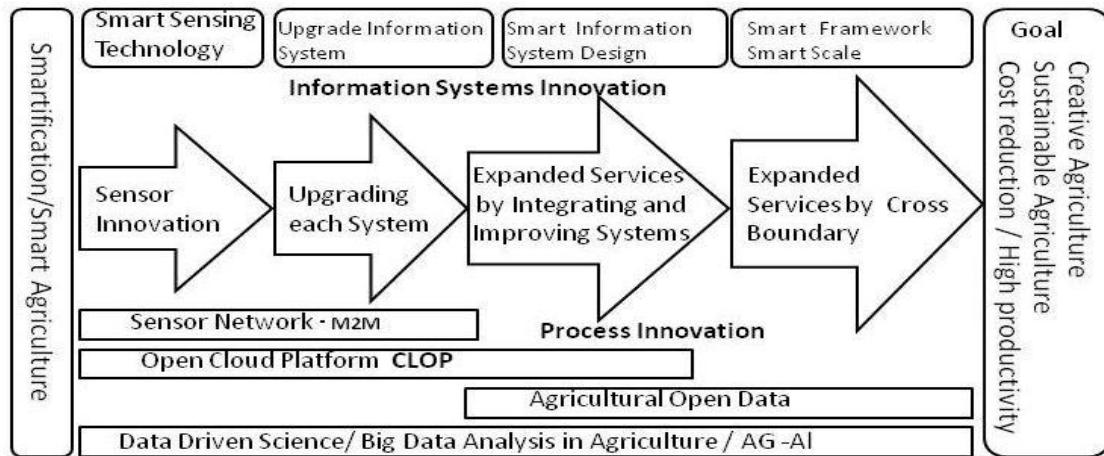


Figure 1. Road map for smart Agriculture

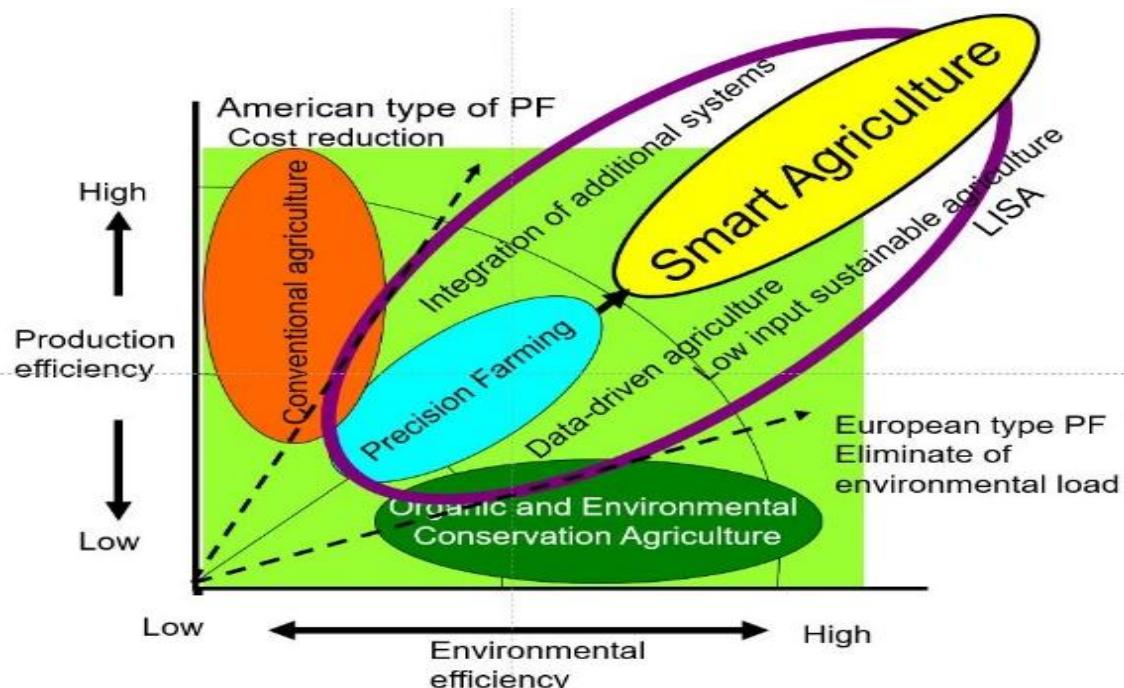


Figure 2. Position of Smart Agriculture

Anything around us can be a target for the implementation of smart technology and can result in improvements in efficiency and convenience, as well as cost reduction within discrete systems; what is more, as exemplified in "smart grid" systems, smart technology can make possible the integration of systems related to efficient and eco-friendly energy usage and assist in the development of a sustainable society. (Fig.1)

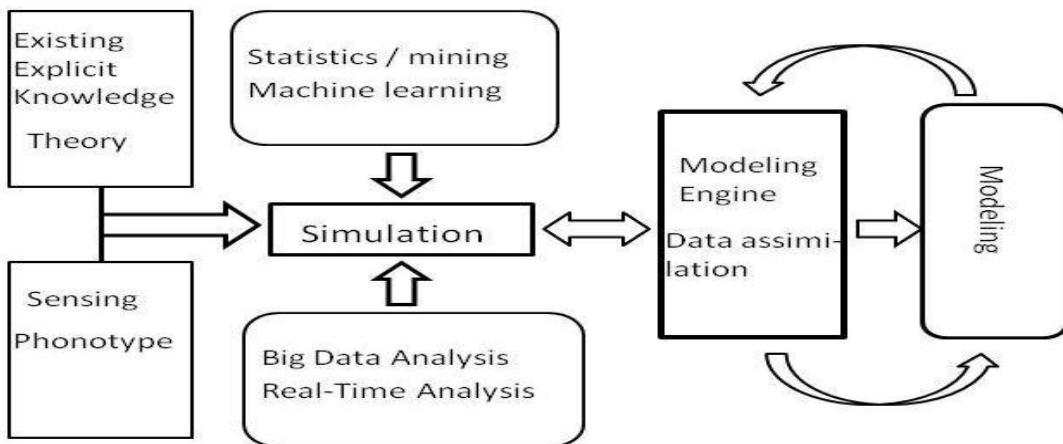
## 2. ICT foundations in agriculture

The movement towards digitization has had a big impact on the progress of component discrete ICT technologies; such progress will continue to play a significant role in systems innovation. For instance, improvements in the accuracy of

GPS technology have made possible quantifications of previously unmeasurable phenomena. This is a fundamental innovation akin to achieving increased processing capacity in computers. Near-infrared biosensors,

tractor GPS guidance sensors, rice-tasting sensors, various GAS density sensors

have all contributed to the systematization of smart technology at agricultural sites.



*Figure 3. Modeling*

Today, our ICT infrastructure consists of sensors, networks, cloud platforms and terminal devices. The advancement in high-speed networks and server computers has led to the development of cloud computing services such as SaaS and PaaS. Various cloud computing services are now indispensable tools that support the efficient and innovative uses of smart devices such as computing tablets and mobile terminals. IoT (Internet of Things) allows an endless range of things to be embedded with smart sensors that can communicate with one another and to be seamlessly integrated into information networks. Smart cloud computing infrastructures enable increasingly flexible and innovative uses of big data in agriculture. Applications of smart technology in agriculture can be found in the form of automated systems for recording, farm management systems, tractor operation data and management, field, facility, fertilizer and production management systems, fruit and produce cultivation, selection, sorting and shipment management systems.

### **3. Development of smart systems in agriculture and its challenges**

Because agriculture deals with biological organisms, as opposed to static objects, the implementation and uses of ICT systems in agriculture face challenges not found in other frameworks. Key factors for ICT implementation in agriculture include sensing and modeling the environment, namely of biological state and of the soil,

as well as crop growth prediction and algorithm development for their cultivation. While much effort has been made in the investigation and development in this area, very little progress has been observed. Successful growth of a crop depends on many variables, such as its species type, climate, soil and various environmental characteristics specific to a given region. The ability to study crop biology scientifically and to systematize acquired information from a bioinformatics perspective is critical in the successful implementation of smart agriculture. To date, there exist very few systems engineers (SE) who possess expertise in both descriptive field biology as well as bioinformatics who would be able to integrate these approaches.

By quantifying acquired data and formalizing underlying relationships between variables, modeling enables the prediction of output from a given set of inputs. For example, a model-based automatic variable fertilizing controller can be constructed to prescribe the appropriate amount and types of fertilizers according to crop yields of the land. Clearly, what is considered appropriate depends on how well the model reflects the real state of affairs. In one example, data of mandarin oranges at fruit sorting facilities are passed through prescriptive modeling systems and results are fed back into the site for iterative fertilization and sorting operations.

The development of prescriptive modeling systems draw upon results from longitudinal testing data, which have been quantified and from which correlation coefficients and other numerical tools will be developed. The use of big data and the development of innovative methods of analyses have shown promise; sparse farming cycles and data collection limited to once to only a few times a year poses challenges to accumulation of data sufficient for robust modeling.(Fig. 3) There exist many challenges ahead, from the collection of terabytes of data and the standardization of bio-sensor data collection. Nonetheless, big data analysis of crop cultivation is an invaluable technique for smart farming.

#### 4. Case study of Smart Agriculture

##### 1)Cloud type solution

Face farm is a production history management system for agricultural management. The farm work records and growth record of each field, and input on the fly while checking in satellite photos

(Google maps), can be aggregated in automatic. Face farm production history, type personal computer, tablet terminal, the daily farm work from smartphone, record of cultivation performance data, productivity analysis of each field, such as for the next fiscal year cultivation plan, can be performed easily.

Listening to raise the level of management force "visualization of data." What is important to long-term continued development of farming, the first thing to know of their management. If management analysis directly take advantage of the bookkeeping. Aggregate data, their "strength" or "problems" which has been vaguely ever can be clearly recognized. This "awareness" what, I will be a big force towards the future of continued development.

Face Farm has 2 main functions, one of production record and other one is business analysis by cloud computer services.(Fig.4)

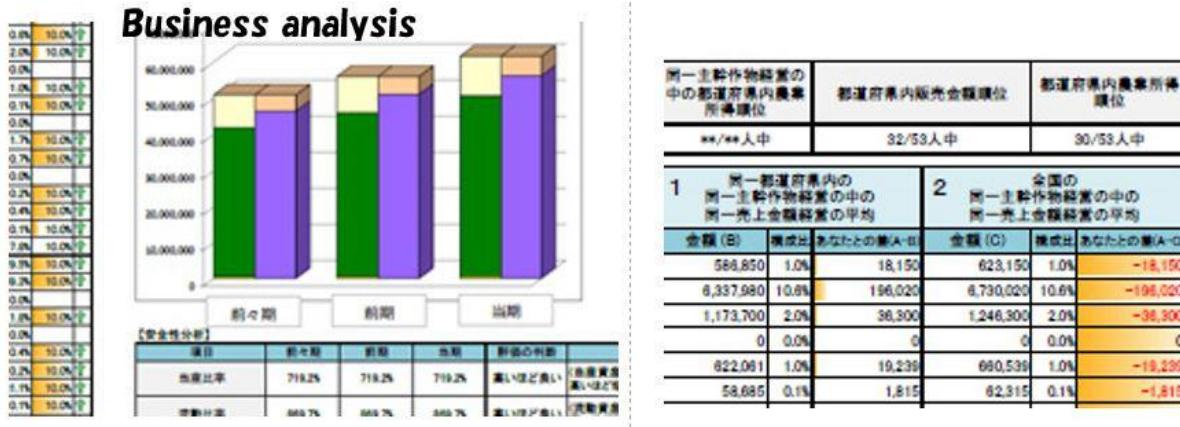


Figure 4. Face Farm

##### 2)KAIZEN for Rice production(MRP for Agriculture) by TOYOTA

"HOUSAKUKEIKAKU" has become a cloud service for rice production. agricultural corporation is easily available from smart-phones and tablet devices. In the system, a large number of paddy multiple workers registered on the map in such a way can work efficiently, work plan for each day is automatically created. (Fig. 5)

Make sure the area to be working with GPS

- 1)improvement of management level
  - 2)reduction of material cost
  - 3)improvement working efficiency
- HOUSAKUKEIKAKU can create the daily work reports automatically.  
(who,where,what kind of work,how much use,how long time work)  
accumulates the data analysis can be utilized for making delicious rice at a lower cost

## KAIZEN for Agriculture



Figure 5. Housakukeikaku



## ● Visualization of farm management ● Fusion of agricultural machinery and ICT



Figure 6. KSAS by KUBOTA

### 3) Cloud type solution services by Tractor company

KUBOTA has developed the KUBOTA Smart Agri. System (KSAS) as a new system that uses information communications technology (ICT) to assist with farming and related services. KUBOTA began offering this service in June 2014. At the same time, introduced agricultural machinery compatible with KSAS and will help farmers improve agricultural operations and management using data accumulated from this machinery.

KUBOTA launched for the first time tractors able to transmit data about land cultivation work records and machinery operating performance, combine harvesters able to measure harvest yields for each farm and flavor variations, and rice trans-planters able to electronically adjust the amount of fertilizer applied.(VRT)

Data gathered by KSAS can be used to formulate agricultural work plans to find optimal harvest yields and rice crop flavors.(Fig. 6)

## REFERENCES

1. Takemi. Machida.,2014, Evolution and innovation of smart agriculture, Proceedings of JSAI 2014 Conference, 3-8.
2. M.Nagaki.,2014 Granddesign of Agricultural and Ruralin Japan, Proceedings of JSAI 2014 Conference,14-18,
3. Takemi.Machida.,2014 Smart Agriculture , NourinToukei pubulishing,8-13,2014
4. Masayuki Hirafuji.,2014,Agricultural Big Data Analyzing System with Open-sourceTechnologies and CLOP(CLoud Open Platform),Proceedings of AFITA 2014,217-222,
5. http:// <http://facefarm.jp/>
6. <http://jp.fujitsu.com/solutions/cloud/agri/>
7. <https://ksas.kubota.co.jp/function/>
8. [https://www.yanmar.com/jp/technology/smart\\_assist.html](https://www.yanmar.com/jp/technology/smart_assist.html)
9. [http://www.agriculture-jp.com/news\\_nlqnVEia.html](http://www.agriculture-jp.com/news_nlqnVEia.html)
10. http://newsroom.toyota.co.jp/en/detail/1571544

## **GRAIN FOOD PRODUCTS FROM BARLEY AT INNOVATIVE PRODUCTION TECHNOLOGIES**

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### **ABSTRACT**

*The studied by-products of barley obtained with the use of traditional and innovative approaches. Found that innovation in the production of cereals and flour from barley allow you to save in the processing of mineral substances, many of which are important for the human body is the New technology contributes to the enrichment of flour dietary fibre and dextrin.*

**KEYWORDS:** minerals, flour, dextrin, fiber.

### **INTRODUCTION**

Toasted grains of wheat, barley and derived cereals and flour, from time immemorial, are a traditional food of Central Asian people – the Buryats, Tuvinians, Altaians, Khakas, Mongols and Tibetans. Tibetan medicine recommends to consume these products with diabetes, diseases of the kidney, lung, sclerosis. They help to normalize the acid-alkaline balance, dissolving cholesterol and salt deposits.

Research opportunities innovative filling traditional cooking technology, conducted by us showed great possibilities in the organization of production of instant cereals and a new kind of flour. As the

most effective way of improving the known technology proposes to develop us blagodarova processing (WTO) crops [1]. It is established that vegetablesa processing of grain allows for a 40-50% reduction in the technological process of production of instant cereals, ready to eat flour. Studies have shown that this significantly reduces the resource consumption, the yield of products is increased by 7-20% and more in comparison with the traditional technology. New technology of processing of grain allows to save mineral substances, food fibers, vitamins in the product.

## MATERIALS AND METHODS STUDIES

Objects of research were pearl barley, flour, produced by traditional technology and grits "Zamba" flour "New", obtained with the use vegetableoil processing (WTO) of barley grain on innovative technology. The definition of the content of macro - and trace elements in the solutions obtained after decomposition of the samples in the microwave system, conducted by atomic absorption technique in air-acetylene flame spectrophotometer

Solaar M6 (Thermo Electroh Co, USA), determination of mercury and selenium with mercury-hydride attachment to the spectrophotometer VP-100. The definition of the content of dextrins – spectrophotometric method. Determination of ash content GOST 26312.5.84, Sampling — according to GOST 26312.1-84. Determination of color, odor, flavor and crunch — according to GOST 26312.2-84 [3].

## RESEARCH PROCESSING AND RESULTS

The aim of this work was study of qualitative characteristics of new types of by-products from barley. It is established that the flour is "New" cereals and "Zamba" are characterized by high organoleptic properties, have a pleasant taste and aroma. Research ash content of barley flour of the "New"

showed that it contains 0.6-0.7% more minerals than conventional flour, the ash content of which amounted to 1.90 percent. Comparative study of mineral composition of flour and groats obtained by traditional and innovative processing technology. The results are presented in table 1.

Table 1.

Mineral composition, 100 g product

Mineral elements	Traditional technology		Innovative technology	
	Перловая крупа	Мука ячменная	Крупа «Замба»	Мука «Новая»
Ash content, %	0.75	1.70	1.95	2.57
Macroelements, mg				
K	17.2	15.7	45.2	21.3
Ca	5.8	9.8	19.0	11.9
Mg	9.2	4.4	14.0	8.2
Na	10.0	23.0	28.0	30.1
Trace elements, mg				
Mn	6.5	16.8	-	23.5
Fe	1.8	6.0	6.4	8.9
Cu	2.8	1.1	1.3	1.2
Ni	2.0	0.6	1.2	0.3
Zn	9.2	1.8	6.7	7.5
Cr	-	0.9	5.5	0.9
Hg	н/о	-	0.01	0.02
Pb	0.2	0.2	0.3	0.2
As	0.2	0.2	0.2	0.2

The data obtained show that the innovative technology of cereals and flour from barley that can be stored in the processing of mineral substances, many of which are important for the human body. So, iron is the main structural component of hemoglobin and hematodermic enzymes: catalase, peroxidase and cytochrome – main catalysts of redox processes. The imbalance of this element causes severe anemia and other blood

disorders. A higher content in the flour is "New" and croup "Zamba" calcium, magnesium, iron, sodium and potassium. This element remained in the rump "Zamba" in the amount of 6.4 mg/kg, and the flour is "New" the iron content was 8.9 mg, which exceeds its content in pearl barley 3.6 times. Along with iron for the redox processes occurring in any living organism are known to be involved copper. Copper is a component of many

enzymes and proteins involved in redox processes. It is part of ceruloplasmin animals and humans, as well as in the composition of plastocyanin plants and is a cofactor in important enzymes such as cytochrome oxidase, polyphenol-, di-, amino and ascorbic acid. The contents in the innovative products of this element is higher than in the pearl barley and barley flour. It is important that the zinc, copper and iron, contained in the product work synergistically with each other [2].

Thus, we can conclude that the innovative method for the production of flour and cereals with the WTO significantly increases the biological value of the product and contributes to the preservation of micro - and macroelements.

Research on quality evaluation of barley flour "New" in fiber and pectin substances of importance showed significant differences. The results are presented in table 2.

Table 2.  
Content of cellulose and pectin substances in barley flour compared to the barley flour by traditional technology

Content, % on dry matter	of Barley flour on traditional technology	of Barley flour "New"
Fiber	0.35	1.32
Pectin	0.28	0.61

The fiber and pectin in barley flour "New" is significantly higher than their content in barley flour according to the traditional technology. This is because in the production of flour according to the traditional technology in the process of peeling and grinding removes the shell and the peripheral layers of the endosperm, which is a source of fiber and pectin, in the production of barley flour "New" these processes are excluded.

As fiber and pectin substances necessary to human body for normal digestion, lack of fiber in the diet contributes to the development of obesity, gallstones, cardiovascular diseases, occurrence of constipation and other diseases, it follows that received barley flour can be used in the diet and is a valuable product.

During technological processing under the action of enzymes and heat accumulated dextrins. The results are presented in table 3.

Table 3.  
Effect of WTO on the content of dextrin in barley flour is "New"

Hydration of the grain, %	Time of malting, h	Content of dextrins, %
0	0	0.67
16	16	1.42
18	18	1.92
20	20	2.45

Changes in the grain at the WTO contribute dextrinization starch and flour has a higher content of dextrins in comparison with the control sample. As a result of conducted research we can conclude that the innovative technology of processing of barley significantly affected

the quality of flour and cereals. Grain products have good organoleptic characteristics, higher nutritional value, are valuable foodstuff and raw materials for the production of bakery products with functional properties.

## CONCLUSION

Thus, changes in the grain at the WTO contribute dextrinization starch and flour has a higher content of dextrins in comparison with the control sample. As a result of conducted research we can

conclude that the innovative technology of processing of barley significantly affected the quality of flour and cereals. Grain products have good organoleptic characteristics, higher nutritional value,

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## REFERENCES

1. Khalapkhanova L. V., Sangitova R. D., Tsybikova G. Ts. Effect of intensification of technological process of processing of barley quality barley flour //Mat. Intern. scientific. scient. Conf. "Technique and technology of food Science. Education. Achievements. Innovation": Ulan-Ude, 2016. – P. 163-169.
2. Tsybikova G. Ts., Darhanova T. A., Ayusheeva G. O. Traditional cereal food products "Zamba" innovative production technology // Mat. VII conference of young scientists and specialists of Russia: Ulan-Ude, 2013. P. 97-99
3. Popov M. P., Shanenko E. F. Method for the determination of dextrans and amylose with the simultaneous presence in solution. –Sat.: Improvers quality food products. - M.: MTIP, 1977. - S. 29-35

## **INVESTIGATION OF BIOLOGICAL NUTRIENT REMOVAL (BNR) PROCESS OF WATER TREATMENT SYSTEM**

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### **ABSTRACT**

*Our research team studied the possibility of natural zeolite for ammonium ions from aqueous solution. We researched the batch study that the effect of relevant parameters such as pH, adsorbent dosage, contact time and initial ammonium concentration. Also, the removal capacity of clinoptilolite improved during our experiment. Furthermore, we studied which the Langmuir and Freundlich models were applied to describe the equilibrium isotherms for ammonium. Based on the results, we concluded that the natural zeolite is suitable for removal of NH<sub>4</sub><sup>+</sup> ions of the wastewater. Therefore, wastewater's Ammonia's nitrogen contributes to accelerated eutrophication of lakes and rivers. Furthermore, we investigated that it effected, strongly at the dissolved oxygen depletion and fish toxicity in water. The BNR process of water and wastewater treatment consists of the nitrification and denitrification. Therefore, these process are suitable for water and wastewater treatments. The various wastewater, especially industrial wastewater contains higher concentration nitrogen compounds are: ammonium, nitrate, nitrite and nitrogen organic and inorganic compounds. Organic nitrogen compounds usually contains at industrial wastewaters. Particularly, Tannery wastewater has the organic and inorganic nitrogen compounds, highly.*

**KEYWORDS:** Clinoptilolite, natural zeolites, ammonium ion, aqueous solution.

### **INTRODUCTION**

Mongolia is high resource of the natural zeolite deposit. Especially: Dornogovi, Umnogovi province etc. Mainly, it has Clinoptilolite zeolite. It is natural very effective in removing ammonia from wastewater. Natural zeolite is porous and hydrated aluminosilicate material which is high adsorbent and ion exchange capacity (IEC).[1]

The general formula of natural zeolite:



In general formula, M<sup>+</sup> and M<sup>2+</sup> are monovalent and divalent cations such as

Na<sup>+</sup>, K<sup>+</sup> and Ca<sup>2+</sup>, Mg<sup>2+</sup>, Ba<sup>2+</sup>, respectively. It is called the exchangeable cations. Al<sup>3+</sup> and Si<sup>4+</sup> are known as the structural cations, and they make up the framework of natural structure with O.[1] In many investigations, reported the use of natural zeolite as a sorbent for trace metals, N compounds and cations. [2-6]

The main objectives of this study were to investigate the effect of pH, dosage of adsorbent and shaking time on ion exchange of NH<sub>4</sub><sup>+</sup> by the natural Mongolian (Urgun) zeolite from aqueous solution and to determine the equilibrium isotherms.

In Mongolia, the Environment and metrology lab report shows, that wastewater treatment plant effluents contain much higher levels of ammonia

than permitted [10]. Therefore, it is necessary to reduce the ammonium contents.

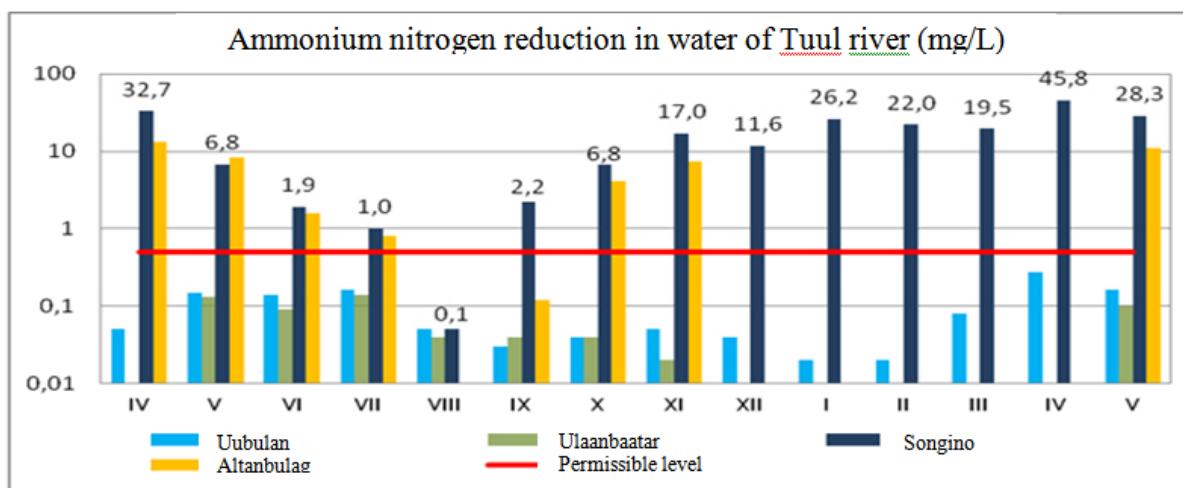


Figure 1. Ammonium nitrogen reduction in water of Tuul River (mg/l)

## EXPERIMENTAL PART

The clinoptilolite used as ion exchanger in the experiments was obtained from Mongolia deposit, in the province of

Dornogovi. The chemical composition of the clinoptilolite used in the study is shown in Table 1.

Table 1.

Chemical composition of clinoptilolite

Component	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	LOI
(%)	65.78	0.36	13.7	2.25	1.44	0.96	2.99	2.68	0.09	9.64

The natural zeolite sample was crushed in a mortar and sieved using 100 µm sieve. The crashed sample was dried in an oven at 105°C for 6 h before is used in experiments. Preliminary experiments were conducted to optimize general pattern for NH<sub>4</sub><sup>+</sup> ion removal from aqueous solution; pH of solution, dosage of adsorbent and shaking time. The ion exchange of NH<sub>4</sub><sup>+</sup> ion on the zeolite was carried out using batch method. The batch experiments were conducted by mixing 0.5g adsorbent with 50ml of ammonia solution in the range of 1-30mg/l. Analytical grade ammonium chloride salt (NH<sub>4</sub>Cl) and deionised water were used in the preparation of the stock NH<sub>4</sub><sup>+</sup> solutions. The stock solutions was diluted to prepare for working solutions. The conical flasks containing sorbate and sorbent were placed in shaker and shaken at room temperature. After equilibrium

time, samples were filtered through whatman 42 filter paper. The equilibrium concentrations of ammonium were determined analyzing samples after filtration by using the colorimetric method with the Nessler solution. The removal efficiency (%) and the amounts of exchanged NH<sub>4</sub><sup>+</sup> ion (Q<sub>e</sub>) by the zeolite were calculated using Eqs. (1) and (2), respectively

$$R(\%) = \frac{(C_0 - C_e) \cdot 100}{C_0} \quad (1)$$

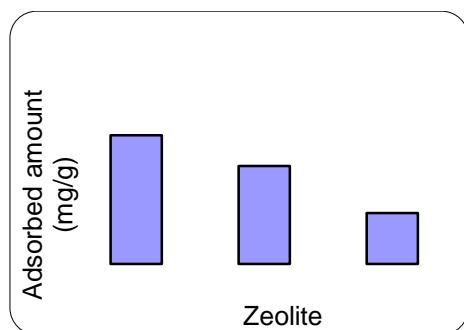
$$Q_e = \frac{(C_0 - C_e) \cdot V}{m} \quad (2)$$

Where Q<sub>e</sub> is the amount of exchanged ammonium ions (mg/g), C<sub>0</sub> and C<sub>e</sub> are the initial and equilibrium concentrations of ammonium in solution (mg/L), respectively. V is the solution volume (L) and m is the adsorbent weight (g).

## RESULTS AND DISCUSSION

For the purpose of an increase in the cation - exchange capacity of natural zeolite were activated by solution 0.1N HCl and 0.1N NaCl. Two replicates of 10g of natural zeolites were shaken with 200ml of 0.1N HCl and NaCl salt for 7 hours. The exchanged forms washed with distilled water and dry in an electric oven at 105°C for 2-3 hours before using adsorption purpose.

The adsorbed amounts were determined using equation 1. The amounts of adsorption were determined 0.25mg/g, 0.48mg/g and 0.63mg/g as a natural zeolite, the zeolite that formed its exchangeable cations to Na and the zeolite that formed its exchangeable cations to H, respectively.( Figure - 1).

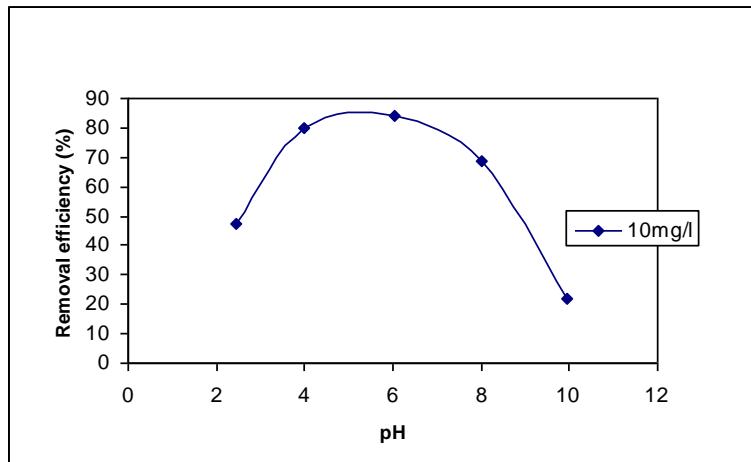


*Figure 2. The effect of exchangeable cation (N-Z is natural zeolite, Na-Z is Na form zeolite, H-Z is H form zeolite, NH<sub>4</sub><sup>+</sup> ion concentration 10mg L<sup>-1</sup>; adsorbent dosage 0.5g; shaking time 180 min; temperature 20°C).*

### EFFECT OF PH

The removal of NH<sub>4</sub><sup>+</sup> ion from aqueous solution using the natural zeolite was studied at pH values 2-10, with the initial

concentration of ammonia of 10 mg/L, and the obtained data are given in Figure 2.



*Figure 3. The effect of pH on NH<sub>4</sub><sup>+</sup> ion removal using the natural zeolite (NH<sub>4</sub><sup>+</sup> ion concentration 10mg L<sup>-1</sup>; adsorbent dosage 0.5g; shaking time 180 min; temperature 20°C).*

The removal efficiency increase with increase of pH from 2 to 6, reaching a maximum value at pH 6, and then decreased at pH 10. The decrease in the

NH<sub>4</sub><sup>+</sup> removal efficiency after pH 6 may be due two factors: (a) partial dissolution of the natural zeolite; (b) the conversion of NH<sub>4</sub><sup>+</sup> into NH<sub>3</sub> specimen [7].

## EFFECT OF ADSORBENT DOSAGE

The effect of adsorbent dosage on removal efficiency of  $\text{NH}_4^+$  ion was studied with 0.1, 0.3, 0.5, 1.0 and 1.5g zeolite, and

with initial concentration of ammonia of 10 mg/L, and the results obtained were given in Fig.3 4.

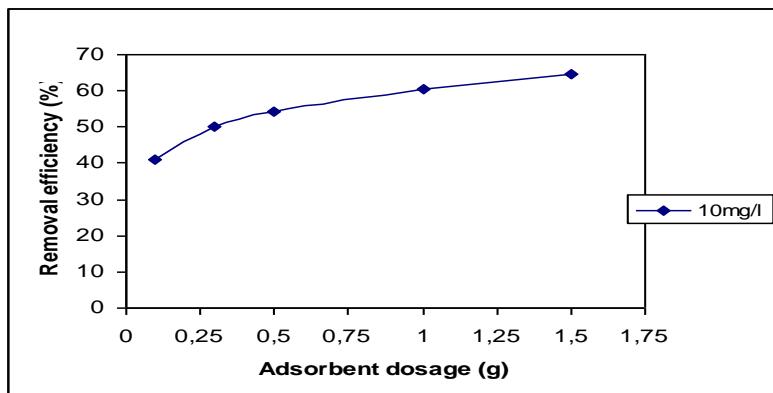


Figure 4. The effect of adsorbent dosage on  $\text{NH}_4^+$  ion removal using the natural zeolite ( $\text{NH}_4^+$  ion concentration 10mg L<sup>-1</sup>, shaking time 180 min, temperature 20°C).

The removal efficiency of  $\text{NH}_4^+$  ions by the zeolite increased with increasing the amount of zeolite, and a plateau occurred at 1.0g of adsorbent. Fig.3 4 also indicated that the  $\text{NH}_4^+$  ion removal did not change at higher amounts of adsorbent than 1.0 g. This may be attributed to the formation of aggregates at higher solid/liquid ratio or precipitation of particles.

**3.4. Adsorption and Langmuir isotherm**  
Two important physiochemical aspects for the evaluation of the adsorption process as a unit operation are the equilibria of the adsorption and the kinetics. Equilibrium studies give the capacity of the adsorbent [9]. The equilibrium relationships between adsorbent and adsorbate are described by adsorption isotherms, usually the ratio between the quantity adsorbed and that remaining in solution at a fixed temperature at equilibrium. There are two common types of adsorption isotherms: Langmuir adsorption isotherms and Freundlich adsorption isotherms

Irving Langmuir, an American chemist who was awarded the Nobel prize for chemistry in 1932 for "his discoveries and researches in of surface chemistry", developed a relationship between the amount of gas adsorbed on surface and the pressure of -gas. Such equations are now referred as Langmuir adsorption isotherms, a theoretical adsorption isotherm in the ideal case. The Langmuir adsorption isotherm is often used for

adsorption of a solute from a liquid solution. The Langmuir adsorption isotherm is perhaps the best known of all isotherms describing adsorption and is often expressed as: [10]

$$Q = Q_{\max} \cdot \frac{K \cdot C}{1 + KC} = Q_{\max} \cdot \frac{C}{1/K + C} \quad (3)$$

$Q_{\max}$  – maximum adsorption capacity (mg/g)

$K$  – an adsorption constant (L/g) and  $a=1/K$

$C$  – metal initial concentration

Then, by raising both members of the previous equation at -1 it is possible to obtain following expression:

$$\frac{1}{Q} = \frac{a + C}{Q_{\max} \cdot C} = \left( \frac{a}{Q_{\max}} \right) \cdot \frac{1}{C} + \frac{1}{Q_{\max}} \quad (4)$$

Considering the axes  $y=1/Q$  and  $x=1/C$ , it is possible to have a linear function of the type  $y=dx+b$ , where  $d=a/Q_{\max}$  and  $b=1/Q_{\max}$ . Then  $1/Q_{\max}$  is equal to the intercept of this straight line on the vertical axis, while  $a/Q_{\max}$  is the slope of the straight-line equation. The correlation coefficient ( $R^2$ ) and  $b$  and  $d$  values have been obtained from the linear equation. By this procedure  $Q_{\max}$  and  $a$  have been derived for each tracer in each soil.

### Freundlich isotherm

Herbert Max Finley Freundlich, a German physical chemist, presented an empirical adsorption isotherm for non ideal systems in 1906. The Freundlich isotherm is the earliest known relationship describing the adsorption equation and is often expressed as: [10]

$$Q_e = K_f \cdot C_e^{\frac{1}{n}} \quad (5)$$

Where:

$Q_e$  - is the adsorption density (mg of

adsorbate per g of adsorbent)  
 $C_e$  - is the concentration of adsorbate in solution (mg/l)

$K_f$  - and  $n$  are the empirical constants dependent on several environmental factors and  $n$  is greater than one. This equation is conveniently used in the linear form by taking the logarithm of both sides as:

$$\log(Q_e) = \log(K_f) + \frac{1}{n} \log(C_e) \quad (6)$$

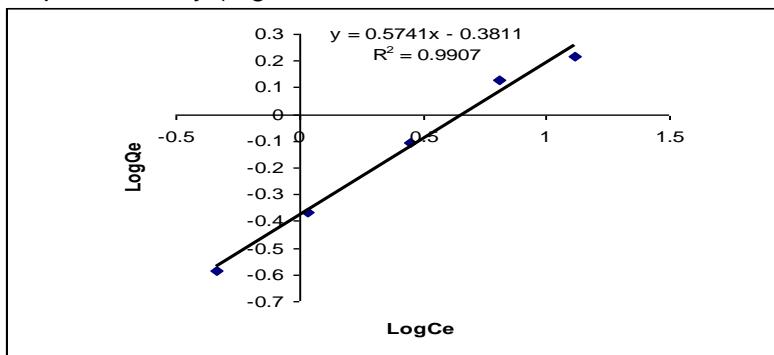


Figure 5. Linear Freundlich isotherm of ammonium ion by zeolite

A plot of  $\ln C_e$  against  $\ln Q_e$  yielding a straight line indicates the confirmation of the Freundlich isotherm for adsorption. The constants can be determined from the slope and the intercept.

Table 2

Langmuir constant and Freundlich constant

$T(^{\circ}\text{C})$	Langmuir constant		Freundlich constant		
	$Q_{\max}$ (mg/g)	$K$ (l/mg)	$K_f$ (mg/g)	$n$	$R^2$
30	1.64	0.345	0.4158	1.74	0.9907

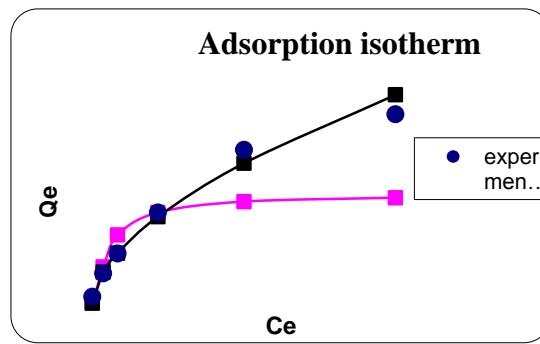


Figure 6. Adsorption isotherms at pH 6.0 and  $T=30^{\circ}\text{C}$

The isotherms are compared based on the parameter values with experimental data at  $30^{\circ}\text{C}$  as shown in Fig. 7. Freundlich isotherm shows better fit than Langmuir isotherm.

#### 3.4.1. Effect of the initial ammonium concentrations

Ammonium exchange by natural clinoptilolite was studied at different initial  $\text{NH}_4^+$  concentrations in the range of

5mg/L-30mg/L. As shown in Fig.3, ammonium exchange capacity increased with increasing of the initial  $\text{NH}_4^+$  concentration and this is the result of an increase in the driving force. [8]. For lower initial concentration of the  $\text{NH}_4^+$ , equilibrium time was lower than for higher concentrations because of the increased competition for the active sites with increasing in of  $\text{NH}_4^+$  concentration. This

may be an indication that the ion-exchange surface becomes increasingly saturated with ammonium ion.

### 3.5 Effect of contact time

Fig.4, 5 shows that ammonium ion removal by clinoptilolite was very fast

within the initial 15 min, and thereafter did not change since equilibrium is attained

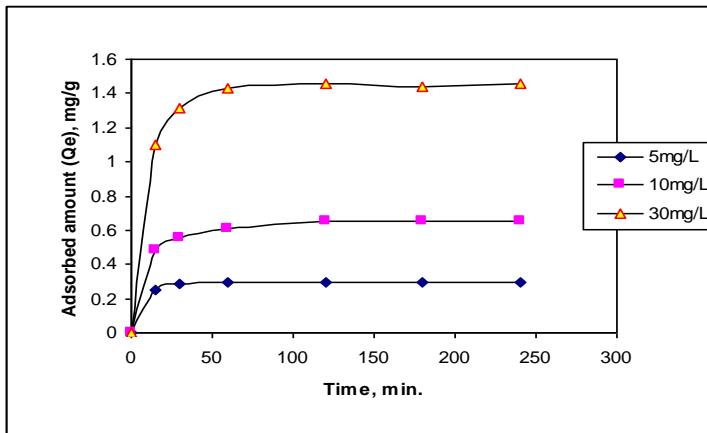


Figure 7. The effect of contact time on  $\text{NH}_4^+$  ion removal using the natural zeolite ( $\text{NH}_4^+$  ion concentrations: 5mg L<sup>-1</sup>, 10mg L<sup>-1</sup> and 30mg L<sup>-1</sup>; adsorbent dosage: 0.5g; pH: 6; temperature: 20°C).

## CONCLUSION

The experimental parameters such as solution pH, contact time, and adsorbent dosage influenced  $\text{NH}_4^+$  ion removal from aqueous system by the zeolite. Freundlich model yield a much better fit than that of the Langmuir model.

Based on the results, it can be concluded that the natural Mongolian

(Urgun) zeolite is suitable for  $\text{NH}_4^+$  ion removal from aqueous solution. Moreover, it can be recommended for wastewater treatments and agricultural purposes in terms of sustainability of environmental quality.

## REFERENCES

- [1] J.B.Dixon, S.B.Weed (1989) Mineral soil Environment, SSSA Pub.Inc., Madison, WI, p.585-610.
- [2] Z.L.He, D.V.Calvert, A.K.Alva (2002) Clinoptilolite zeolite and cellulose amendment to reduce ammonia volatilization in a calcareous sandy soil, Plant Soil 247, 253-260.
- [3] M.Amon, M.Dobeis, R.W.Sneath, V.R.Philips, T.H.Misselbrook, B.F.Pain (1997) A farm-scale study on the of clinoptilolite zeolite and debodoras for reducing odor and ammonia emission from broiler houses, Bioresour. Technol.,61, 229-267.
- [4] A. Chlopecka, D.C.Adriano (1997) Influence of zeolite,apatite and Fe-oxide on Cd and P, uptake by crops, Sci. Total Environ., 207, 195-206.
- [5] T.S.Perrin, J.L.Boettinger, D.T.Drost, J.M.Noron (1986) Decreasing nitrogen leaching from study soil with ammonium loaded clinoptilolite, J.Environ. Qual.,27, 656-663.
- [6] US-EPA (1971) Optimisation of ammonia removal by ion exchange using clinoptilolite, EPA report, Project-17080.
- [7] E.Maranon, M.Ulmanu, Y.Fernander, I.Anger (2006) Removal of ammonium ion from aqueous solution with volcanic tuff, J.Hazard. Mater., 136(1), 502-512.
- [8] Y.S.Ho, T.H.Chiang, Y.M.Hsueh (2005) Removal of basic dye from aqueous solution using tree fern as a biosorbent, Process Biochem., 40, 119-124.
- [9] G.M.Haggerty, R.S.Bowman (1994) Sorption of chromate and other inorganic anions by organo zeolites, Environ. Sci. Technol., 28, 452-458.
- [10] T.J.Casey (1997) Unit Treatment Processes in Water and Wastewater Engineering, John

## A STUDY COMPARING OF EFFICIENCY WORM GEAR

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### ABSTRACT

*Of all the different types of gear configurations, worm gear systems are considered some of the most problematic because they present unique lubrication challenges due to their distinct design. To overcome these challenges, you must understand not only the complexities of worm gears but also which qualities to take into account when choosing a worm gear lubricant. Worm drives can present a unique boundary lubrication challenge, with the focus more on friction reduction than on the effects of wear.*

**KEYWORDS:** Oil, equipment, friction, load

### INTRODUCTION

A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear). The two elements are also called the worm screw and worm wheel. The terminology is often confused by imprecise use of the term worm gear to refer to the worm, the worm gear, or the worm drive as a unit. Like other gear arrangements, a worm drive can reduce rotational speed or transmit higher torque.

A worm is an example of a screw, one of the six simple machines. One of the

major advantages of worm gear drive units are that they can transfer motion in 90 degrees. Worm drives are inefficient because the gears experience sliding rather than rolling contacts, leading to operating temperatures much higher than other gear types.

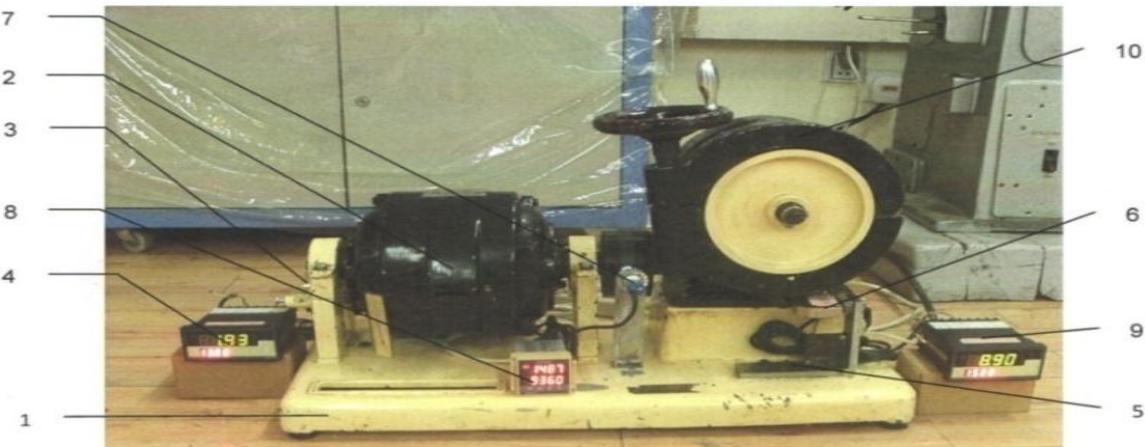
The following factors affect worm gear efficiency:

- Lead angle of the worm
- Sliding speed
- Lubricant
- Surface quality
- Installation conditions

### METHODOLOGY

The overall efficiency of a worm gear is a little lower because of friction losses in the bearings and shaft seals, and because of “churning” of the lubricating oil.

Test equipment (TMM39A) shown figure 1 and worm gear is technical specification shown table1.



*Figure 1. Installation of remote sensor in the worm gear*  
 1-Base of equipment, 2- electric engine, 3,6-remote sensor, 4,9-controller of force,  
 5-Base of driven elements, 7-remote sensor of metall,  
 8-controller of torque, 10- hand brake

Table 1.  
*Technical specification of Worm gear*

Items	Performance
Ratio of gearbox speed, $u$	28
Number of threads, $z_1$	1
Ratio of gear teeth, $z_2$	28
Module, $m$ [mm]	5
Pressure Angle	$7^{\circ}7'$
Pitch diameter, $q$ [mm]	8
Rotating speed, $n_1$ [mm/min]	1487
Torque of worm screw, $T_1$ [Hm]	4,82
Torque of worm wheel, $T_2$ [Hm]	97,17

## RESULTS

The test was carried out by installing a 3.8 kg load s-type sensor element in the driving shaft of the worm gear and a 9k load sensor element in the driven shaft and measured tangential forces  $F_{n1}$ ,  $F_{n2}$  respectively. Also, the number of rotating speed of driving shaft was measured by the sensor element. Three types of

lubricants such as TM-3-18 /TCP-15k/, TM-3-18 /TAP-15B/ and TCZ-14 were selected and used for conducting experiments. Measurement of three lubricant materials in total of four load values is shown in the table. It has show in table 2

Table 2.  
*Test result*

№	Load of driven gear	Load I (min)		Load II		Load III		Load IV (max)	
		The type of oil	$F_{n1}, H$	$F_{n2}, H$	$F_{n1}, H$	$F_{n2}, H$	$F_{n1}, H$	$F_{n2}, H$	$F_{n1}, H$
1	TM-3-18 /TCP-15k/	1,68	8,29	1,13	3,6	1,098	3,12	1,088	2,08
2	TM-3-18 /TAP-15B/	1,508	7,65	0,998	2,77	1,148	2,37	0,818	1,62
3	TCZ-14	1,501	8,81	1,0025	4,622	0,822	2,97	0,756	2,41

Table 3.

## Load of driven shaft

Load I	Load II	Load III	Load IV (max)
$N$ (H)	$N$ (H)	$N$ (H)	$N$ (H)
3,5	5,2	10,3	30,5

Table 4.

## The torque moment depends of the load

The type of oil \ Torque moment, Hm	$T_2$ (1)	$T_2$ (2)	$T_2$ (3)	$T_2$ (4)
TM-3-18 /TCP-15к/	567,604	246,486	213,964	142,41
TM-3-18 /ТАП-15В/	522,842	190,137	162,27	110,92
TCz-14гип	603,207	316,495	203,351	165,01

The graph shows the load of driven shaft and torque moments in the center of the ledge depending on the type of oil.

It has show in figure 2

Table 5.

## The efficiency depends of the load

The type of oil \ Efficiency	$\eta$ (1)	$\eta$ (2)	$\eta$ (3)	$\eta$ (4)
TM-3-18 /TCP-15к/	0,604877	0,390522	0,349	0,234
TM-3-18 /ТАП-15В/	0,621845	0,341089	0,253	0,243
TCZ-14	0,719477	0,565216	0,443	0,391

Depending on the type of oil, the load of driven shaft and the efficiency in the middle of the ledge is shown in graphic. It has show in figure 3.

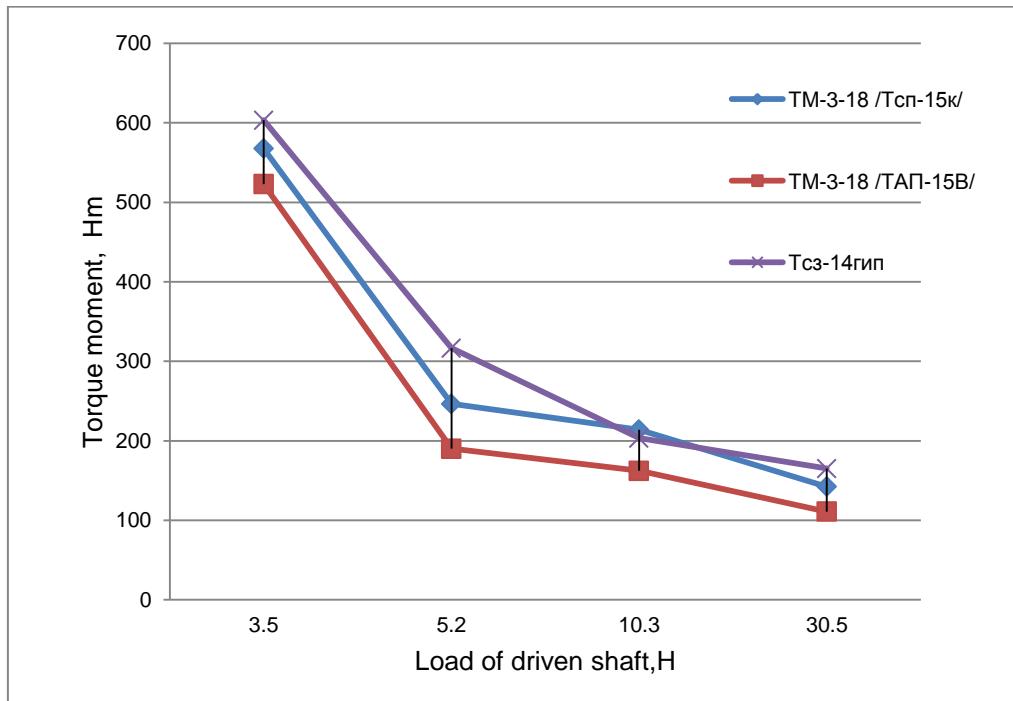


Figure 2. Relationship between torque moment and load

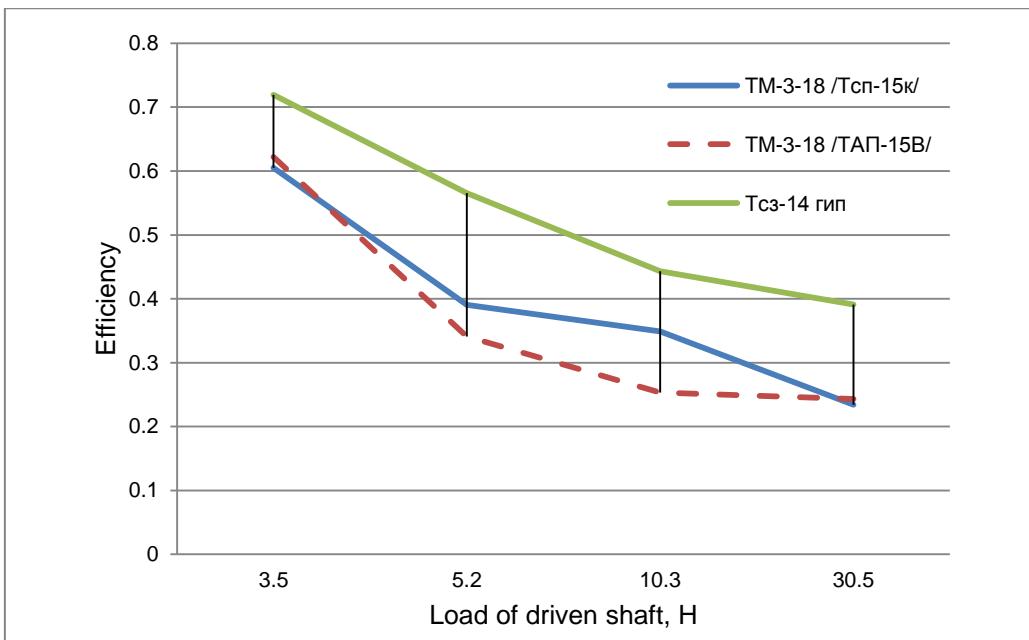


Figure 3. Relationship between efficiency and load

## CONCLUSION

There was a direct correlation between load of driven shaft and torque moment to the test results.

By comparing the efficiency coefficient of the driven shaft with lubrication material, the efficiency of TCZ-

14 lubrication coefficient was 0.72 and it was higher than other oils.

It shows that it is essential to select correct lubricant depending on the efficiency coefficient of the lubricants. This results in improved lubricity, reduced friction and decreased sliding wear.

## REFERENCES

1. Ch.Avdai, M.Ulambayar "Lubricants", 2000
2. G.Chimed-ochir, T.Namnan "Machine elements", 2009
3. Д.Н.Решетов, А.П.Гусенков, Ю.Н. Дроздов "Машиностроение энциклопедия", М. 1995
4. [http://robomec.blogspot.com/2010/07/blog-post\\_24.html](http://robomec.blogspot.com/2010/07/blog-post_24.html)
5. <http://www.uralves.ru>

## EXPERIMENTAL STUDY OF SOLAR AIR HEATER

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### ABSTRACT

*Mongolia has lot of sunny days, therefore heating supply of buildings by solar energy is one of the most effective choice for both environmentally and economically. A solar air heating system is one of the popular renewable energy collection supplying hot air for everyday life. Here, we designed heat collector of tin pail type. The size of the heat collector is 105cm in height, 85cm in width and the heat flux collected at the heat collector from sunlight was assumed 1.2kW/m<sup>2</sup>. The air velocity at the exit of the pipe operated in the heat collector was varied from 0m/sec to 6m/sec to see the change of the air temperature with the velocity. Finally we found that the maximum temperature of the exit on the heat collector shows 80°C as the forced air velocity at the exit is 6m/sec.*

**KEYWORDS:** Heat collector, heat flux, sunlight, air velocity, air temperature

### INTRODUCTION

Mongolian environmental pollution steady increased by usage of traditional energy resources for growth of energy consumption. 36.9% of air pollution in Ulaanbaatar is caused by utilization of raw coal for heating of ger district and Ulaanbaatar has second most polluted air in the world. Replacement of energy resources by the renewable energy is the one option to reducing of air pollution [1].

As a heating device that produces and supplies hot water by using solar energy, plate type or vacuum tube type collectors have already been introduced into our lives. However a simple type of air pipe type collector is more simple than conventional solar hot water collection system and it can heat air at room temperature above 75°C and can be used

as heating energy for living space. Therefore, it has economic advantages and more convenience of device system than solar hot water collection system. The energy conversion efficiency of the air-heated solar collectors is expected to be over 70% and the efficiency of the collector is lower than that of the conventional flat or vacuum tube type apparatus, which is 85%. But in terms of production cost of the heat collecting device, it can be lowered by 40%, which is about four times the economic effect.

In addition, the temperature of air that can be produced through this device is more than 75°C and the temperature that can be used for indoor heating in everyday life is more than 40°C. Therefore it has value of use in life. A solar air

heating system is one of the wonderful renewable energy collection systems supplying hot air in our daily life [2].

In this study, a simple flat plate type heat collector was designed and the

## DESING OF SOLAR AIR HEATER

When solar radiation is applied to an air heat flat solar collector, the surface of the tubes installed inside the collector's inner diameter increases and the internal air temperature rises. Due to this cause, the atmospheric pressure inside the tube is formed due to increased pressure inside the tubes, and the natural convection currents of air are formed. The program was used by the British CHAM to interpret the natural convection phenomenon of air inside the collector in a finite volume method.

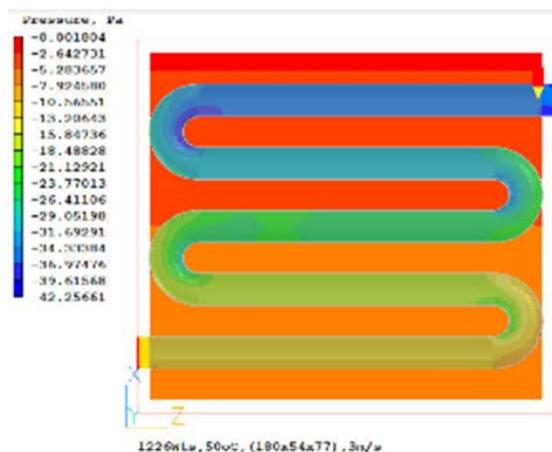


Figure 1. Variation of volume flow rate of air due to exit air velocity.

Fig.1 shows changes in air flow rates according to the variation in the rate of forced air discharge at the output pipe.

Production of warm air produced through this device can be found to produce warm air of up to a maximum of  $161 \text{ m}^3/\text{h}$  with a maximum discharge rate of 6 m/s.

heating performance of the system was analyzed numerically to understand the availability of the system for the practical application in industry.

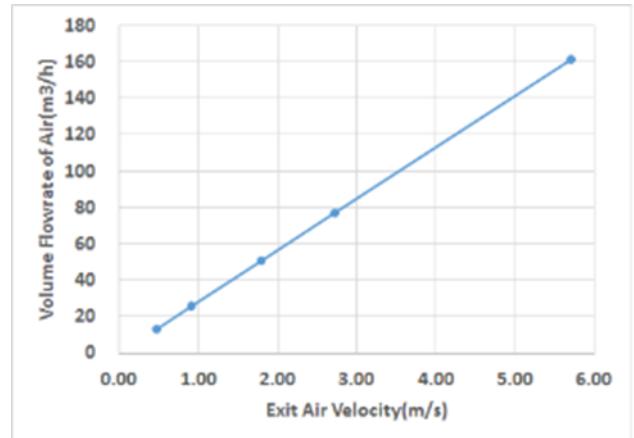


Figure 2. Changes on air temperature against output velocity of heat collector.

Fig.2 shows changes in air temperature due to changes in output velocity of heat collector. When the output velocity of heat collector exceeds 6m/sec, the temperature of output air is increased to  $40.5^\circ\text{C}$ .

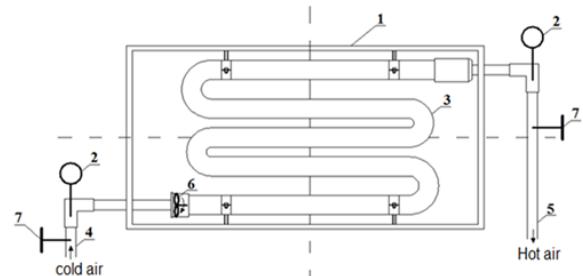


Figure 3. Schematic diagram of heat collector.  
1. collector box 2. temperature sensor 3. collector pipe 4. cold air input 5. hot air output 6. circulated fan 7. control valve

Fig.3 shows schematic diagram of heat collector. In heat collector, heat collector consist of aluminum pipes ( $\varnothing 10\text{cm}$ ) and U-type pipes.

The size of collector box is 105cm in length, 85cm in width and 20cm in depth. And the solar flux of heat collector was applied average  $1.2\text{kW}/\text{m}^2$ . The air velocity at the exit of the heat pipe installed in the heat collector was varied

from 0m/sec to 6m/sec to see the change of the air temperature with the velocity.

## RESULTS

From the study, it was found that the maximum temperature of the hot air at the exit of the model solar heat collector is  $80^{\circ}\text{C}$  as the forced air velocity at the exit is 6m/sec and the volume flow rate of the air is 161.3m<sup>3</sup>/h. This information would be incorporated to decide the reasonable size of the solar. The tilt angle of heat collector is adjusted  $45\sim60^{\circ}\text{C}$  on the horizontal surface.



Figure 4. 1. Actual air heating system  
2. Checking collector output temperature

Table 1.  
Various data of air heating system

No	time	solar flux (w/m <sup>2</sup> )	collect or output temp ( $^{\circ}\text{C}$ )	indoor temp ( $^{\circ}\text{C}$ )	ambient temp ( $^{\circ}\text{C}$ )
1	14:30	1040	50	20	-14
2	14:50	1040	53	24	-14.3
3	15:10	1045	60	25	-14.5
4	15:30	1043	56	23	-15.6
5	15:50	1033	48	22	-18.6
6	16:10	1015	34	20	-22

In table 1, On the over time, the lower the temperature of the solar flux, the lower the temperature of heat collector. An indoor temperature appears the heat loss considerably according to ambient temperature.

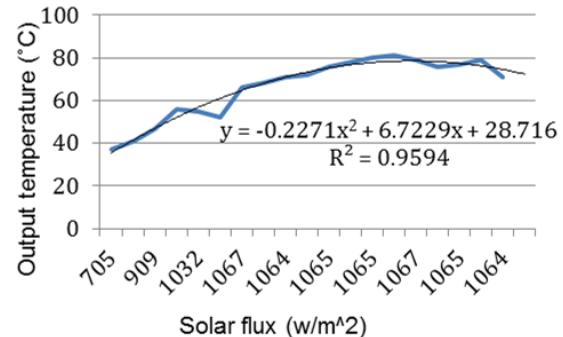


Figure 5. Collector output temperature against solar flux

In fig.5 the heat collector efficiency is shown as function of collector output temperature against solar flux. In especially, the Mongolia has a natural condition of solar power plant that products solar energy because of its average solar flux, which has an average solar flux of 1.2kW/m<sup>2</sup> per year, compared with other countries. Thus, the temperature difference between sunrise and sunset shows a temperature difference of 10~20 degrees.

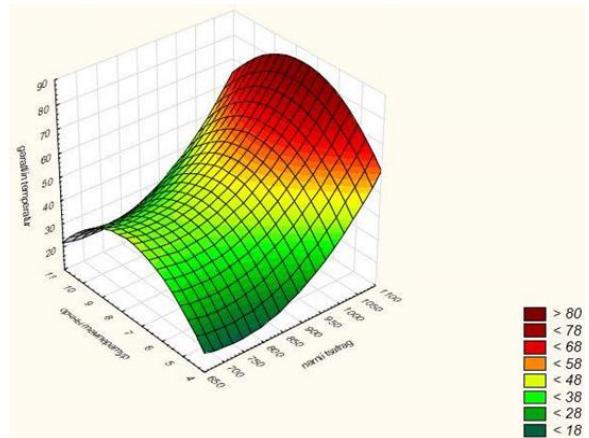


Figure 6. Collector output temperature against solar flux solar flux (X) and relation of ambient temperature (Y) and collector output temperature (Z)

In Fig.6, the larger the solar fluxes, the higher the ambient temperature, the more increase the output value of the collector. The performance of the heat collector indicates a high value in red color. Also the correlation coefficient related to solar

flux and collector output temperature is 0.82 which indicates that all arguments of this model are relatively correlated.

The regression equation is

$$y = -0.2271x^2 + 6.7229x + 28.716$$

Under Fisher's indicators  $F_{real} = 38.78$  but in theory  $F_{theory} = 4.6$ . If it is  $F_{real} > F_{theory}$  regression equation is accurately 95%.

If we calculate useful energy of collector.

$$Q_A = 1086.87$$

Experimental work outcome shown efficient of collector

$$\eta = \frac{Q_A}{A * I_T} = 0.64$$

Where:

$A$  –Collector square m<sup>2</sup>

$I_T$ –Solar radiation density w/m<sup>2</sup> striking collector square per share

## CONCLUSION

Based on the purpose of using the solar energy heating system, the purpose of developing a simple type of solar powered air heating collector, the amount of usable energy was theoretically calculated, and the development model was actually produced.

The air temperature produced by the size of the solar collector (105cmX85cmX20cm) was 40.5°C, and the output of the air produced at this time was estimated at approximately 161m<sup>3</sup>/h.

Solar thermal energy could be utilized to maintain the environment in

which the climate was suitable for human activity.

The solar collector had 1064.65W power and 0.64 coefficients of efficiency and these values were almost same to other collector values, which are used in practice.

In particular, it can be used as a good heating mechanism that can be used economically for the Mongolia as northern region, and preferably for future heating and development.

## REFERENCES

1. Baatarkhuu D., Amgalanzul J. and Buuveibaatar R. "Results of Experiment of Solar Collector with Spiral Tube" The 8<sup>th</sup> National Renewable Energy Forum, 5-6, May, 2017
2. Baatarkhuu D., Amgalanzul J. and Hee-Kyu Lee "Development of Solar Air Heating System in Mongolian Winter Season" Journal of Multidisciplinary Engineering Science Studies, Vol. 3, Issue 5, May, 2017
3. Esen Hikmet., (2008) "Experimental Energy and Exergy Analysis of a Double-Flow Solar Air Heater Having Different Obstacles on Absorber Plates". Building and Environment., Vol.43 pp 1046–1054.

## ELECTROCHEMICAL DESULFURIZATION OF COAL AND IT IS STRUCTURAL STUDY

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### ABSTRACT

*Sulfur is a counter-product from the coal processing, coal gasification and coal liquefaction. A number of studies have been carried out to remove sulfur compounds from coal. However, these methods use toxic chemicals and require expensive technologies. Therefore, we have studied a facile electrochemical method for the desulfurization process from coal water slurry in the present research work. In this study, proximity analysis including the determination of ash, volatile matter, moisture, caloric value was conducted. The electrolysis process was carried out using NaCl/NaOH solution as an electrolyte. The structural characteristics for raw and treated coal samples were analyzed by FT-IR and X-ray diffractometer. The results indicated that both inorganic and organic sulfurs were removed significantly.*

**KEYWORDS:** Coal, electrolysis, sulfur

### INTRODUCTION

Although currently, alternative energy sources are being studied extensively to overcome issues concerning the depletion of nonrenewable energy sources, it is expected that coal will remain one of the main energy sources in the near future [1][2][3]. However, because there are many non-environmentally friendly aspects of using coal, throughout the world, nations have started placing quality standards on coal [4]. Among the many causes that contribute to the environmental issues have arisen due to the use of fossil fuel, one of the most crucial is the content of sulfur in coal [5].

Depending on coal type and resources, coal contains 0.2% to 10.0% of sulfur. Composition of the sulfur is mainly

occur sulphate ( $SO_4^{2-}$ ), sulphide ( $S_pS_p$ ), and organic ( $S_0$ ). Those of coal composition so called total sulfur ( $S_t$ ), while if total sulfur content more than 1.5% considered as high sulfur content coal.

When coal is burned, the sulfurs are transferred into the atmosphere in the form of  $SO_x$ , which then proceeds to react with the water vapor in the air to produce sulfuric acid, or acidic rain [5]. Moreover, during the process of preparing the coal, the existence of sulfur content in the coal can lead to easy erosion of the equipment.

Conventional desulfurization methods of flotation, and washing etc are require heavy equipment, toxic chemicals, and high pressure and temperature, making these methods inadequate in terms of

economical efficiencies. Consequently, electrochemical desulfurization is being studied due to its less cost and facile techniques

In this study, the electrochemical desulfurization method was carried out to

sufficient condition of electrolysis and remove both inorganic and organic sulfur forms using carbon electrodes as an anode and cathode electrode and sodium chloride and NaOH solutions as an electrolyte solution.

## **EXPERIMENTAL DETAILS, AND METHOD**

### **1.1. Proximity analysis and sulfur contents of coal**

This study used the sample of coal from the Nariin Sukhait coal mine in Mongolia. Its proximity analysis and sulfur contents are shown in Table 1. Those of analysis including total volatile matter (MNS ISO 589:2003), ash (ISO 1171:1997), and humidity (MNS ISO 562:2001) etc.

### **1.2. Electrolysis experiment**

We used carbon electrodes as an anode and cathode electrode and sodium

We used Australian standard of AS1038.11.2002 to identify sulfur type in coal. This method used for identify inorganic sulfur, pyrite sulfur, and sulphate sulfur. And also we used X-ray diffractometer (XRD).

## **2. RESULT**

### **Proximity analysis and sulfur contents**

#### **2.1. Research of inorganic sulfur**

X-ray diffraction patterns of raw coal and after electrolysis shown in Figure 1. In the XRD pattern for the treated coal sample, the plane peaks at 2 theta = 38.41, 43.19, and 47.61 were significantly decreased as a result of electrolysis.

#### **2.2. Research of organic sulfur**

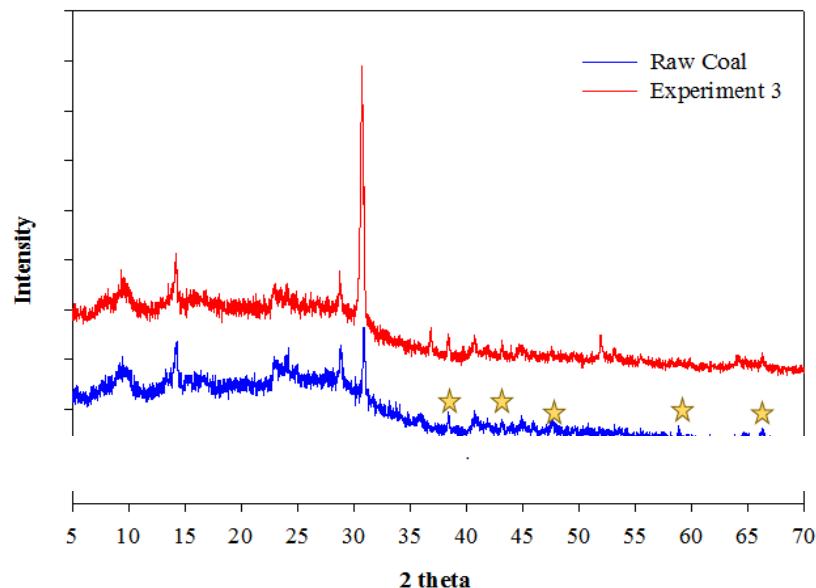
The FTIR spectra of the coal samples before and after electrolysis are shown in Figure 2.

chloride and NaOH solutions as an electrolyte solution.

During electrolysis, pyrite in coal was oxidized and transferred into the solution. Therefore, pyritic sulfur was considerably removed from the coal sample.

Table 1.

Ash [A <sup>A</sup> %]	Volatile [V <sup>A</sup> %]	Caloric value [Cal/gr]	Total sulfur [%]	Pyrite sulfur [%]	Sulphate [%]	Organic sulfur [%]
15.49	33.36	6871	1.11	0.7	<0.10	0.40

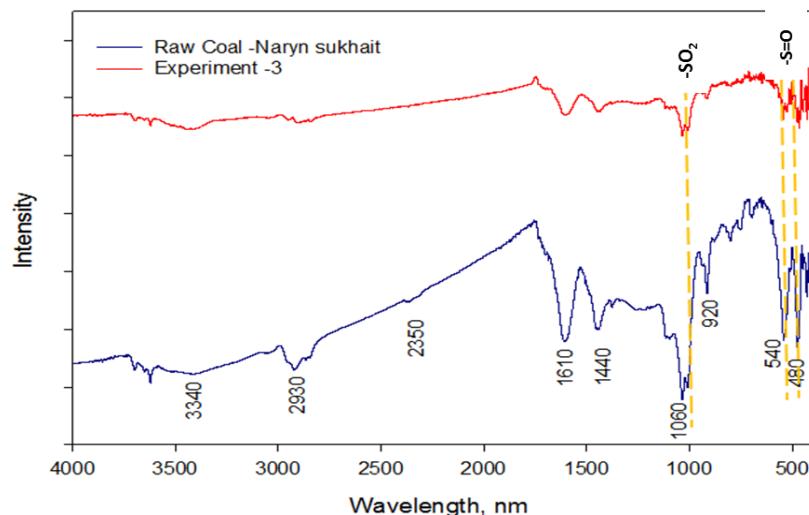


*Figure 1. X-ray diffraction patterns of raw coal and after electrolysis  
From the FTIR spectra's result, we can see organic sulfur structure's change and reducing values of sulfur is shown in peaks of 1135, 539, 6a 436 cm<sup>-1</sup>.*

### 3. DISCUSSION

Reducing sulfur content to using electrolysis method is simple and decreasing both value of organic and

inorganic content of coal. This is a main advantage of this study



*Figure 2. FTIR spectrum of raw coal and after electrolysis*

Now we are researching desulfurization method for optimal

condition of flotation cell to reducing sulfur content.

### CONCLUSION

This study used the sample of coal from Nariin Sukhait coal mine in Mongolia. Our result was total sulfur content

decreased 38.78%, sulphite sulfur content reduced 61.43%, and also calorific value increased 6781 cal/gr to 7080 cal/gr.

## REFERENCES

1. [1] Coughlin, R.W., Farooque, M., "Hydrogen production from coal, water and electrons", *Nature* 279, (1979), pp. 301-303.
2. [2] Rahman, M., Pudasainee, D., Gupta, R., Review on chemical upgrading of coal: "Production processes, potential applications and recent developments", *Fuel Processing Technology* 158, (2017), pp. 35–56.
3. [3] Xia, W., Xie, G., "A technological review of development in chemical-related desulfurization of coal in the past decade", *International journal of Mineral Processing* 161, (2017), pp. 65-71.
4. [4] Alipoor, Z., Behrouzifar, A., Rowshanzamir, S., Bazmi, M., "Electrooxidative desulfurization of a thiophene-containing model fuel using a square wave potentiometry technique", *Energy Fuels* 29, (2015), pp. 3292-3301.
5. [5] Shen, Y., Yang, X., Sun, T., Jia, J., "Innovative desulfurization process of coal water slurry under atmospheric condition via sodium metaborate electroreduction in the isolated slot", *Energy Fuels* 25, (2011), pp. 5007-5014.

## **FRAMEWORK FOR ELECTROMAGNETIC COMPATIBILITY I N ELECTRIC POWER SYSTEMS**

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### **ABSTRACT**

*The aim of this paper is to propose principles on how to apportion responsibilities between grid and connected equipment with the aim to achieve electromagnetic compatibility in electric power systems. Examples of good engineering practices for grids in relation to electromagnetic compatibility are shown. Also, how to identify and characterize voltage dips is discussed. A dual approach of responsibilities for grid and connected equipment with respect to electromagnetic compatibility is proposed. In public low voltage systems where product standards are generally available, coordinated grid and product requirements will be a basis for electromagnetic compatibility. In medium and high voltage systems, in absence of comprehensive equipment emission and immunity standards, it is suggested that the grid responsible party provides relevant data such as on voltage dips to the party responsible for connecting equipment to the grid.*

**KEYWORDS:** electromagnetic compatibility (EMC), voltage dips

### **INTRODUCTION**

Electromagnetic Compatibility (EMC) is a fundamental concept meaning “the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electro-magnetic disturbances to anything in that environment” [1]. Applying the terminology of the EMC

Directive [2], a system can be a fixed installation. The umbrella term equipment is used for apparatus and fixed installations in the EMC Directive, i.e. equipment = apparatus + fixed installation. In this paper only conducted electromagnetic disturbances are discussed.

### **THE ELECTRIC GRID AS EQUIPMENT**

Annex I of the EMC Directive states: “A fixed installation shall be installed applying good engineering practices and respecting the information on the intended use of its components, with a view to meeting the protection requirements...”. Protection requirements are the fundamental properties of emission and immunity for

equipment. The EMC Directive furthermore state that “Those good engineering practices shall be documented and the documentation shall be held by the person(s) responsible at the disposal of the relevant national authorities for inspection purposes for as long as the fixed installation is in operation”.

Disturbance propagation between equipment connected to an electric grid (electric network) is illustrated in Fig. 1. Disturbances can also propagate from the grid itself to connected equipment or vice versa as presented in Fig. 2 [3]. Furthermore, seen from a site in which equipment are connected to the grid it cannot always be identified if a disturbance originates from within the grid

itself or from equipment(s) connected to the grid.

According to the EMC Guide [4], the definition of fixed installation is wide and the “definition covers all installations from the smallest residential electrical installation through to national electrical and telephone networks, including all commercial and industrial installations”. An electric grid is thus equipment for which protection requirements apply.

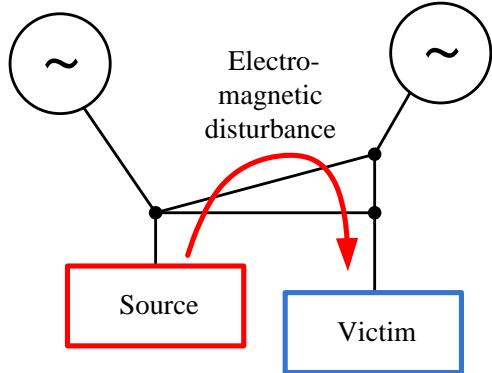


Figure 1. Propagation of an electromagnetic disturbance between equipment connected to the grid

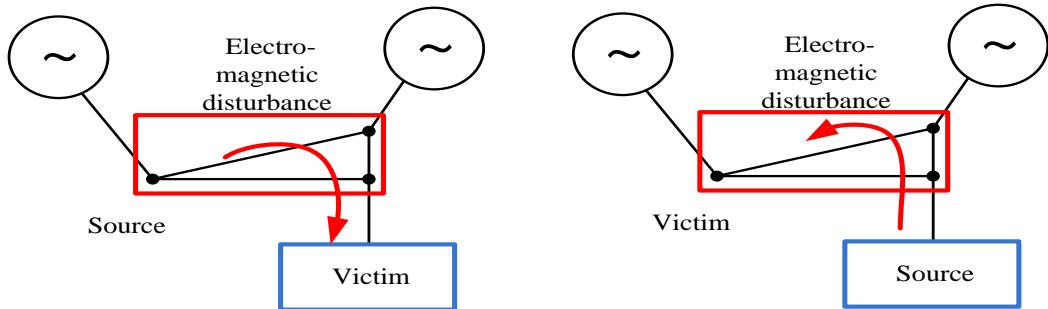


Figure 2. Propagation of an electromagnetic disturbance between the grid and equipment connected to the grid

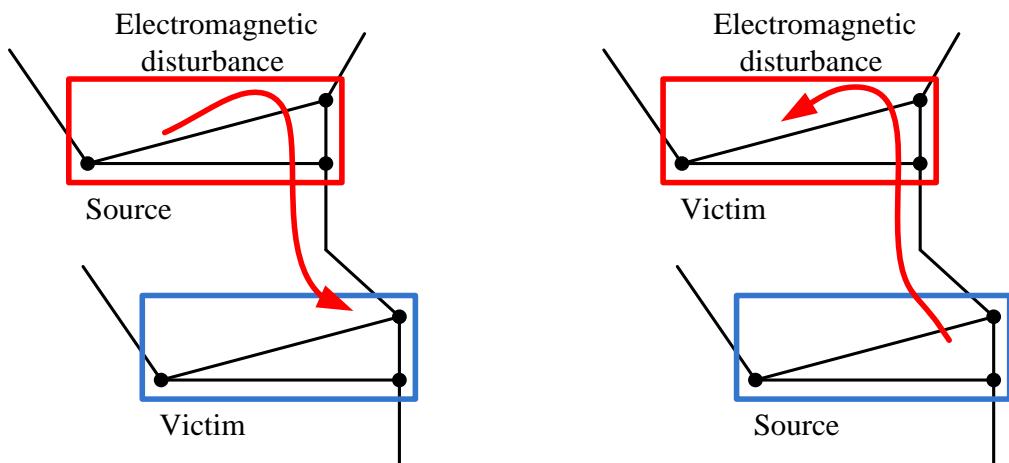


Figure 3. Propagation of an electromagnetic disturbance between grids

*Electric grid (network) is also referred to equipment in clause (18) of the EMC Directive preamble: “Fixed installations, including large machines and networks, may generate electromagnetic disturbance, or be affected by it”. Basic function of an electric grid is energy transfer with adequate Voltage Quality at connection sites, i.e. with electromagnetic disturbance levels within reasonable limits. Emission and immunity are thus most relevant also for grids. Disturbances may propagate*

between grids as illustrated in Fig. 3 and emission from a grid may be seen as a cumulative effect of a large number of connected equipment. A disturbance can also originate in one grid, propagate first to another grid (possibly with a different grid responsible party) and cause interference for end-user equipment connected to this latter grid.

## BASIC CONCEPT TO ACHIEVE ELECTROMAGNETIC COMPATIBILITY

In order to achieve electromagnetic compatibility in an electric system, immunity of equipment connected to a grid should to a reasonable extent be higher than the electromagnetic disturbance level to which it is exposed. For a device connected to a power grid, this disturbance level is the Voltage Quality.

The disturbance level in a grid is generally not constant and varies with time and site location. Also the immunity of equipment may vary with time and between different equipment of the same type. As a result probability distribution of emission and immunity levels should be considered. This is shown schematically in Fig. 4.

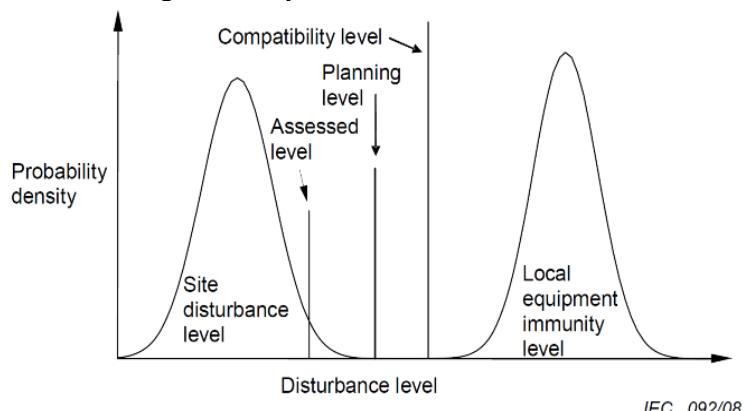


Figure 4. Voltage Quality concepts with time statistics in a site within a grid [5]

## ELECTROMAGNETIC DISTURBANCES

### A. Principal Electromagnetic Phenomena

The IEC – International Electrotechnical Commission defines the following principal electromagnetic conducted phenomena [6]:

Conducted low-frequency phenomena:

- Harmonics, high level harmonics
- Signals superimposed on power lines
- Voltage fluctuations
- Voltage dips and interruptions
- Voltage unbalance
- Power frequency variations
- Induced low frequency voltages
- DC component in AC networks

Conducted high-frequency phenomena:

- Induced voltages or currents
- Unidirectional transients
- Oscillatory transients

### B. Voltage Dips

Voltage dips is one type of disturbance phenomena emitted from grids which result in substantial economic costs. A common source of voltage dips is natural

lightning causing flashover on overhead lines. During flash-over one or several electrical phases are electrically connected to each other and/or to ground through the arc in open air, thus resulting in a voltage close to zero at the location of the lightning strike. After automatic opening and reclosing of the line breaker(s), the line insulation level is mostly sufficient for normal line operation. During the process of short-circuit, breaker opening and re-closing, electrical equipment connected to a meshed grid may experience a short-time reduction in voltage, which is the voltage dip. Voltage dips are discussed in detail in [7].

Studies in Sweden has estimated the cost for short duration interruptions ( $\leq 3$  min.) and voltage dips to be 100 to 150 million € per year [8], where the main cost is related to stops in industrial processes such as paper mills. Studies for other countries have shown similar results.

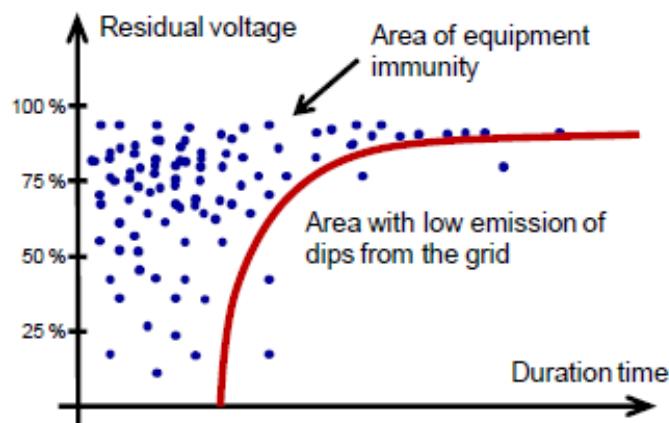


Figure 5. Areas of equipment immunity and low emissions of voltage dips  
C. Assessment of Voltage Dips

An individual voltage dip is, according to [9], characterized by two parameters; the residual voltage and the duration. Individual voltage dips during a certain time period are indicated as blue dots in Fig. 5 using the residual voltage and

duration as coordinates. In order to achieve electromagnetic compatibility, immunity of connected equipment is preferably such that a reasonably share of dips are within the immunity area.

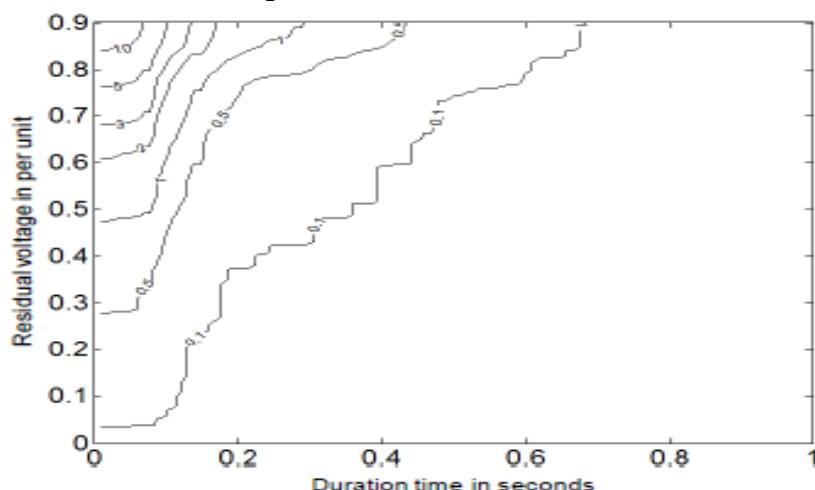


Figure 6. Example of contour map for voltage dips [11]

The scatter plot in Fig. 5 can be made for a specific site in a grid or for a large geographic area such as a country or continent representing many sites within a given time frame, e.g. one year.

An alternative representation of voltage dips is the use of contour maps [10], [11] – see Fig. 6. Also contour maps can be made for a specific site or as a representation of many sites in a geographic area. Each contour in the map represents the same number of dips during a time interval e.g. one year. For a specific site it is normally very challenging to base the contour map on measurements due to infrequent events [12].

and related lack of statistical confidence. A more practical method is to apply engineering judgment and/or calculations. Naturally, in a three-phase electrical system there are a number of different types of voltage dips due to e.g. various combinations of faults and transformer connections between the fault and the observation point in the grid [7]. A classification of dips in three phase-systems is used by CIGRE/CIRED/UIE working group C4.110 [12]. Voltage dips can be characterized to facilitate immunity requirements on equipment, individual or groups of equipment in industrial processes such as a paper machines [

## THE RESEARCH OF MONGOLIA ENERGY SYSTEMS RELAY PROTECTION AND AUTOMATION

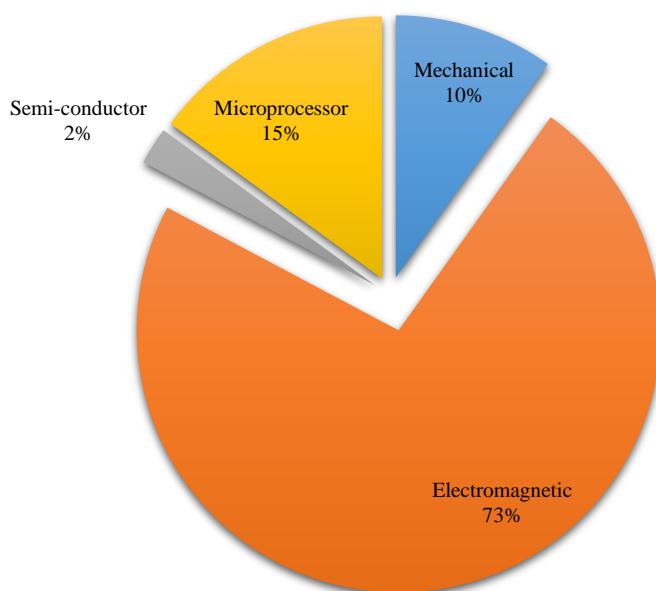
In the last years within the frame of reform works of Mongolian Energy systems, Power resources, widely have been introduced monitoring and protecting devices based on the microprocessor.

Here we have been conducting the research on the usage and exploitation, maintenance of recently introduced monitoring and protecting devices based on the microprocessor.

In this research we have involved Central Energy system (main resources such as Power Plants N2, 3, 4, in Ulaanbaatar,

Darkhan and Erdenet Power Plants, Durgun Hydro power plant, Taishir-Guulin Hydro power plant, Dalanzadgad Power Plant, and main substations of energy system such as 220kV Ulaanbaatar, Tuul, Erdenet substations, 110kV Baganuur, Choir, Arvaikheer, Undurkhaan substations), Altai-Uliastai local Energy Network, Western Energy systems.[17]

If classify the relay protection automatic equipment of Energy system of Mongolia by the type of element base:



Research suggests that relay protection & automatic devices based on the microprocessor element are intensively introduced into Mongolian Energy System.

Despite the rapid development of relay protection & automatic devices, it might cause the danger for the stable operation of Energy system. The reason is that these digital devices for relay protection, now used in Mongolia, have a poor compatibility with each other, because all these devices are imported from different countries, and all have different brand.

For example: Digital relay protection devices used in Central Energy system: NANGING NARI, DONG PANG, CDA9001, DMP (CHINESE), ORION (ITALIAN), BMRZ, BRESLER (RUSSIAN), SEL (AMERICAN), SIEMENS (GERMAN), ABB (SWEDEN), ALSTOM, MICOM

(BRITISH) and in Altai-Uliastai Region Electrical system: NANGING NARI, CDA9001 (CHINESE), SEL (AMERICAN).[17]

The main problems faced with these new installed digital devices:

- ◆ Don't match to the Mongolian weather conditions. Some of devices might freeze under -25 C degrees or in hot days the semi-conductor elements might be broken
- ◆ Sometimes there is no possibility to receive the information due to freeze of LED display in winter time, also comes to change the battery of devices every year
- ◆ Sometimes the devices are disturbed by electromagnetic interference and

furthermore causes the danger for stable operation of the system

Accordingly the Mongolian engineers can not rely on digital devices fully and continuing to use the mechanical relays same time.

The main reason why digital relay devices are disturbed easily by electromagnetic interference is: all our Power station and sub-stations have old building, old equipment, some equipment already run-out the exploitation time, also buildings, relay protection and automatic and monitoring devices are located close to high capacity equipment, and lack of protection from disturbance of magnetic

interference or radio wave as well as lack of screening of electromagnetic field, all these cause the irregular operation of microprocessor devices.

So to solve all above mentioned issues we need to have Mongolian State standard for installment of relay protection and automation devices.

Within the frame of this standard it is important to implement works such as to measure the electromagnetic interference and hazard, to determine the data for electromagnetic compatibility matching for Mongolian condition, to work out the technical conditions of microprocessor devices.[18]

## FRAMEWORK FOR ELECTROMAGNETIC COMPATIBILITY IN POWER SYSTEMS

### A. Protection Requirements for Grids

To achieve EMC in power systems, coordinated requirements for grid and equipment connected to the grid are essential. Examples of good engineering practices for a grid to fulfill protection requirements of equipment (emission and immunity) are:

- Reasonable network strength [13], [14]
- Proper frequency control (for system operators)
- Appropriate voltage control, e.g. transformer tap changer settings and reactive power control
- Selection of right-of-ways for new lines considering geographical natural lightning density
- Proper line maintenance and inspections including right-of-ways tree trimming
- Adequate lightning protection
- Effective earthing and bonding
- Application of bird deterrent to avoid insulator flashover from bird droppings when needed
- Regular substation inspections and maintenance
- Fast relay protection and circuit-breaker operations for the benefit of short duration time of voltage dips
- Synchronized switching applied for energizing of capacitor banks and reactors when appropriate to avoid inrush transients

Adequate network strength is mainly relevant with respect to low frequency phenomena such as low order harmonics

and flicker. Reasonable network strength can be expressed as a maximum voltage step of e.g. 3 % for connection or disconnection of the contracted power demand as in [13]. Good network strength increases the grid ability to absorb low frequency emissions from disturbing equipment, i.e. supporting immunity against deficient Voltage Quality. For the severance and occurrence rate of voltage dips and interruptions being emitted from a grid, maintenance and design including relay protection speed combined with circuit-breaker operating times are essential. Emissions of voltage transients originating from switching and to some extent also natural lightning can be mitigated using modern switchgear technology. It can be repeated that for fixed installations, such as grids, the EMC Directive states that application of good engineering practice shall be documented.

### B. Grid Planning Levels and Allocation of Emission Levels

Having a grid designed according to good engineering practices, planning levels can be defined to apply a margin to a compatibility level as illustrated in Fig. 4. In **medium and high voltage** systems, with a lack of comprehensive equipment emission and immunity standards, the grid responsible party is proposed to take the responsibility to allocate available emission levels to connected equipment in order to keep disturbances within planning levels.

### C. Protection Requirements on Connected Equipment

For public **low voltage** systems, product standards harmonized to EMC Directive are generally available. These product standards are linked with compatibility levels defined in electromagnetic environment standards. Here work within the standardization community is vital as expressed in clause (14) in the preamble of the EMC Directive: "Network operators should construct their networks in such a way that manufacturers of equipment

Apply Good Engineering Practices for the Grid and Define Planning Levels Based on Electromagnetic Compatibility Level Standards

Adopt Product Standard Emission and Immunity Limits to Compatibility Levels; Responsibility of the Standardisation Community

#### Standardisation Approach

liable to be connected to networks do not suffer a disproportionate burden in order to prevent networks from suffering an unacceptable degradation of service. The European standardization organizations should take due account of that objective (including the cumulative effects of the relevant types of electromagnetic phenomena) when developing harmonized standards."

Apply Good Engineering Practices for the Grid and Define Planning Levels Based on Electromagnetic Compatibility Level Standards

Allocate Emission Levels to Connected Equipment

Design Grid Connected Equipment Emission and Immunity Performance According to Allocation and Grid Data

#### Site Specific Approach

*Figure 7. Dual approach to achieve electromagnetic compatibility*

With this as a basis, corresponding product [equipment] standards will be based on compatibility levels from which also grid planning levels can be defined. Proposed grid and product responsibilities are given in Fig. 7 where the left part summarizes the standardization approach applicable to e.g. low voltage public systems. The standardization approach is a coordinated holistic basis to achieve electromagnetic compatibility.

At **medium and high voltage** levels, it is reasonable that the grid responsible party provides relevant information to the party connecting equipment to the grid in order to ensure proper design of the equipment right part of Fig. 7. Examples of such information are planning levels relevant to immunity of connected equipment and allocated emission levels possibly along with network strength. For voltage dips, planning

levels may be given as site contour maps as of Fig. 6. With this information, proper investment decisions can be made for equipment to be connected to the grid using e.g. dip immunity classes in standards [15], [16]. It is recognized that setting appropriate immunity requirements is a trade-off between investment cost and the cost of interruptions in e.g. an industrial process.

## CONCLUSION

It is proposed that the electrical grid is regarded as equipment and good engineering practices for electro-magnetic compatibility protection requirements are to be considered and documented. A number of such technical considerations can be included in the design, maintenance and operation of the grid. In public low voltage systems where product standards are generally available,

coordinated grid and product requirements will be a basis for electromagnetic compatibility. In medium and high voltage systems, in absence of comprehensive equipment emission and immunity standards, it is suggested that the grid responsible party provides relevant data such as on voltage dips to the party responsible for connecting equipment to the grid.

## REFERENCES

- [1] International Electro-technical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility, IEC 600 50-161 Std., Available: <http://www.electropedia.org>.
- [2] Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC, L 390/24, Official Journal of the European Union, 31st Dec. 2004.
- [3] Magnus Olofsson, Ulf Grape, —Voltage Quality in the context of EMCII, paper accepted for publication at 2009 International Symposium on Electromagnetic Compatibility, Kyoto, Japan in July 2009.
- [4] Guide for the EMC Directive 2004/108/EC, 21st May 2008, Available: [http://ec.europa.eu/enterprise/electr\\_equipment/emc/guides/emcguide\\_may2007.pdf](http://ec.europa.eu/enterprise/electr_equipment/emc/guides/emcguide_may2007.pdf).
- [5] Electromagnetic Compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems, IEC/TR 61000-3-6, Ed. 2.0 , Feb. 2008.
- [6] IEC Guide 107 Edition 3: Electromagnetic Compatibility – Guide to the drafting of electromagnetic compatibility publications, IEC, February 2009.
- [7] Understanding power quality problems – Voltage dips and interruptions, M.H.J. Bollen, IEEE Press, 2000.
- [8] Åkerlund, Utveckling Elkvalitet Slutrapport (in Swedish), Elforsk report 04:46, March 2004.
- [9] Electromagnetic Compatibility (EMC) – Part 4:30: Testing and measurement techniques – Power quality measurement methods, IEC 61000-4-30 Std.
- [10] Handbook of Power Quality, Angelo Baggini, John Wiley and Sons, 2008, ISBN 0470065613, 9780470065617.
- [11] Signal processing of power quality disturbances, M. H. J. Bollen, I. Y. H. Gu, Wiley – IEEE Press, 2006.

## **THE BARLEY FLOUR PREPARATIONS WITH BONE OIL AND IT'S PRODUCTION TECHNOLOGICAL STUDY**

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### **ABSTRACT**

*With reference to cleaning the mix oil of the horse bone at 121-125°C for 20 to 24 hours by dedicated equipment according to principle for centrifugal force, decreased the distinctive flavor and odor by activated carbon, clarified the color by translucent, reduced the volume for oil balloons, vacuum packed in plastic bags are being currently developed on a sterilizing technology at 85°C for 30 minutes. The horse bone oil and barley flour are mixed with ratio for 40:60 and are minimized with mixing moisture content and are developed under formulation capsule technology.*

**KEYWORDS:** Horse, superoxide, number of iodine, number of acid, characteristic

### **INTRODUCTION**

The consumption of biologically active food is being increasing in our country. Livestock and animal bones are rich in biological active ingredients and are valuable raw materials in the nature. It is important to process bone without waste under value-added technology is economically and socially in the market turnover systems [1].

The research work on extending the shelf life of the oil was started in the early XIX Century in abroad and is beginning in the late 1960s in Mongolia. The researchers of "Food Tech" Corporation of Mongolia as a food research industry have been researching the development of technology for producing "High-purity

cosmetics from Horse fat". The results of this new technology have been developed till nowadays. In addition, the determination on the discovery and utilization of flora reserves and the development of a variety of grain product technologies are enabled the improvement of the nation's consumption on food needs [2;3].

The most majority of the population is unable to use the nutritional content specified in the "Recommended Nutrition Facts of Mongolia" is concerns because of country's economic difficulties, low income of the population and a lack of biological active food product sizes and quantities. Consequently, there are needs for

consumers to make production and diversity of products that are suitable for their consumption [4].

The purpose of this research is to determine the composition and characteristics of horse bone oil and to develop appropriate technology based on processing and utilization fields. In order to accomplish the aim have included

following targets: Develop technology for horse bone oil purification; Determine the physiological-chemical, its composition and microbiological parameters; Develop a dry-mix technology of bone oil and barley flour mixing; Identify and evaluate the hygienic and safety characteristics of the preparation.

## RESEARCH MATERIALS AND METHODOLOGY

In the research materials has taken 32 kg sample from oil production of thickened broth of the bone soup HASU processing plant of the "Khatansuikh Impex" LLC. The original researching sample was stored at - 80°C and the specimen at -2°C + + 2°C for the tests.

Technological testing was performed which is used the following places include; the Bone Oil Processing Plant of "Khatansuikh Impex" LLC, Food Laboratory of Technological University and the Mongolian-Chinese Jointly Invested

"Molecular Biological Laboratory" respectively. The indicators for the quality and hygiene of the test product were analyzed in the laboratory of the Research Institute of Biochemistry, the "SAMO" Institute of Food Chemistry and Research and the National Food Safety Laboratory of the State Professional Inspection Agency of Mongolia. In the research was conducted using a standardized analysis and related standard methods and the results of the survey were processed by IBM SPSS 20 programming.

## RESEARCH PROCESSING AND RESULTS

Cleaned and chopped the horse pelvic and marrow bones for the purpose of decomposing the oil at 121-125°C for 20 to 24 hours in the dedicatory pot during the boiling processes, heat at 35-45°C for cleaning equipment /separator/, distinguished residuals in a complete,

cleaning the centrifuges twice and filtered through coal and concrete filtration machines. Then it was evaporated by container and packed in a vacuum sealed bag in dedicated plastic bags and sterilized for 30 minutes in water at 85°C (Fig.1).



Figure 1. Horse bone oil

When the horse bone oil was characterized; it was a smooth, homogenous, semi-solid, and yellowish, with unique flavor and odor as a main raw material. The grease is designed to accelerate the flow of water and to

increase the color of the oil and the percentage of oil weight, there were added food salt and then mixed well with the intended mixer. The result of the first day-to-day test for horse bone oil is summarized.

Table 1.

Physical-chemical and microbiological characteristics of horse bone oil.

No	Description	Proper Vol. amount /MNS CAC 117:1998/	Results
The average of physical-chemical parameters			
1	Acids number, mg/g	-	1.49
2	Number of iodine J <sub>2</sub> /100g	-	6.24
3	Number of superoxide %	-	0.05
4	Moisture %	<50.0	40.93
5	Salt %	<5.0	0.48
Microbiology parameters			
6	TBC (The total bacteria count), in 1g	-	2.4*10 <sup>2</sup>
7	Rod-shaped Bacteria of intestinal tract in 1g	-	No detected
8	Pathogenic bacteria of Intestinal tract	No present	No detected
9	<i>S.aureus</i> , in 1g	No present	No detected
10	Aflatoxin J <sub>1</sub> , J <sub>2</sub>	No present	No detected

The moisture content, salt content and microbiological parameters of the horse bone oils are met full compliance with the standards. The amount of iodine that is expressed as a proportionate

amount of unhealthy acid is relatively high (6.24 J<sub>2</sub>/100g) is indicates that the product has a highly biologically valuable characteristics (Table 1).



Figure 2. The barley flour preparations with bone oil

The demand for horse bone oil is not only in abroad additionally it has a demand to use it domestically. Therefore, it is capsuled with an optimal ratio of barley flour in order to use it easy to extend its storage time and to increase its regulating effects.

The establishment of the ratio of bone oil and barley flour was adjusted by the 40:60 for the statistical analysis of sensory characteristics, customer tasting and physical-chemical analysis results (Fig.2).



Figure 3. Press device used in the test

It is capsuled by dedicatory press device under reducing technology for the moisture content of bone oil and barley

flour (40:60) by means of solar energy and hot dry air sieve (Fig.3).

Table 2.

Physical-chemical properties of the barley flour preparations with bone oil

Nº	Parameters	Barley flour sample	Barley flour preparations with bone oil sample
1	Moisture %	8.0	6.69
2	Fat %	-	9.72
3	Ash %	1.85	1.60
4	Cellulose %	-	3.29

The moisture content of the barley flour preparations with bone oil is 1.31 and the ash is 0.25 percentages less than the

main raw material if compared to (Table 2).

Table 3.

Hygiene and safety parameters of the barley flour preparations with bone oil

Nº	Parameters	Standard		Barley flour preparations with bone oil sample
		Description	Requirement	
1	Bacterial numbers in 1g	MNS 6308:2012	-	<1*10 <sup>1</sup>
2	Salmonella, 25 in 1g		No present	No detected
3	Amount aflotoxin /ppb/		4-15 µg/kg	No detected
4	Metsulfuron-methyl	MNS 2091:1997	No present	No detected

The general bacterial numbers of the barley flour preparations with bone oil is less than 300, and did not determine the presence of microbial bacteria, aspergillus flavus toxins and metsulfuron-methyl

/pesticide remains/ are indicating that the hygiene and safety requirements of this preparation are met all their standards (Table 3).

## CONCLUSION

1

- . Successfully developed a technological solution to eliminate the distinctive aroma and taste of the horse bone oil by double filtering methods.
- 2. Established an average moisture content of horse bone oil is 40.93%, salt is 0.48%, acid is 1.49, number of methyl acetate is 0.05 and iodine is 6.24 respectively.
- 3. Determined that the iodine number, the main indicator of the amount of unhealthy

acid is relatively high for horse bone oil (6.24).

- 4. Established additives for horse bone oil are can be added to the production with barley flour products.
- 5. The results of the accredited laboratory test proves that the requirements of hygiene and safety are met all their standards.

## ACKNOWLEDGEMENTS

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## **REFERENCES**

1. Badamkhand.L, Battsetseg.C, Uyanga.C, Comparative study some animal resource oil. Composition Research Workbook of Mongolian University of Science and Technology. Serial №2. UB. 1997. "(In Mongolian)
2. Skurikhin. I.M. The chemical composition of food products. A guide for Red .., M .., 1978 (in Russian)
  - Dissertation
3. B.Enkhtuya Biochemical and technological research of meat of Mongolian pastoral animals. The Ph.D. of Science (Sc.D). UB. 2009
4. Enkhtuya B. Basic characteristics of biochemical technology of sheep, beef and horse muscles. Ph.D for Education. UB. 1995

## **MEASURED RESULTS OF FUEL CONSUMPTION OF CITY BUSES USING GPS DATA**

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### **ABSTRACT**

*The number of city buses has increased as the number of car have increased in recent years. The increase of the number of city buses has a positive effect by transferring passengers more quickly. But from the other side, emissions in the exhaust gas from bus engines and fuel consumption has become a problem that is drawing attention from public transportation authorities and the people as well. For fuel consumption measurement we used the Hyundai Aero City bus and choose "Ch:3 Zuunsalaa-Khaldwart" route runs of about 220km. The measurement was executed during 02<sup>nd</sup> – 16<sup>th</sup> October, 2016. According to the fuel consumption comparison result between Diesel fuel and Diesel-LPG dual fuel buses, Hyundai Aero City bus saved 22956.75 tugrugs per day.*

**KEYWORDS:** GPS data acquisition, fuel consumption meter, average speed of the bus, number of passengers.

### **INTRODUCTION**

In Ulaanbaatar, there are about 900 buses during work days and during the weekend 700 buses provide public transportation, travelling about 240 km on average. These buses are estimated to consume 33 liters in the summer and 39 liters of diesel fuel in the winter for each 100 km run. The fuel consumption has changed depending on various factors, such as traffic jams, weather conditions, number of passengers that ride the buses and technical conditions. Regarding to these facts, the following seven

attachments are provided: to increase the base standard [2], a sample standard of fuel consumption per 100 km run throughout Mongolia [1]. The ratio of increasing or decreasing the base standard of fuel consumption in capital city or center of provinces [3]. How to increase the base standard of fuel consumption in cold weather and period to follow [4], how to increase the base standard of fuel consumption based on the condition of the road and feature of the services [5]. Standard of fuel consumption for loading

and unloading truck per 100 km t·km [6]. The instructions for calculating the standard of fuel consumption [7].

Furthermore, the following limits will be applied: the average speed and number of passenger relation will be defined, which is the main fuel consumption factor of the bus, and the chance to reduce fuel

consumption will be defined when transformed into Diesel-LPG dual fuel and compared with theoretical values.

There are several things that affect the speed of a bus in traffic, including traffic intensity, weather and season conditions, traffic jams, work days or weekends and cross roads and intersections.

## TO CALCULATE FUEL CONSUMPTION REGARDING TO THE AVERAGE SPEED

Fuel consumption per 100 km run related to the speed [8] can be estimated by (1)

$$q_t = \frac{10^3 G_f}{36\rho_f v} = \frac{g_e N_e}{3600 \rho_f v}$$

fuel consumption per hour [9], [10] (2) as well.

$$G_f = \frac{g_e N_e}{1000} = \frac{3600 Q \rho_f}{t} \quad (2)$$

Here:  $g_e$  – brake specific fuel consumption [g/kWh],  $N_e$  – brake specific power [kW],  $v$  – average speed of the bus [km/h],  $\rho_f$  – diesel fuel density [ $\text{kg/m}^3$ ],  $Q$  – perfect design of the car is estimated by fuel consumption [l],  $t$  – time corresponding to fuel consumption  $Q$  [sec].  
Hyundai Aero City bus technical specifications [11] and [12] are in attached in Table 1.

Table 1.

Hyundai Aero City buses technical specifications

Engine model	C6AC
Type	Turbo charger, intercooler
Bore x Stroke (mm)	130 x 140
Compression ratio	11.5:1
Max power (kW)	213.3
Number of cylinder	6 in-line
Piston displacement (cc)	11.149
Max power (kW/rpm)	213.3/2000
Seat capacity	38 + 1
Empty vehicle weight (kg)	7,040
Gross vehicle weight (kg)	16,000

Hyundai Aero City bus brake power [12]

$$N_e = \frac{p_e V_d n}{30\tau} = \frac{0.924 \cdot 11.149 \cdot 10^{-6} \cdot 2200}{30 \cdot 4} = 188.128 \text{ kW} \quad (3)$$

brake specific fuel consumption [13]

$$g_e = \frac{3600}{H_u} = \frac{3600}{42.44 \cdot 0.3577} = 237.4 \text{ g/kWh} \quad (4)$$

The fuel consumption of Hyundai Aero City bus [9] was theoretically estimated by the following formula:

$$q_t = \frac{g_e N_e}{36\rho_f v} \quad (5)$$

Here:  $\rho_f = 838 \text{ kg/m}^3$  - density of diesel fuel

bus.

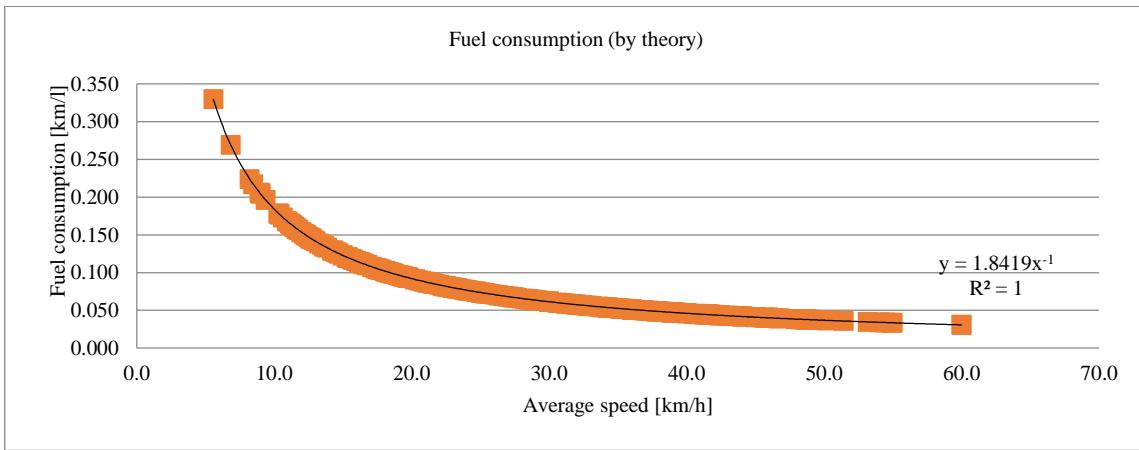


Figure 1. City bus fuel consumption and average speed relation

On a figure above, for Hyundai Aero City bus the fuel consumption and average speed are related exponentially based on a theoretical estimate, and the determination coefficient  $R^2=1$  which means it is considered to be a good model based on the current bus technical specifications size.

### Fuel consumption measurement

FC-9521 Japanese fuel consumption meter was used, and GPS information of “Erdem trans” co., Ltd, of passengers in the bus of the day, distance between each bus stops and others was collected and compared from “Ulaanbaatar smart card” from the city public transportation authorities.

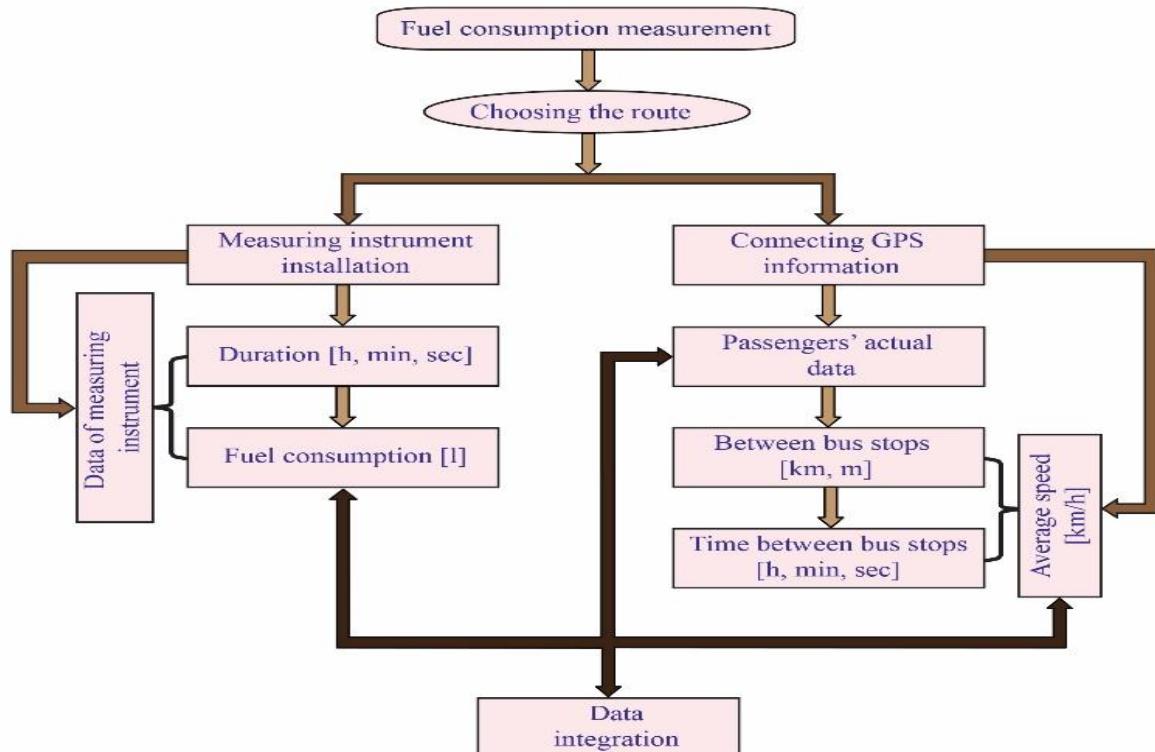


Figure 2. Planning scheme of fuel consumption measurement

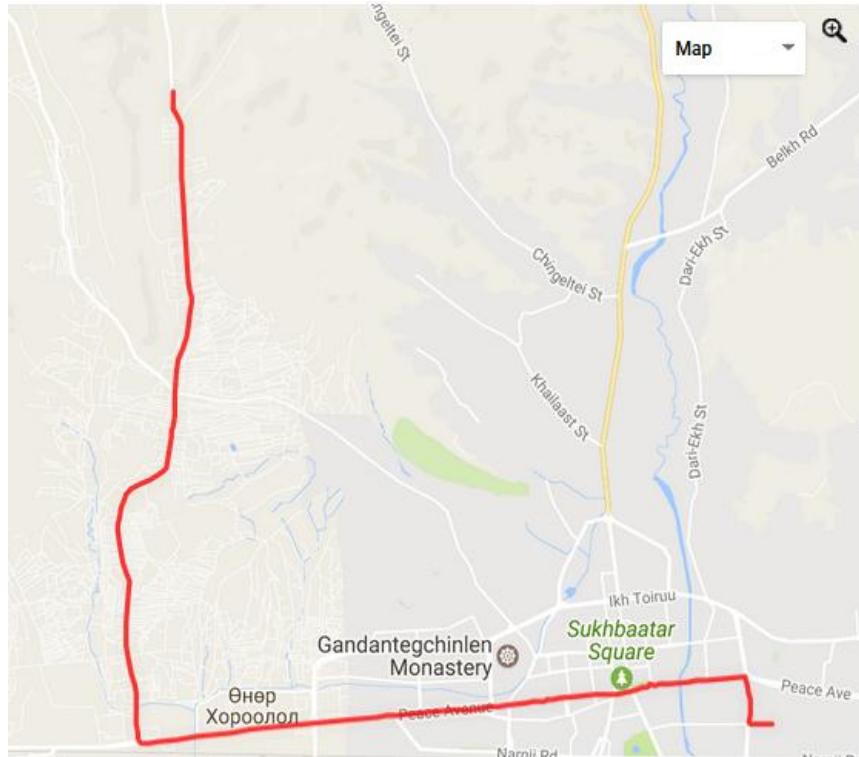


Figure 3. Topographic map of Route 3, fuel consumption measuring

Hyundai Aero City bus from “Erdem trans” co., Ltd, with a parking number of 13-193 on a “Ch:3 Zuunsalaa-Khaldwart” route

runs for about 220km per day and the measurement was executed during 02<sup>nd</sup> – 16<sup>th</sup> October, 2016.

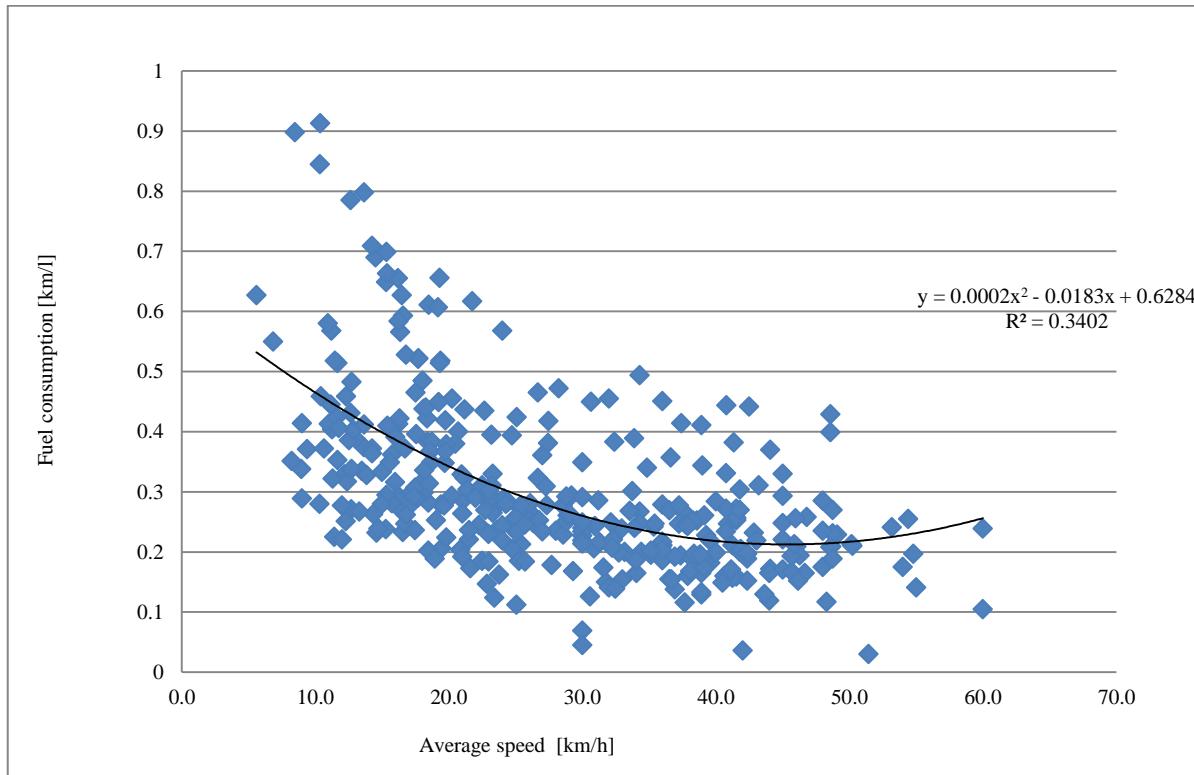


Figure 4. City bus Fuel consumption meter Model FC-9521

The FC-9521 Japanese fuel consumption meter works by measuring the difference

of fuel flow in inlet and outlet pipe of the high pressure fuel pump.

## MEASUREMENT RESULTS



*Figure 5. Fuel consumption and average speed relation (by measurement)*

By the figure above, it shows that fuel consumption and average speed relation has multi-variables as the measurement results. From determination coefficient  $R^2=0.3402$ , the equation quality of fuel consumption and

average speed relation looks weak, which means the equation of the figure needs to be changed. During the measurement factors like traffic jam, weather condition etc. observed affecting the fuel consumption.

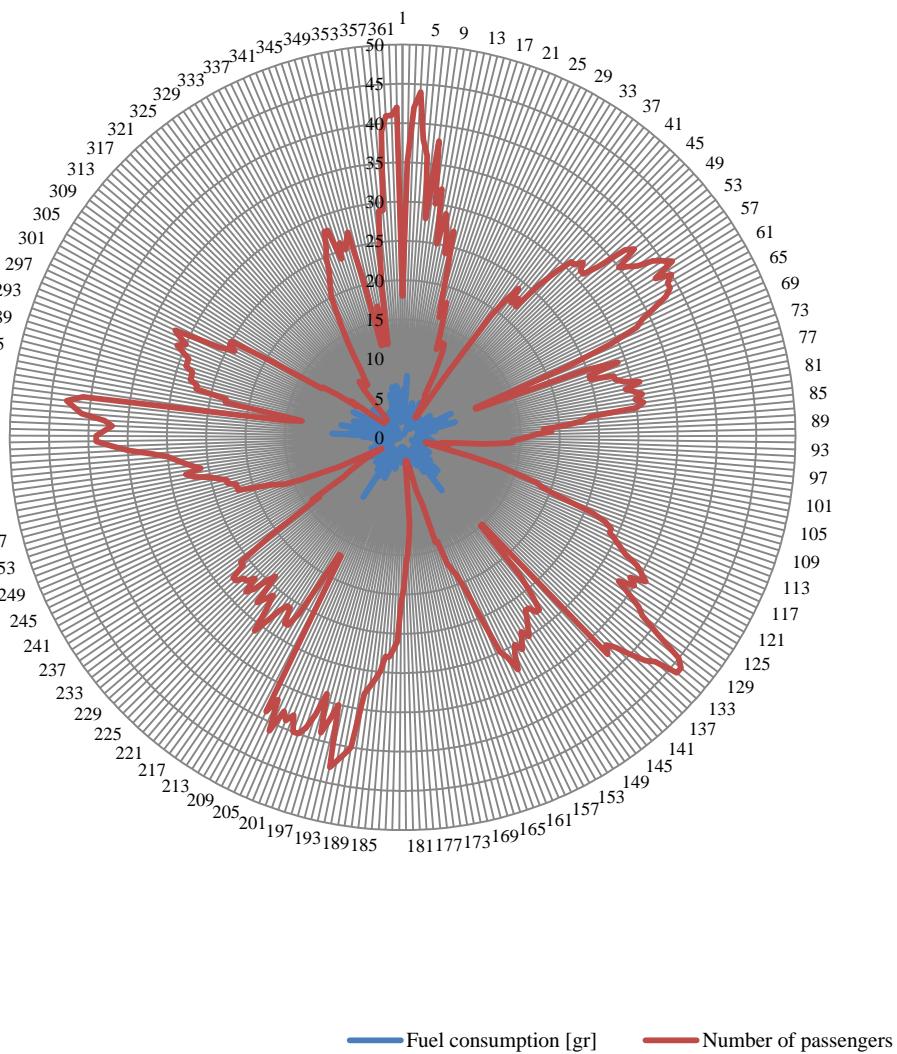


Figure 6. Fuel consumption and number of passengers relation

During the measurement, the number of passenger affection was observed to the fuel consumption but according to a lack of information about passenger's weight, it was less

meaningful for the affection and it was not specifically included in the fuel consumption standard.

Table 2.  
Comparison of fuel consumption limit and measurement data

No	Data	Fuel consumption [100km/h]	Consumption of diesel fuel [l] (for 215.45 km )
1	By specified limit [l], (when average speed is $v=37 \text{ km/h}$ )	39	84,02
2	By measurement instrument [l], (when average speed is $v=37 \text{ km/h}$ )	50,7	109,315
3	Difference of fuel consumption [l]	11,7	25,295
4	Total price of fuel consumption, tugrugs (by limits)	64350	138633
5	Total price of fuel consumption, tugrugs (by measurement)	83655	180369,75
<b>Difference, tugrugs</b>		<b>19305</b>	<b>41736,75</b>

According to the fuel consumption results above, 11,7 liters of fuel per 100km, i.e in total 25,295 liters of fuel per 215,45 km were additionally used than

limit amount which was caused of traffic jam, traffic intensive, weather condition and other factors.

Table 3.  
Comparison for consumption of Diesel fuel and Diesel-LPG dual fuel on bus operation

№	Data	Consumption of diesel fuel [l], (for 215.45 km)	Here on	
			Diesel fuel, l (70%)	LPG, l (30%)
1	By measurement instrument [l]	109,315	76,52	37,795
2	Total price of fuel, tugrugs (by measurement instrument)	180369,75	126258	31155
<b>Difference, tugrugs</b>		<b>22956,75</b>		

According to the fuel consumption comparison result between Diesel fuel and Diesel-LPG dual fuel buses, Hyundai Aero City bus saved 22956.75 tugrugs per day. For "Erdem trans" co., Ltd where the

measurement was executed, the bus is on service for 300 days a year which means it saves 6 million and 886 thousand tugrugs a year for a bus.

## CONCLUSION

1. According to a multi-variable relation of fuel consumption of the bus to the average speed, when an average speed decreases the fuel consumption increases. And it is related to the factors like traffic load, technical condition of the vehicle intensity, weather condition etc.
2. Even though, the fuel consumption of a bus relates to a number of passengers, it would be more accurate when considering the weight of passengers.
3. Based on this research work we like to create the methodology that estimate the

relations fuel consumption from average speed and number of passengers running several routes on a bus.

4. Furthermore, when estimating fuel consumption considering its factors in Mongolia, it is good to have "Vehicle fuel consumption standard" which also fulfills the standard of other countries.
5. When transforming a fuel of a bus into Diesel-LPG dual fuel, it can save 6 million and 886 thousand tugrugs a year which means it has a positive effect for economic matter.

## REFERENCES

- [1] <http://www.legalinfo.mn/annex/details/3991?lawid=8399>
- [2] <http://www.legalinfo.mn/annex/details/3992?lawid=8399>
- [3] <http://www.legalinfo.mn/annex/details/3993?lawid=8399>
- [4] <http://www.legalinfo.mn/annex/details/3994?lawid=8399>
- [5] <http://www.legalinfo.mn/annex/details/3995?lawid=8399>
- [6] <http://www.legalinfo.mn/annex/details/3996?lawid=8399>
- [7] <http://www.legalinfo.mn/annex/details/3997?lawid=8399>
- [8] V. K. Vakhlamov, M. G. Shatrov and A. A. Yurchevskii, 'Automobile,' Moscow, 2003, pp. 324-326.
- [9] I. S. Turevskii, 'Theory of automobile,' Moscow, 2005, pp. 98-99.
- [10] KH. V. Borislovich, 'The method of improving the environmental performance of the vortex-chamber diesel engine by injecting water into the intake manifold' Dissertation on the scientific degree of candidate of technical sciences, Moscow, 2016, pp. 79-80.
- [11] <http://worldwide.hyundai.com/WW>Showroom/Commercial/Bus/SuperAeroCity/PIP/index.html>
- [12] <https://www.scribd.com/document/94600347/Super-Aero-City-Bare-Chassis>
- [13] A. I. Kolchin, V. I. Demidov, 'Calculation of the automobile and tractor engines', Moscow, 1980, pp 67-69.

## COMPARED RESEARCH OF RHEOLOGY PERFORMANCE OF JERKY

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### ABSTRACT

*Meat is an important meal that provides protein to the human kind. Other meals are mostly made by planting or manufacturing, it is distinctive that meats are prepared from livestock and animals through a biological method.*

*Traditional method of producing jerky is freezing and drying a meat and natural way is freeze-drying method. Even though, method of jerking a meat is not based on scientific research and estimation, it is the best way which has been developed through the many years by the folks.*

*Research method of the Rheometer and Rheology is to study mechanical features and characteristics of food materials, then appropriate machine and equipment can be invented, also efficient food producing procedure can be offered.*

*Rheology is a science to study difference of various objects, and “deformation” the way of changing a features influenced by the force.*

**KEYWORDS:** rheology, penetrometer, artificial wind

### INTRODUCTION

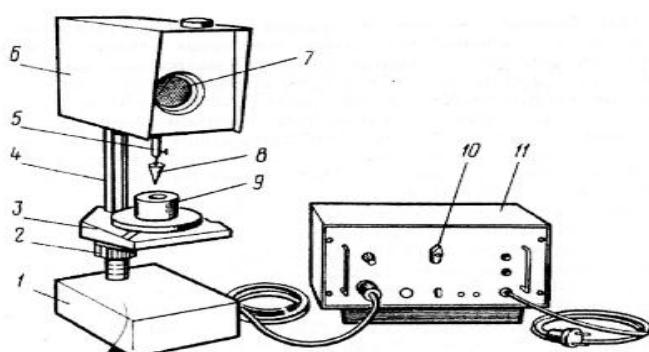
#### Equipment to determine Rheology characteristics

- Viscosity - Viscometer
- Adhesive – Adhesimeter
- Friction - Tribomeater

- Pushing and printing of food mass - extruder
- **Vehemence of resistance of sticking– penetrometer**
- Traction and compression – valirograph

### AUTOMATIC PENETROMETER

- 1- Base board
- 2- Screw to attach measuring desk
- 3- Measuring desk
- 4- Vertical pillar
- 5- Attaching nut
- 6- Drop off system
- 7- Result of measuring
- 8- Stick head into to a product
- 9- Product
- 10- Adjusting screw
- 11- Voltage adjustment



## PREVIOUS RESEARCHES

Freeze-drying method is the best drying way that includes all advantages of dried and frozen products.

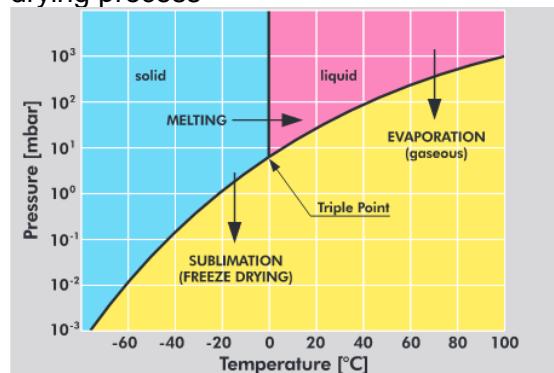
According to Doctor. Tungaa.J, beef jerky includes 7.1% of wet, 12.5% of fat, 78.8% of protein. /wet, nitrogen, non-protein nitrogen, extract water/

Doctor Tserenpuntsag.Sh have made a jerky by camel meat in a Gobi desert that includes 7.25% of wet, 19.22% of fat, 68.03% of protein, and 13 types of amino acid. Also, he confirmed that camel jerky has same quality of standard.

## 2. MATERIAL AND METHODS

To reduce processing duration of the traditional food jerky that is made during the winter depending on our country's weather condition, without changing its unusual characteristic and quality by using artificial wind.

- To study base of theory of Freeze-drying method
- To produce a jerky by both traditional and artificial way and define standard performances of it
- To define rheology performances of the jerky Theoretical graph of the Freeze-drying process



Phase diagram for water

## 3. RESULTS AND DISCUSSION

### 3.2 Quantity of Priming during a day, ram

Further, Scientist Urtnasan.D and Badamkhand.L defined structure and odor substance of the jerky, and have some interesting results as below:

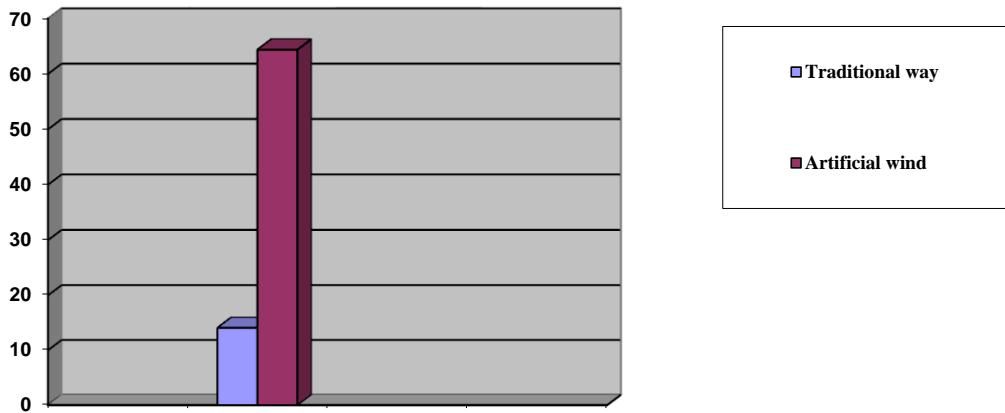
- They observed structure of the jerky through an electronic microscope, and found out that basic structure of the meat remains the same,
- Estimated there are aromatic substances that organic acids, ethyl ketone, ester and sulfide.

### Traditional technology of producing the jerky

- Material /meat/
- Cut /size 2x3 sm ,  $t=+2\ldots+4^{\circ}\text{C}$ /
- Hang /distance 5-6 sm/
- Freeze / $t=-25^{\circ}\text{C}\ldots-30^{\circ}\text{C}$ /
- Freeze and dry /110 days/
- Mature jerky /wet 3.84%, fat 12.39%/

### A technology of producing the jerky using artificial wind

- Material /meat/
- Cut /size 2x3 sm ,  $t=+2\ldots+4^{\circ}\text{C}$ /
- Hang /distance 5-6 sm/
- Freeze / $t=-15^{\circ}\text{C}\ldots-20^{\circ}\text{C}$ /
- Dry using artificial wind blow /23 days/
- Mature jerky /wet 4.39%, fat 11.7%/



3.2 Color differences of above 2 different methods



The jerky made by traditional way

The jerky made by using artificial wind

Table.1

Nº	Performance	Standard performance of jerky /YCT3002-80/	The jerky made by traditional way	The jerky made by using artificial wind
1	Appearance	Soft, fluffy, flexible	Soft, fluffy, flexible	Soft, fluffy, little bit solid
2	Color	Fawn colored, fat is pale	Jerky color	
3	Smell and taste	Unusual	Includes no external smell, unusual	
4	Wet %	Up to 7.5 %	3.84	4.39
5	Fat %	Up to 15 %	12.39	11.7
6	Ash %	Up to 3.5	6.4	5.5
7	Calorie /kcal, 100gr/	51.3	429.97	427.95

Limit voltage of the jerky made by two ways were measured on the automatic

penetrometer by changing weight and time of sticking also along and cross of muscle.

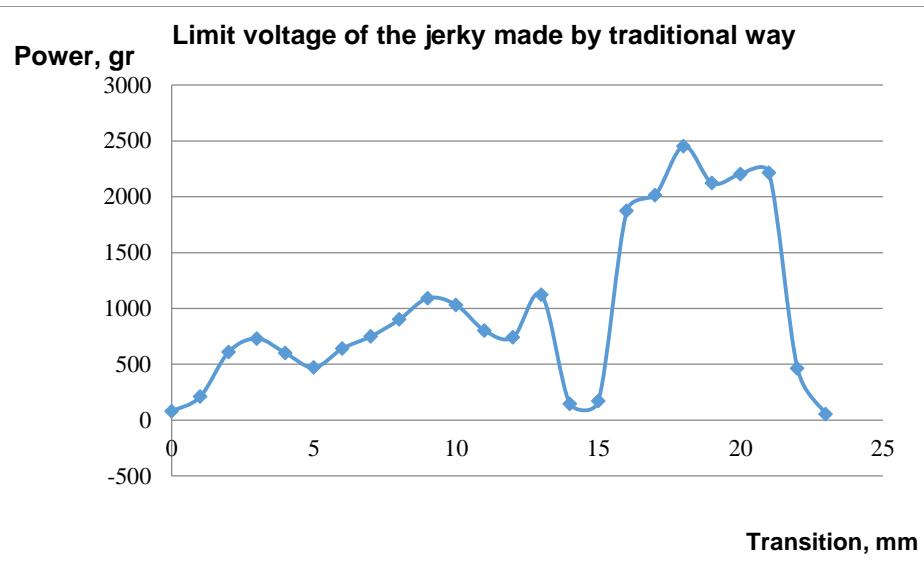


Figure 1. Limit voltage of the jerky made by traditional way

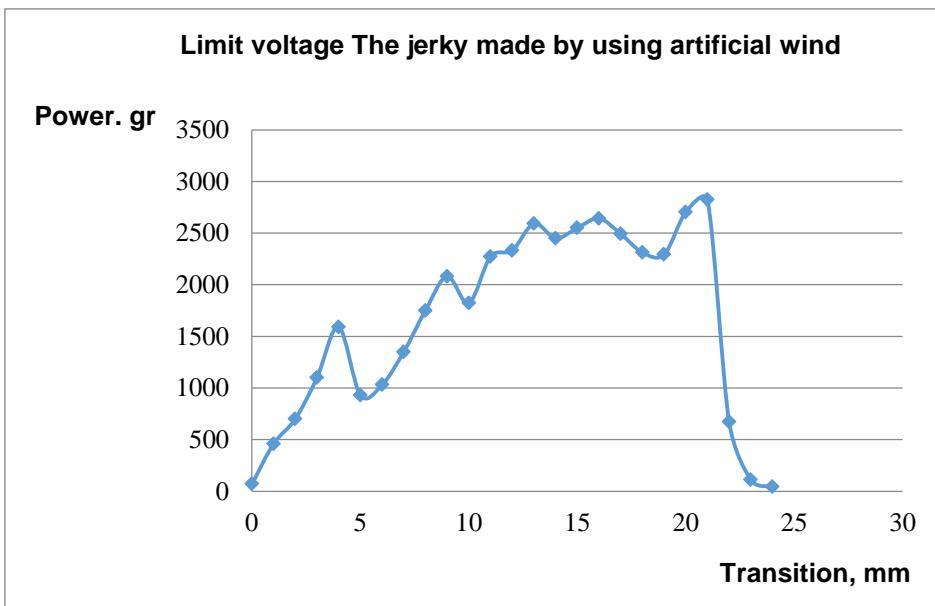


Figure 2. Limit voltage The jerky made by using artificial wind

## CONCLUSION

- Traditional way of processing the jerky takes 110 days and it is possible to reduce processing duration of the jerky 3-4 times that only takes 23 days to produce the jerky by using artificial wind, improving airflow and intensifying steam of the wet.
- According to the previous researches, a jerky made by a horse meat and mutton is rank, so that, it is bad for human liver, gall and stomach and it is appropriate to use beef, sheep and camel meat to produce a jerky
- For rheology performances, sticking tension of artificial wind method is 14% higher than it of traditional way.
- Examination has been made on 2 types of jerky made by two above different methods and result meets performances of standard and quality.

## REFERENCES

1. Avdai.Ch , Tumurjav.S "Traditional technology of Mongol"
2. Badamkhand.L "Result of research on jerking a meat" UB 2005
3. Badamkhand.L, Urtnasan.D. Result of research on jerky, "Meat export-2000" Compilation of theory and practice, UB 2000
4. Davaasambuu.Ch, "Pump, fan, compressor" UB 2007
5. Gungaa.G "Biochemical research of Jerky meat and milk" UB 1966
6. Gunsendorj.M, Khukhnuu.D "Rheology of food materials" UB 2009
7. Tserenpuntsag.Sh "Research on camel jerky" UB 1969
8. MNS 2002 "Beef jerky" UB 1980
9. [www.marinecuisine.us/aboutus.cfm](http://www.marinecuisine.us/aboutus.cfm).
10. [www.bepress.com](http://www.bepress.com)
11. [www.ald-vt.de](http://www.ald-vt.de)

## **METHODICAL BASES OF DEVELOPMENT OF TECHNOLOGICAL PROCESSES OF CROP PRODUCTION**

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### **ABSTRACT:**

*The article describes the application and further development of the methodology of system-structural analysis with the aim of constructing effective models of complex objects and technological processes in agriculture. They are characterized by complex spatio-temporal relationships, the dependence of the general properties of the object not only on the properties of its constituent elements, but also on the nature of the relationships between them. The use of the deductive method allows us to justify the combination of the principle and its approval, which must be taken into account when designing effective technological processes of plant growing. The developed system of statements has a hierarchical structure.*

**KEYWORDS:** Technological process, deduction method, design methodology, principle and statements.

### **INTRODUCTION.**

The continuous scientific and technical process and the associated increase in the quantity and complexity of the new products created, and the reduction in the periods of their moral aging lead to a sharp increase in the complexity and complexity of design and technological work. In agricultural science and practice, a large number of experimental factors accumulated, which are taken into account in the design of new technological processes and working organs. At present, in connection with the automation of design, there is an urgent need to comprehend the accumulated experience and build the foundations of the theory of technological design,

revealing the main regularities of the design process.

**Conditions and methods of research.** Continuous improvement of technologies, designs of agricultural machines, intensification of their operating modes with simultaneous improvement of the quality of work processes significantly complicates the methods of calculating the structure and parameters of machines in their design. In this case, experimental-design methods and testing of prototypes of machines in the field are of great importance. However, this method is not effective, because when creating agricultural machinery, it becomes necessary to experiment from season to

season, which is associated with a large expenditure of labor, time and money [1].

Therefore, there is a need to design technical processes to determine their effectiveness. In this regard, the application of methods of synthesis of technological processes on the basis of the characteristics of soil cultivation, sowing and production system of the economy, in which conditions it is necessary to implement the projected technological process is topical.

To solve such complex problems it is necessary to apply the methodology of the system approach. The system approach proceeds from the fact that the specificity of complex objects and processes is not exhausted by the features of its constituent parts and elements, but lies in the nature of the connections and relations between them. A specific feature of this methodology is the desire to base it on the principle of isomorphism of laws in various fields of knowledge. Hence the thesis about the interdisciplinary nature of the systemic approach and the possibility of transferring laws and concepts from one area to another [2,3,4,5].

The methodical foundations of the construction of the theory of technological design are considered by V. Tsvetkov. [6]. In this paper, the theory of design is built on the basis of the formulated fundamental assumptions and principles of the whole system of more specific statements, the structure and content of the design operations of the synthesis of the choice of solutions disclosed.

With such a construction of the theory, the starting assumptions and principles should reflect the fundamental technological regularities of the processing processes and the principles of their systemic organization. They are obtained on the basis of generalized data, systematization of the results of theoretical and practical work in engineering technology in system studies.

The proposed methodology for designing technological processes can be used in designing agricultural machines and processes. However, the specific nature of the technology and the lack of technical means for performing certain operations require modernization of the proposed methodology.

The specific nature of the technology of cultivation of crops is limited by certain limitations. The technical restrictions that determine the permissible variants of the technological process are the progressive methods of soil cultivation and sowing applied in the economy, the composition of the unit and its technical characteristics, a set of universal and special working organs, and many basic and auxiliary materials. In this case, it is necessary to take into account changes in the production environment in the holding. These include adjusting the structure of sown areas, replacing obsolete machines with new ones, continuous replenishment of technological equipment and working bodies, renewal of the application of basic materials and technological standards. The results of the research and their discussion. So, based on the essence of the system approach, we will build a methodology by deductive generalization of the results obtained by agricultural science and practice, that is, "from top to bottom" with the help of the formed initial premises of the whole system and more specific statements that reveal the structure and content of design solutions.

On the basis of the initial assumptions deductively, that is, from the top down, a system of more specific assertions being the basis of the construction algorithms and programs of technological design. Thus, the constructed system of statements has a hierarchical structure. The upper (zero) level forms a set of initial parcels ( $\Pi_1, \Pi_2, \dots, \Pi_n$ ). On their basis, a number of intermediate statements of the first level are formed ( $Y_1, Y_2, \dots, Y_n$ ).

In the future, when using the original premises and claims of the first level, more concrete statements of the second level are constructed. This process continues until the statements determining the function, structure and parameters of the elements of the projected technological process are received. The statements of the last level are mathematical models for constructing the possible variants of solutions that are permissible by technical limitations and serve for constructing algorithms and programs for technological design

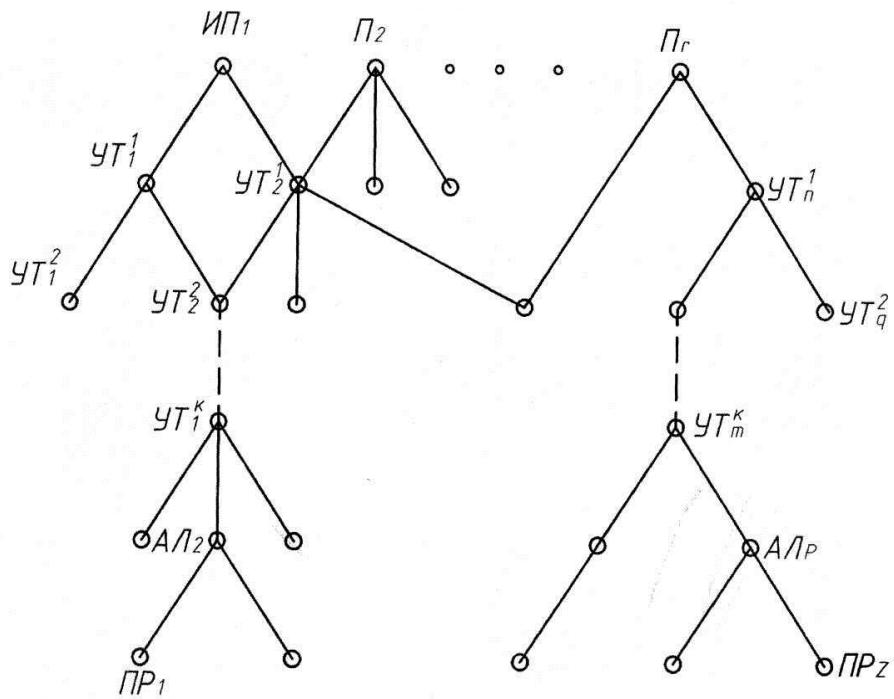


Figure 1. Structure of automation of technological design: ИП1, ИП2 - initial assumptions and principles; УТ<sup>k</sup> - k-th level statements; АЛ, ПР - algorithms and design programs.

Let us consider one of the principles and its approval of the system-structural analysis of a modern wide-grained seeding complex.

**Principle of compatibility.** The totality of objects can be combined into a system if they have the property of compatibility, that is, a commonness in the functions performed by the structural and functional properties that ensure their joint functioning as a single entity in accordance with the specified agro technical requirements. So, soil cultivation and sowing are compatible if the shape and size of the tubular vomer with the cultivator type foot corresponds to the shape and size of the seed piping of the sowing complex. The operations of the technological process are compatible if the state of the soil at the output of one operation is the starting one for the other.

In real technical systems, the inputs and outputs of some objects can differ in their design, location in space, size and other properties. All this leads to the fact that it is impossible to ensure direct compatibility of subsystems or their elements. Let us formulate the statements that determine the conditions for combining elements in a system in the absence of direct compatibility.

**Assertion 1.** The incorporation into the system of elements incompatible with one or several kinds of connections is allowed by introducing special intermediary links performing the compatibility functions for uncoordinated types of connections between interacting elements. Thus, the fan is an intermediary link between the trailer bunker and the cultivator of the seeding complex, intended for forced transportation of seeds along the vas deferens from the bunker to the paws. In addition, one or two switchgears can be installed along the conveying path to evenly distribute seed when approaching the coulters.

**Assertion 2.** The optimal cost for technological compatibility will be a variant of the technological process that, with the provision of a given productivity, agro technical requirements for tillage and sowing, determines the minimum costs for special devices that perform the function of compatibility.

We introduce the concept of the optimality of a system, which unlike traditional representations relates the system characteristics of an object to the costs of their implementation. First, this concept provides measurability of the level of efficiency when choosing a rational

variant of technology and a complex of machines, and under certain conditions reflects the advantages of the new technologies being developed, the effectiveness of which is confirmed in production conditions. In this regard, this statement determines only one side of the system's optimality - this is the minimum cost ( $3_c$ ) for compatibility of the system with the environment, that is, the cost of the design of the fan, its drive and the switchgear is taken into account.

The second side of the system's optimality is the minimum costs of  $3_{F,Z}$  for the implementation of a given function of the system F and the set of specified parameters Z, that is, the cost of the hopper, cultivator, rollers, control and

monitoring systems, and the reliability and wear resistance of their working bodies.

The third side of the system's optimality is the costs  $3_M$  associated with upgrading and upgrading the technical system over the period of operation. On the basis of the foregoing, we formulate an assertion on the optimality of the system as a whole.

**Assertion 3.** The optimal variant of Q among the set of variants of projected objects that are allowed by technical limitations will be the one that provides the minimum total costs for system compatibility with the environment, performance of specified functions and modernization in the period of operation:

$$Q = (3_c + 3_{F,Z} + 3_M) \rightarrow \min$$

## CONCLUSIONS

The principle of compatibility and the assertions 1, 2, 3 following from it determine the important laws of the construction of technological processes and the design of technical systems.

The criterion of system optimality differentially takes into account the costs for the implementation of the system

characteristics of the object in the design stage, in contrast to the traditional technical and economic criteria, which are of a calculating nature and are calculated after that the object has been designed, the technological process has been developed and normalized.

## REFERENCES

1. Modeling of agricultural aggregates and their control systems, Ed. A.B. Lurie - L.: Kolos. Leningrad Publishing House, 1979. - 312 p.
2. Buslenko N.P. Modeling of complex systems / N.P. Buslenko // - Moscow: Nauka, 1978.- 400 p.
3. Ksenevich I.P. Aspects of the design of complex probabilistic nonlinear dynamic non-holonomic systems / IP Ksenevich // - Tractors and agricultural machinery, - 2007. - No. 8. - P.20-27
4. Jabborov N.I. Optimization of the width of the capture of machine-tractor units at the design stage / NI Dzhabborov, VA Eviyev, AV Dobrinov, PN Dzhabborov // - Tractors and agricultural machinery. - 2008. - No. 10. - P.30-31
5. Radnayev DN Application of methods of the systems approach for the design of technological processes / D. N. Radnaev // Agrarian Science. - 2010.-№ 5. - P.28-30
6. Tsvetkov V.D. System-structural modeling and automation of design of technological processes / VD Tsvetkov // - Minsk: Science and Technology, 1979. - 264 p.

## THE MATHEMATICAL MODELING OF A VORTEX WATER FLOW IN THE PIPELINE SPRINKLER SYSTEMS

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### ABSTRACT

*The article presents the scientific problem related to uneven irrigation of agricultural land and green areas with the help of static sprinkler and related pressure loss and the pressure along the length of the water conveyance pipeline, on which you install sprinkler sprinkler heads. Piezometric line of the pipeline slopes downward, so the nozzle operate at different working pressure. In the case of application to equalize the pressure before the nozzle chokes, there is a need to continually adjust the value of the living section of the flow passing through the throttle, which is extremely inconvenient when a large number of nozzles. In this regard, the uniform distribution of flow and pressure between sprinklers-nozzles along the length of the water conveyance pipeline is proposed to install the pipeline to the special design of swirl flow of water, which will lead to a reduction of energy intensity of pumping units and unification domeabra attachments and reduce the consumption of materials, which is important in current market conditions. The article also presents the various mathematical models of flow moving at different modes. In addition, the comparative experimental results showing the effectiveness of using the developed design of the swirler.*

**KEYWORDS:** vortex flow, irrigation systems, pipelines, flow speed, turbulent regime, irrigation, mathematical model of a vortex flow.

### INTRODUCTION

The uneven distribution of pressure between the pressure along the length of the water conveyance pipeline leading to uneven watering. In this regard, we have developed and experimentally the special design of the swirler a flow of water [1], redirect transverse turbulent vortex flows in the longitudinal, thereby allowing to reduce hydraulic pressure losses along the length of the pipeline. To justify the process of reducing the pressure losses along the length of the tubing when you install it swirlers must be detail theoretically describe this phenomenon.

In accordance with the problem, the aim of this study is to develop a mathematical model of the process of turbulence flow of water in the tubing when you install it swirl helicoid shape.

In the framework of research on the topic the object of study was chosen static system sprinkler dynamic sprinkler-nozzles in a circular action, where the subject studies the changing speed of water flow along the length of the pipeline depending on the flow regime.

To develop a mathematical model of the process of the swirl flow of water in the

tubing when you install it swirl helicoid form, the user needs to solve several problems:

1. analyze the flow of water through the pipeline with laminar regime;
2. produce a vector analysis of the flow of water through the pipeline with turbulent regime;
3. develop a mathematical model of the process of longitudinal turbulence of the water flow when installed in the pipeline swirl helicoid shape.

### The conditions and methods of research

Development of a mathematical model the process of longitudinal turbulence water flow when installed in the pipeline swirl helicoid form is produced using analytical, mathematical and computer modeling techniques.

In the laminar flow of liquid through pipe of circular cross section, the line speed of the current varies according to a parabolic law (Fig.1)

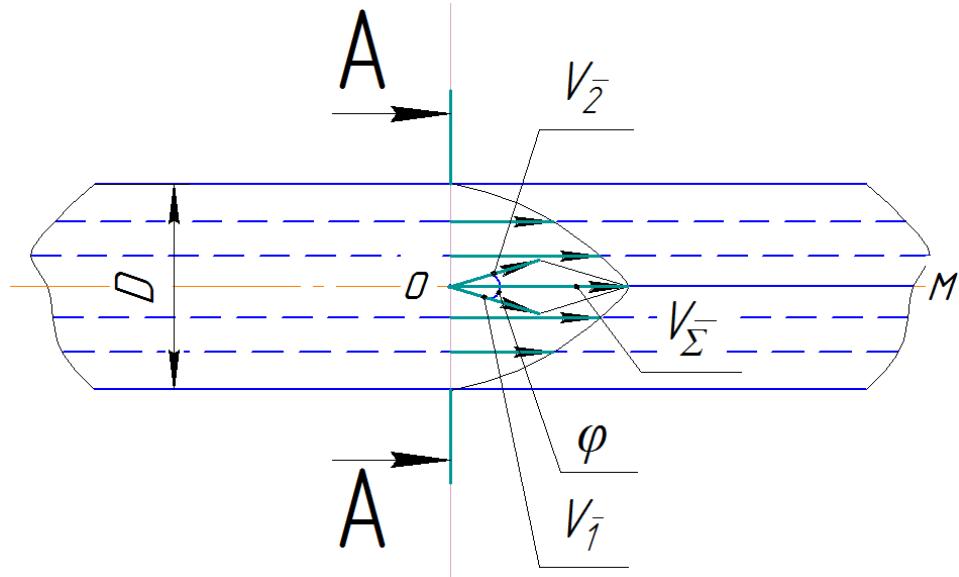


Figure 1. Vector model of laminar flow in a pipe of circular cross-section

Consider a cross-section (A-A) diameter pipe  $D$  and the point  $O$  (fig. 1), located on a centerline coincident with the center line of flow  $OM$ . Speed  $p$ .  $O$  and line  $OM$  the same and equal to the vector  $\vec{V}_\Sigma$ . Vector  $\vec{V}_\Sigma$  is decomposed into 2 components –  $\vec{V}_1$  and  $\vec{V}_2$ , equal to each other and located symmetrically of the line of flow  $OM$  at an angle  $\varphi$  to each other. In the case of laminar flow regime:

$$\varphi \rightarrow 0 \text{ и} \quad |\vec{V}_1| \rightarrow |\vec{V}_2| \rightarrow |\vec{V}_\Sigma| \quad (1)$$

In the case of the transition of flow from laminar to turbulent, the central vector  $\vec{V}_\Sigma$  will not be located on the axis of symmetry of  $OM$  and will deviate at some angle  $\beta$  (Fig. 2). Then the vectors  $\vec{V}_1$  and  $\vec{V}_2$  are not symmetrical contrary line  $OM$ ,  $|\vec{V}_1| \neq |\vec{V}_2|$ .

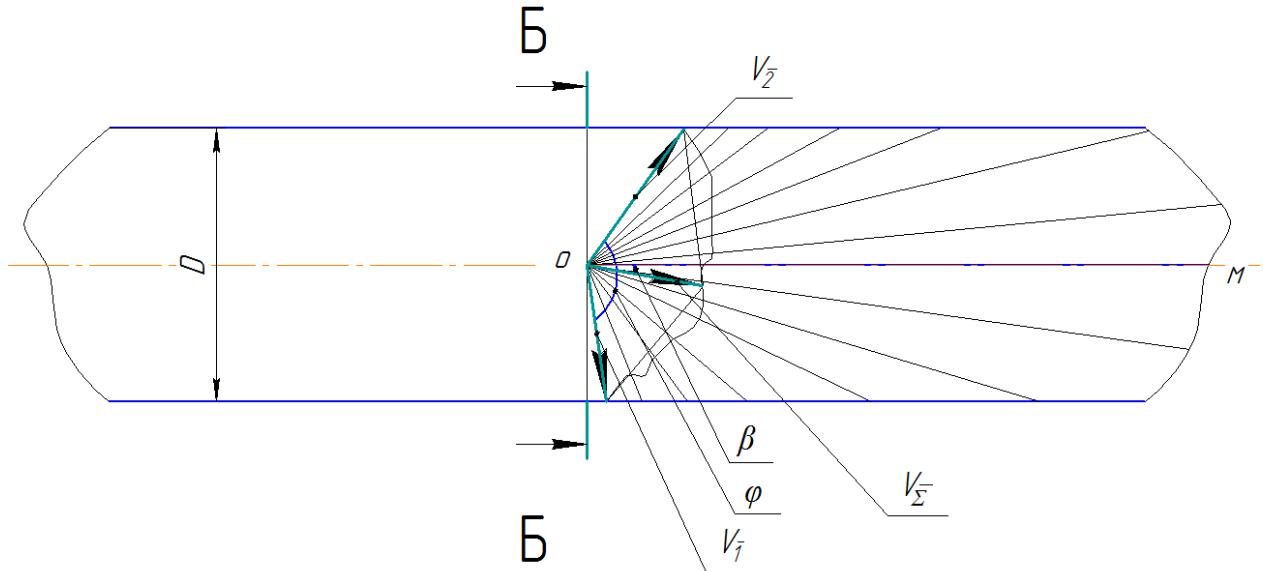


Figure 2. Vector model of the turbulent flow liquid in a circular cross-section pipe

In reality, the fluid flow in the transition from laminar to turbulent will be divided and rotated according to the ascending order of the components  $\vec{V}_1$  and

$\vec{V}_2$  of the velocity  $\vec{V}_\Sigma$ . And each component will also be split up into components. This fact is demonstrated by the photograph of the transition process (Fig. 3).



Figure 3. Photograph of the transition process fluid flow.

Consider a section of pipe with a diameter  $D$ . The tube is inserted into the swirler in the form of a helix with a pitch  $h$ , the diameter of the wire from which it is

made is much smaller than the diameter of the pipe (Fig. 4).

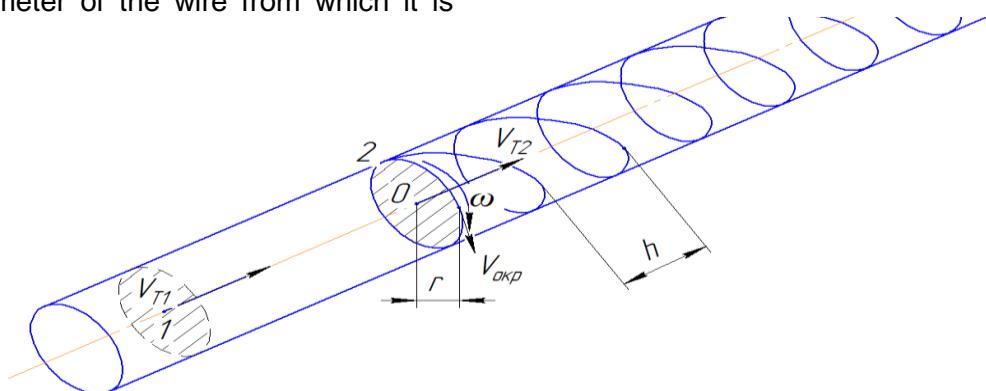


Figure 4. A design scheme of transition from turbulent flow in the vortex

In section (1) the flow is turbulent with an average speed of  $V_{T1}$ . In section (2), the flow acquires a rotary motion with an angular velocity  $\omega$  and translational movement at a speed of  $V_{T2}$ .

According to the Bernoulli equation the change in kinetic energy  $E_k$  flux passing from section 1 to section 2 is due to the committed work with the pressure  $\Delta P$ :

$$\Delta P \cdot V = E_{k2} - E_{k1} \quad (2)$$

A pressure change  $\Delta P$  over the length of the pipeline taking into account the characteristics of the liquid is equal to the respectively:

$$\Delta P = \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \cdot \frac{L}{D} \cdot \frac{v^2}{2} \cdot \rho \quad (3)$$

The kinetic energy  $E_{k1}$  consists only of the energy of translational motion and is equal to:

$$E_{k1} = \frac{m \cdot v^2}{2} \quad (3)$$

The kinetic energy  $E_{k2}$  consists of 2 components:

$$E_{k2} = \frac{m \cdot \dot{v}^2}{2} + \frac{J \omega^2}{2} \quad (4)$$

where  $\dot{v}$  - is the translational velocity of the vortex flow;  $J$  - the moment of inertia of a vortex flow, equivalent to the moment of inertia for cylinder with diameter  $D$ :  $J = \frac{mD^2}{8}$ ;  $\omega$  - the angular velocity of rotation of the stream determined by step  $h$  and  $\dot{v}$  speed.

At a constant step  $h$  and the velocity  $\dot{v}$  along the length of the insert-swirler:

$$h = 2\pi \frac{\dot{v}}{\omega} \quad (5)$$

so:

$$\omega = 2\pi \frac{\dot{v}}{h} \quad (6)$$

group together (3-6):

$$\left( \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \cdot \frac{L}{D} \cdot \frac{v^2}{2} \cdot \rho \right) V = \frac{m \cdot v^2}{2} - \left( \frac{m \cdot \dot{v}^2}{2} + \frac{mD^2(\pi \frac{\dot{v}}{h})^2}{4} \right) \quad (7)$$

where  $m = \rho V$ . Then:

$$\frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \cdot \frac{L}{D} \cdot \frac{v^2}{2} \cdot \rho = \frac{v^2}{2} - \left( \frac{\dot{v}^2}{2} + \frac{D^2(\pi \frac{\dot{v}}{h})^2}{4} \right) \quad (8)$$

Equation (8) shows that the loss of kinetic energy along the length of the friction kompensiruet rotational component. Express from the equation (8)  $\dot{v}$  :

$$\dot{v} = \sqrt{\frac{\frac{v^2}{2} \left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{\left( \frac{1}{2} + \frac{D^2 \pi^2}{4h^2} \right)}} \quad (9)$$

The total vector of velocity  $\vec{v}_\Sigma$  vortex flow will consist of the sum of a tangential component, which is peripheral speed of  $v_{OKP}$  and normal  $\dot{v}$ :

$$v_{OKP} = \omega \cdot \frac{D}{2} = 2\pi \frac{\dot{v}}{h} = 2\pi \sqrt{\frac{\frac{v^2}{2} \left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{\left( \frac{1}{2} + \frac{D^2 \pi^2}{4h^2} \right)}} \quad (10)$$

$$v_\Sigma = \sqrt{\frac{\frac{v^2}{2} \left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{\left( \frac{1}{2} + \frac{D^2 \pi^2}{4h^2} \right)} + 2\pi \frac{\frac{v^2}{2} \left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{\left( \frac{1}{2} + \frac{D^2 \pi^2}{4h^2} \right) h}} \quad (11)$$

After conversion, the equation (11) takes the form:

$$v_\Sigma = v \sqrt{\frac{\left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{1 + \frac{D^2 \pi^2}{2h^2}} \left( 1 + \frac{2\pi}{h} \right)} \quad (12)$$

The fluid flow passing through the swirler will be equal to:

$$Q = \left( v \sqrt{\frac{\left( 1 - \frac{0,316}{4\sqrt{\frac{v \cdot D}{v}}} \frac{L}{D} \rho \right)}{1 + \frac{D^2 \pi^2}{2h^2}} \left( 1 + \frac{2\pi}{h} \right)} \cdot \frac{\pi D^2}{4} \right) \quad (13)$$

corresponding average speed  $v_\Sigma$  full kinetic energy of the vortex flow can match the kinetic energy of a turbulent flow

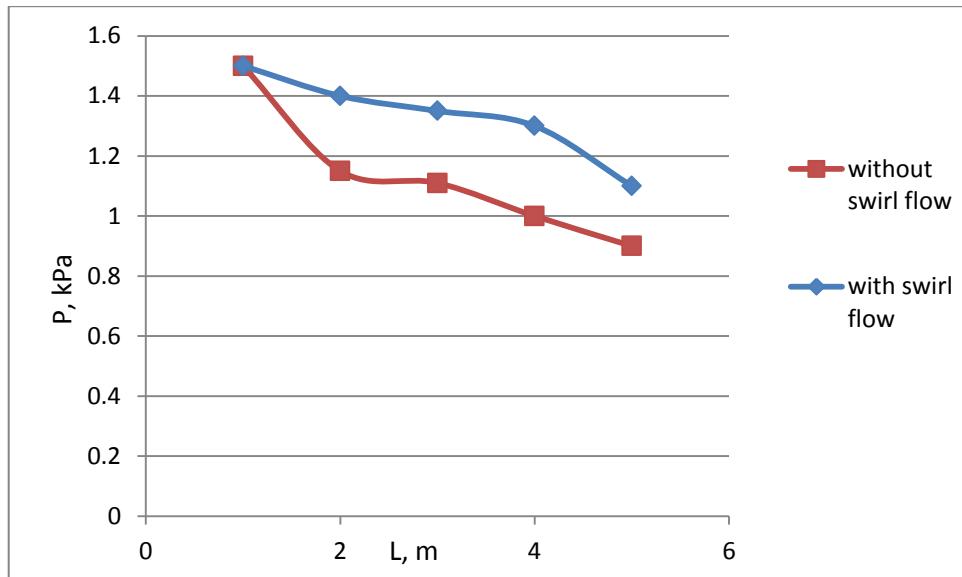
## THE RESULTS OF RESEARCH AND ANALYSIS

As a result of mathematical modeling it can be concluded that for certain values of the step  $h$  of the swirler, the

moving to swirler, thereby blocking the energy losses that occur due to friction along the length.

This fact indirectly proves an experimental study of the pressure changes along the length of the tubing when you install it swirl [1] (Fig. 5).

From the graph (Fig.5) it can be concluded that with increasing length of the pipeline, the pressure decreases, however, with the installation in the pipeline of the swirl flow, the character of change of pressure becomes smoother.



*Figure 5. Comparative plots of change of pressure  $P$  along the length  $L$  of the duct with a swirler without it*

## CONCLUSION

Having considered the various flow regimes of fluid flow through the pipeline static sprinkler systems, it can be concluded that for certain values of the step  $h$  of the swirler, the corresponding

average speed  $v_{\Sigma}$  full kinetic energy of the vortex flow can match the kinetic energy of a turbulent flow moving to swirler, thereby blocking the energy losses that occur due to friction along the length.

## REFERENCES

1. Konovalov, V. I. To the question of the use of the devices normalizes the flow in pipelines sprinkling machines // Bulletin of the Buryat state Academy of agriculture. V. R. Filippova.. 2017. No. 2 (47). P. 76-83.
2. Budarin, V. A., Methods for calculation of fluid motion. Odessa: Astroprint, 2006. 136 p.

## WEAR RESISTANCE OF THE CUTTING TOOLS

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### ABSTRACT

*This study has been carried out to investigate the wear resistance of the cutting tools on draft requirement under simulated conditions. There are three kinds of cutting tools which used for common secondary tillage in Mongolia. A sweep cultivator is any of several types of farm implement used for secondary tillage. We have field experiment of those sweep cultivator's wear resistance by modification of tip area losses and also weight loss and assessed their capacity and investigated further to show how soils structure play important role to worn sweep cultivator. Also the mineralogical analysis has been done to the soil by checking the depth of cultivation.*

**KEYWORDS:** Abrasive wear, life time of machine elements, geometric configuration, intensive abrasive wear

### 1. INTRODUCTION

The modern cultivator is a widely used machine in Mongolia. It has become a part of every farmer's operation and is used for weed control, trash burial, seedbed preparation and chemical incorporation [1]. In fieldwork, the sweep cultivators suffer from abrasive wear, modifying its geometric configuration and weight losses, which reduces their effectiveness.

The scientific research concluded that the soil granules causes micro -ploughing and micro- cutting, when a tangential motion is introduced, the material is removed from the softer surface.

Contents of the soil are: Fluorite (982 NV), quartz (1161 NV) and other minerals. But the sweep cultivator material has hardness of 484 NV (Vickers hardness) and after covering by hard layer the edge of 674 HV becomes harder[5].

Sweep cultivator's that one we use in our country, has a life of approximately 15-30 hectare for tillage, depending upon the soil granules and wear resistance of the tool material [2].

Agricultural companies use different kind of sweep cultivators depending on their settings. They use products which are made in Russia and Canada, and also the one casting in Mongolia. They are all different from each other, regarding the design and the capacity of wear resistance.

The aim of this research is to know, which sweep cultivator will be suitable to the soil of Mongolia and which one has strong wear resistance under similar circumstances

## 2. MATERIALS AND METHODS

To start tillage trials at a site, all equipments including XT3-150 tractor were used. The depth of operation was set at 12 cm in the experiment. Similarly, speed of operation for trials was kept constant 9.5 km per hour. After finishing trial of one treatment in its designated plot, all of the sweeps were taken off and weighed for assessment of mass losses. After this, next treatment was operated in its designated plot till all the treatment was completed. All this resulted in a set of data on original weights of all sweep cultivators

and weight losses of sweep as recorded in table 2.

A part from weight losses of sweep cultivator, the wear rates were also examined in terms of modifications in the edge thickness of tools and tip area losses.

In the experiment, using sweep cultivator was made in Canada (figure 1,C) and Russia (figure 1,B), casting sweep cultivator (figure 1,A). Parameter of sweep cultivator in experiment is given in table 1



A

B

C

Figure 1. Kinds of cutting tools. A. Casting sweep cultivator B. Sweep cultivator made in Russia, ЭКТШ 27.408, points with their alloyd rear surface, C.Sweep cultivator made in Cannady, (Lift angle 210)

Table 1.

Parameter of sweep cultivator in field experiment

Sweep cultivator	Symbol	Hardness of working face (HRC)	Material	Edge thickness (mm)	Lift angle $\beta$ (degree)	Strengthening method	Mark	Number of figure
Casting sweep	Tsut-ur	32	50X	10	21	WFF	One line	1
Casting sweep	Tsur-ar	34	50X	10	21	WRF	Two line	2
КПЭ- 3.8 Sweep (China)	Bu-1	38	65Г	9	21	IHS	One line	
КПЭ- 3.8 Sweep (China)	Bu-2	36	65Г	9	21	IHS	Two line	
КПЭ- 3.8 Sweep (Russian)	Op-3	46	65Г	9	21	IHS	Three line	3
КПЭ- 3.8 Sweep (Russian)	Op-4	48	65Г	9	21	IHS	Four line	
Sweep (Canada)	Ca-21	46		6	21			4
Sweep (Canada)	Ca-38	46		6	38			5

Тайлбэр

IHS - Induction hard surfacing, WFF- Welding of a cutting edge front furfase WRF- Welding of a cutting edge rear furfase

The wear of sweep cultivator is defined in terms of weight losses and geometrical configuration modification. Electronic scale with a least count of 0.01

gram and geometric configuration of a least count of 0.01 MM instruments were used.

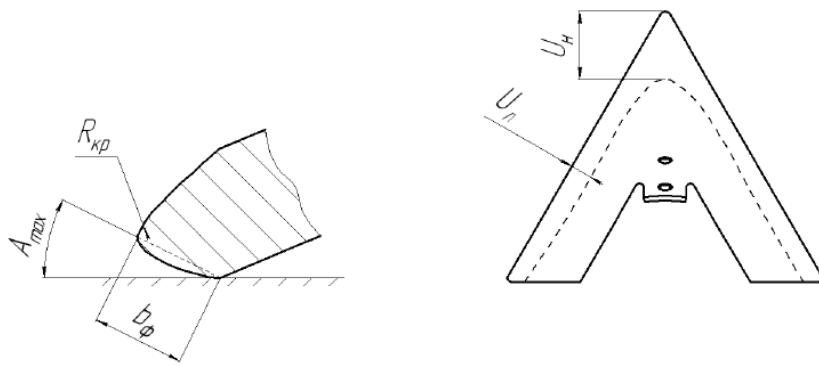


Figure 2. Geometric configuration of sweep cultivator.  $U_H$ - The wear of nose side,  $U_n$ - The wear of inclines side face,  $b_\phi$ - The wide of rear side surface of edge,  $R_{kp}$  – Blunt radius

## CONDITION OF EXPERIMENTS

**The Soil textures** - Sandy loams, Loamy sands, **Expermantal place:** Selenge province. Following figure.3 shows that  
Saihan sum “Ургацын Ундраа” CO.  
LLT, Burgaltai sum “Buren burgaltai” CO.  
LLT

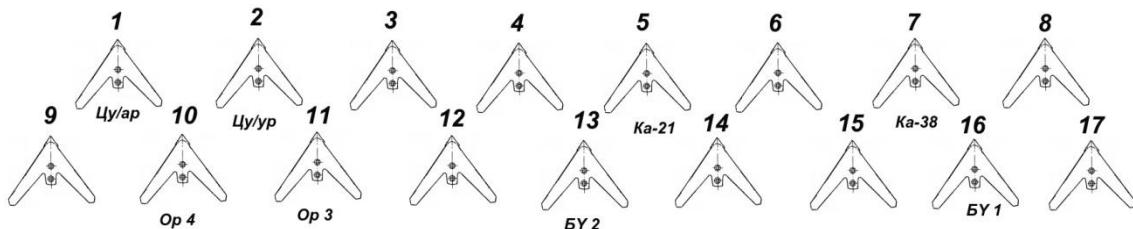


Figure 3. Position of sweep shovels on experiment cultivator (XT3-150 Лидер -6)

## 3. RESULTS AND DISCUSSION

We experimented cultivating 2.9, 5.5, 9.35, 17.7 hector of land and measured. Weight losses of sweep cultivator were determined during field observations data is given table 2. The highest weight loss of the sweep cultivator marked tsut-ar of 240.3 g/ha was recorded in the experiments.

The Institute of Ferrous Metallurgy UkrSSR have proposed steel Kh6F1 for soil-cutting parts. Steel Kh61 (1.45-1.70% C, 5.5-7.0% Cr, and 0.8-1.2% V) has been used for the hard cladding layer of bimetallic plowshares and disks of harrows and stubble plows [3].

Table 2.  
Condition of wear resistance of the sweep cultivator (G)

Name of experiment area and square	The soil textures	Set	Operation seed (km per hour)	Performance (hectare)	Sweep cultivator's name							
					Tsut-ar	Tsut-ur	Bu-1	Bu-2	Or-3	Or-4	Ca-38	Ca-21
					Mass of cultivator before experiment (by weight, gramm)							
					4869	400	464	459	395	397	298	286
						0	9	4	4	8	4	9

Urgatsii n undraa (180 hectare)	Sandy loams	belorus- 1221, KPE-3.8	9.5	2.9	4857	396 0	462 2	457 5	392 4	396 4	294 8	285 3
Buren burgalta i (500 hectare)	Sandy loams	Jon Dear- 9340, Morris- 8900	10.4	2.6	4823	392 0	454 0	452 1	391 1	392 8	290 7	280 5
Buren burgalta i (510 hectare)	Loam y sands	HTZ T- 150, Lider-6	9	3.8 5	3898	319 6			360 8	347 0	258 0	226 0
Buren burgalta i (710 hectare)	Sandy loams	HTZ T- 150, Lider-6	9	8.3 5	2697				218 4	264 3	202 3	169 2

Current and rate of wear of sweep  
cultivator are shown figure 4 and figure 5.

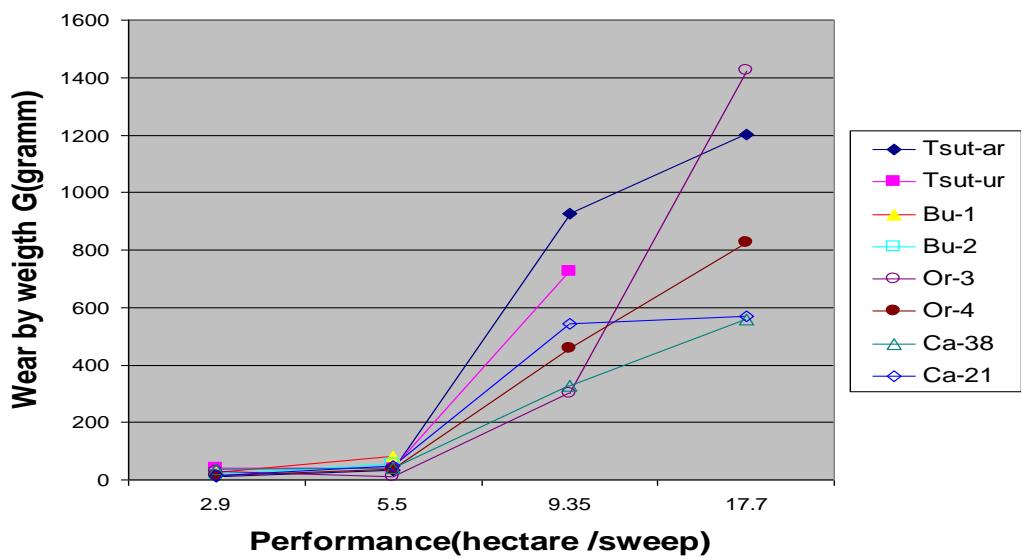


Figure 4. Current wear of sweep cultivator

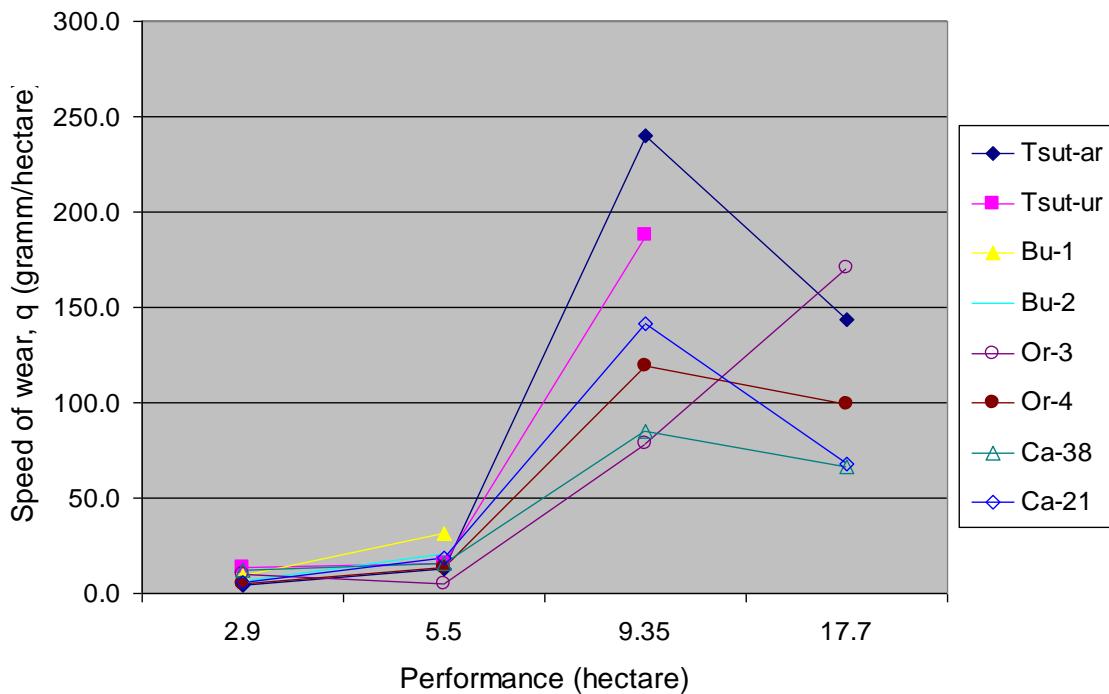


Figure 5. Rate of wear sweep cultivator

The result of the experiment of Canadian sweep cultivator showed, that it cuts the root of the weed clearer and it doesn't leave any wrap tine of weed on the sweep and the blunt radius ( $R_{kp}$ ) is 3mm. Which means it meets the requirement of our agriculture standard.

Soil texture of loamy sand had very strong effect in wear resistance than

## CONCLUSIONS

With research results the following conclusion can be made:

1. Casting sweep cultivator had most wear out. When the wide of rear side of surface reaches 22mm, it increases the resistance of the soil.
2. Sweep cultivator the one made out of casting metal in sand mold doesn't meet the standard of agriculture. It is because blunt radius reaches 8mm and 1kg heavier than others. Also the width

others. It has been analyzed in Central geological laboratory.

According to the test result of sweep cultivator from Russia shows most wear resistance to loam sand. The strength of selfsharpening soil-cutting parts depends mainly on the mechanical properties of the base metal, particularly its ductility.

of sweep becomes 20 mm bigger than from the original size.

3. The Canadian sweep cultivator the one has 38 degree lift angle, has most strong resistance wear.
4. After investigation of Central Geological laboratory, it was concluded that the loam soil, contains 74% quartz (1161 NV) and fluorite (982 NV). Because of its contents the loamy sand soil is 1,5-1,7 times stronger than the material (65G hardness 674 HV) of sweep cultivator.

## **REFERENCES**

1. Новиков В.С "Обеспечение долговечности рабочих органов почвообрабатывающих машин" диссертации доктор технических наук. Москва. 2008
2. Khruschiev, M.M., Babichev, M.A. Abrasive Wear. -Moscow: Nauka, 1970.-251p. (in Russian).
3. Tkachiov, V.N. Working Capacity of Machine Elements under Abrasive Wear Conditions. - Moscow: Mashinostroenie, 1995.-336p. (in Russian).
4. Vinogradov, V.N., Sorokin, G.M., Kolokolnikov, M.G. Abrasive Wear. -Moscow: Mashinostroenie, 1990.-224p. (in Russian).
5. Tenenbaum, M.M. Resistance to Abrasive Wear. -Moscow: Mashinostroenie, 1976.-271 p. (in Russian).
6. ASM Handbook. V.18. Friction, Lubrication and Wear Technology / Peter J.Blau. The Materials Information Society, 1992.-881p.
7. Веллингер.К, Уетц.Г . Изнашивание струей абразивного материала. Машиностроение, 1986 №2 , с 52-77

## **EVALUATION OF INTERNAL COMBUSTION ENGINE PARTS WEAR BY MECHANICAL CONTAMINATION CONTAINED IN THE ENGINE OIL**

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### **ABSTRACT**

*The working resources of the machinery operating in agricultural and mining site of field work in Mongolia are changed in the wide ranges of utilization condition and there are various factors that affect them. The produced technology, fuel used, engine oil quality, terms of use and environment conditions are important role for engine parts wear. In this paper presented are experimental results on evaluating wear contamination particles (Fe, Al, Cu, Pb, Sn, Cr, Ni) in the engine oil using the atomic emission spectrometer analysis.*

**KEYWORDS:** Wear elements, engine oil analysis, particle contamination and regression analysis.

### **INTRODUCTION**

In my country, machine and equipment, their spare parts, lubricating oils get to import from abroad. Recently, all of the kind of auto motive's numbers increase high. In regarding my country that has a dry and arctic climate, machine technics with high price.

Due to that, analysis of oils, based on properly defined program, represents a very effective method for monitoring the state of technical systems, which ensures

early warning signals of potential problems that could lead to failure and break down of the technical systems. Using Oil Analysis programs for engine oils has several benefits: reduction of unscheduled vehicle downtime, improvement of vehicle reliability, help in organizing effectiveness of maintenance schedules, extension of engine life, optimization of oil change intervals and reduction of cost of vehicle maintenance.

### **MATERIAL AND METHODS OF RESEARCH STUDY**

Aim of our research study is appreciate for wear rating of spare parts by content of metal particles in the engine oil. As an engine oil analysis technique used spectrometric investigation.

Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) is one of the most common techniques for elemental analysis. Its high specificity, multi-element capability and good

detection limits result in the use of the

technique in a large variety of applications.

## RESULTS OF THE RESEARCH STUDIES

The engine oil samples were collected from the engine operated in mining field excavator of Bucyrus RH340.

Tested oil is Mobile 15W-40. Table 1. shows results of experimental.

Table 1.

Result of experimental, ppm

№	Equipment meter	Metal elements				
		Cu (copper)	Fe (iron)	Cr (chromium)	Al (aluminum)	Pb (lead)
1	2381	0	7	0	0	0
2	2667	1	9	0	2	1
3	2985	1	9	0	2	1
4	3607	0	5	0	1	0
5	4148	22	15	0	3	1
6	4268	32	35	0	6	0
7	4736	11	23	0	2	0
8	5148	2	19	2	2	3

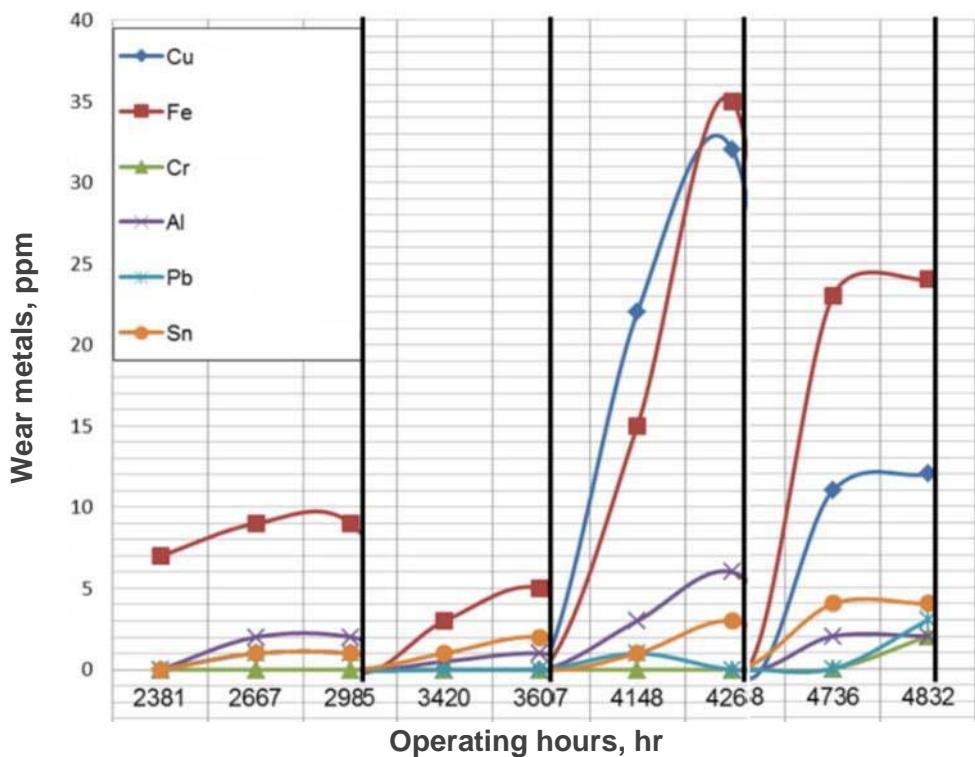


Figure 1. Content of wear metals in the used engine oil of excavator of Bucyrus RH340

As shown in Figure 1, black line is drawn the time for oil changed period, and it was increasing that Iron and Copper contents rather than other elements. These elements contain in most parts of the engine and indicative of components wear such as piston rings, connecting rods, crankshaft, engine block and bearing.

The following graph is a representation of the relationship between iron levels and operating hours of engine in one interval for changing the oil (Figure 2). This graph has confirmed that iron content in the engine oil was as dependence of operating hours of engine and it will be expressed as  $y=0.555x+6.465$ , and the linear fit has a coefficient of determination value of 0,91.

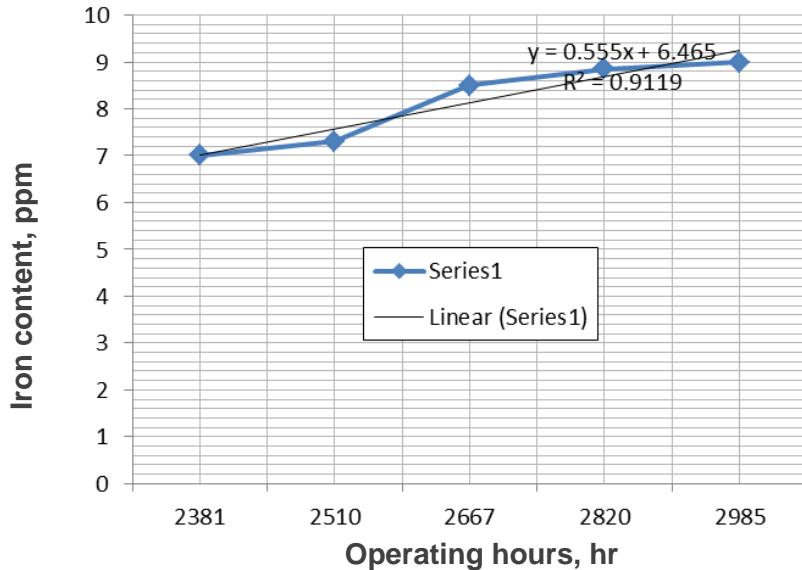


Figure 2. Content of Iron in the used engine oil of excavator of Bucyrus RH340

Iron (Fe): In engines, the cylinder liners and the crankshaft are the major wearing components along with timing gears, shafts and valves. In gearboxes and drive train components, iron is the major constituent of the gears, shafts and antifriction (rolling element) bearings. Finally, iron can also be a contaminant. When iron reacts with water (which contains oxygen) and atmospheric oxygen, rust can form, which may indicate contamination or component degradation. Rust, containing iron, can be formed in cooling systems. If an internal coolant leak occurs whereby the coolant comes into contact with the lubricating oil then the

coolant may evaporate at working temperature and pressure whilst leaving coolant additives and contaminants behind in the oil. This will be covered in more detail under sodium.

The following graph is a representation of the relationship between copper levels and operating hours of engine in one interval for changing the oil (Figure 3). This graph has confirmed that copper content in the engine oil was as dependence of operating hours of engine and it will be expressed as  $y=0.49x-0.57$ , and the linear fit has a coefficient of determination value of 0,97.

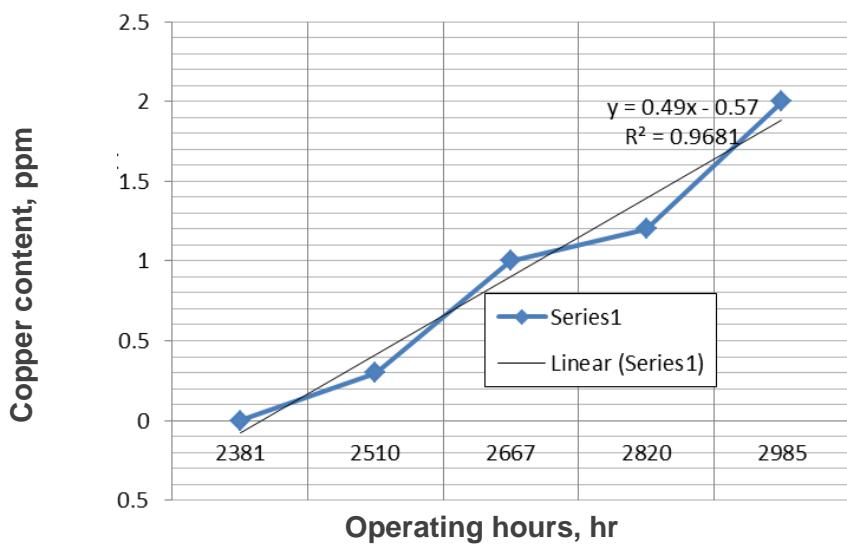


Figure 3. Content of Copper in the used engine oil of excavator of Bucyrus RH340

**Copper (Cu):** Copper has many wear metal sources although it, too, can be a contaminant and occasionally an additive. Copper comes from plain bearings, bushes, thrust washers, worm gears, sintered clutch packs and brakes. Anything with a 'yellow' metal component will contain copper. The alloy of copper and tin is called bronze whilst copper and zinc make brass. Bronze gears are frequently used as worm gears in worm drive gearboxes. Very high levels of copper can leach from oil coolers and

radiators as a contaminant. Cooling system components are frequently made of copper and this can leach directly into the oil. This does not mean that the cooler is dissolving and it is not an indication of a problem. However, it can be a little disturbing to see several hundred ppm of copper in a sample suddenly appear in an oil analysis report. Copper can also leach into the water side of the cooler and if this water gets into the oil it can evaporate off leaving the copper behind which is an indication of a problem.

## CONCLUSIONS

We have evaluated the contamination of the wear products of the engine oil samples collected from the engines mounted to the excavators Bucyrus RH340.

We have confirmed that iron content in the engine oil was as dependence of operating hours of engine and it will be expressed as  $y=0.555x+6.465$ , and the

linear fit has a coefficient of determination value of 0.91

We have confirmed that iron content in the engine oil was as dependence of operating hours of engine and it will be expressed as  $y=0.49x-0.57$ , and the linear fit has a coefficient of determination value of 0.97.

## REFERENCES

1. Dampil B., Nigamet T., Davaajav T. "Engine of the tractor and auto motives" 2012
2. Avdai Ch., Sharaa M. "Lubricants" 2000
3. Avdai Ch., Gantulga G. "Fuel, lubricants and engine oil" 2002
4. Shackelford, James F. "Structure of Materials", "Materials Science and Engineering Handbook" 2001
5. Bharat Bhushan "Modern tribology handbook" 2001

## **FIELD EXPERIMENT RESULT OF CENTER PIVOT SPRINKLER UNIFORMITY**

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### **ABSTRACT**

*The purpose of this experiment was to determine irrigation regime and operating parameters of sprinkler irrigation specification associated with soil and climate conditions, discharge of each nozzles of Valley Center Pivot sprinkler irrigation, which is using in the Selenge province.*

**KEYWORDS:** Center pivot, sprinkler irrigation, LEN sprinkler, uniformity evaluation.

### **INTRODUCTION**

In our country from the 2006 developed irrigated agriculture the government policy started a lot of technical and technological strategy. Irrigated cropping fields have reached 54.0 thousand hectares in 2015. As per survey it is estimated that up to 100 hectares are possible to be irrigated. Their about 15 thousand hectare were irrigated sprinkler irrigation and mini irrigation equipment of 197 irrigation systems and mechanization level was 32,2 percent. In irrigated agriculture production increases new design, number of high capacity irrigation

equipment by year by year, but not have research study new design of irrigation machinery and equipment in our soil and weather conditions. Thus very important issue

to development irrigation scheduling power saving in the agricultural central region soil, weather conditions, qualified plant physiology, to protect soil erosion. The field experiment irrigation system was model Valley 8000 center pivot's specifications is LEN sprinkler packages, mechanical control panel, machine length 567 m, pump options 1.0 HP.

### **EXPERIMENT METHODS**

The experiment field was chosen agricultural central region, which is used to sprinkler irrigation system in Selenge province. For experiment and survey used next experiment methods. Therefore:

- Comparative method of experiment
- Sample survey
- Mathematic and statistics method

The field soil moisture expressed by statistic method, soil mechanical

constitution, soil bulk density, volumetric weight was determined by soil, agrochemical laboratories of Agro-Biological School. The uniformity test method were used the ASAE S436.1

standard, by scheme pivot point from parallel to the lateral line, catch can spaced 3 meter apart.

## RESULT OF EXPERIMENT:

The experiment was potato planted field with sandy-rock soil types, leveled slope in Valley center pivot. First, in center pivot per revolution determined applied water of sprinklers 30 m between 30 m spacing of total system length (figure 1). By the proposal methods applied water of each nozzles test was perpendicular to the direction of travel of the machine and catch can (collector) volume  $14.5 \text{ cm}^2$ . During the experiments center pivot planned irrigation rate /application rate/ was 225 cubic meter or 22.5 mm. Figure 1 illustrates applied water was increased from the pivot point, when actual rate in average 25.77 mm, it was more 2.77 mm planned irrigation rate. But near the pivot point was less (low) 4.09 mm, also near to the end point of system more 17.5 mm. After first experiments, when compared sprinkler nozzles with specifications of center pivot was not correct installed distance from the pivot point number of nozzles. Therefore, by the specifications of center pivot near to the pivot point 1,2 mm

nozzle diameter, very far from the pivot point 7.4 mm nozzle diameter was installed and started next experiment. After corrected installation of nozzles, when experiment was same methods the first (figure 2) applied water of one nozzle was 23.6 mm either in average 1.1 mm more from the application rate, when irrigation system per revolution.

A rise of diameter of nozzle was improved the uniform, irrigation rate provided distance 450 meter (79.3 percent) from the pivot point, but located end point sprinklers more discharge seen figure 2. End point sprinklers amount of water less than 69 percent approach to planned irrigation rate.

After uniform the diameter of nozzles determined by variation coefficient of sprinkler uniform of water were 10,5 percent, it shows sprinkler uniformity to reach 89,5 percent. By the second experiments was Valley center pivot spend 102 hours per revolution at 13%, speed in 0.61 M/min.

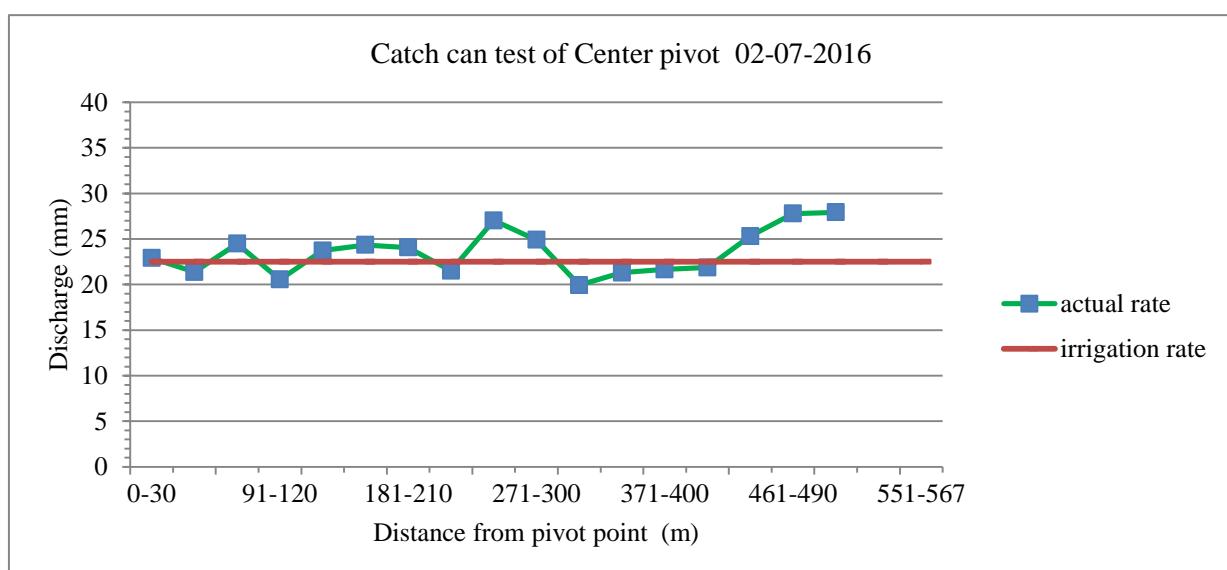


Figure 1. The uniformity of the sprinklers in a center pivot depends on radius ( $R$ ), /before correct installation of nozzles/

Pump pressure was 48 PSI, sprinkler pressure 10 PSI. From the results of experiments can reduce at percent of per revolution timer setting, not possible to regulate the sprinkler pressure, when to supply planned application rate. One characteristic of efficiency of sprinkler irrigation is sprayed water to soil infiltration process. Soil and weather characteristics data are shown figure 3 from 19 June to 01 August 2016, there air temperature and humidity, wind speed, soil temperature, three times a day get soil moisture data.

But there not included rain, air temperature increased from 05 July to 15 July days by the pre planned application rate, between 4,2 days get special measurements and compared them. Figure 3 shows from 07 July started heat /sunny, hot day/ and during the 10 days at 2 pm was air temperature average in 28,8 C°, soil temperature average in 24,0 C°. Due to irrigation potato field's soil temperature was low from the air temperature.

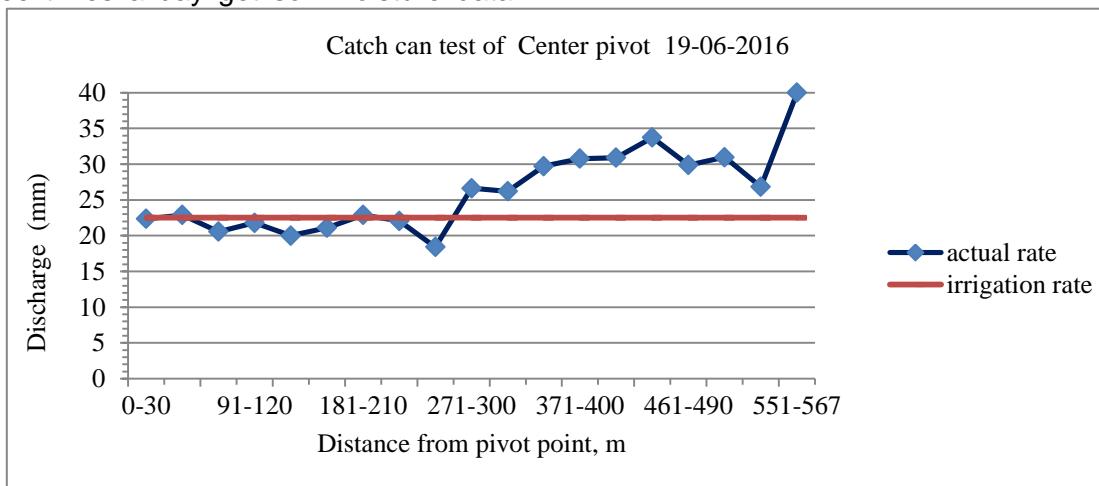


Figure 2. The uniformity of the sprinklers in a Center pivot depends on radius ( $R$ ), /after correct installation of nozzles/

Pump pressure was 48 PSI, sprinkler pressure 10 PSI. From the results of experiments can reduce at percent of per revolution timer setting, not possible to regulate the sprinkler pressure, when to supply planned application rate. One characteristic of efficiency of sprinkler irrigation is sprayed water to soil infiltration process. Soil and weather characteristics data are shown figure 3 from 19 June to 01 August 2016, there air temperature and humidity, wind speed, soil temperature, three times a day get soil

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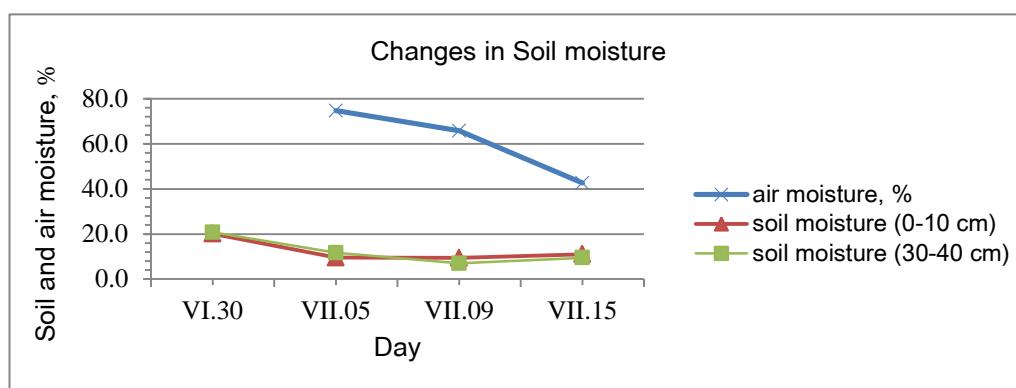


Figure 3. Relation between air and soil temperature

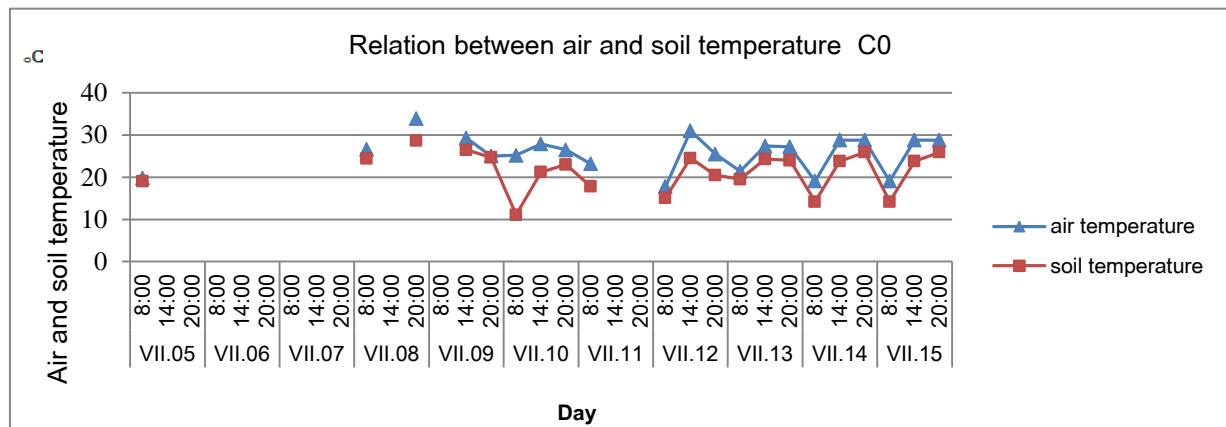


Figure 4. Relation between air and soil moisture

Above during the time not rain wherefore air humidity was 74.7 % on 05 July, but by 15 July reduced 42.6% see the figure 4. But currently oil moisture was comparably constant. Figure 4 illustrates specially, on 07 July soil surface (0-10 cm) moisture was 9.4% or 12.2 mm, but

15 July moisture rate was low grade increased 11% or 14.3 mm. Potato root zone at 30-40 cm deep soil moisture was on 15 July. 9.5% or 12.3 mm, it less than 11.3 mm applied irrigation water means overheat affects evaporation of water, also explained water deep percolation.

## DISCUSSION

When Valley 8000 center pivot regulation 102 hours per revolution timer setting was applied water by the pump was 24480 cubic meter but calculated actual rate equals to 23.0 mm. But after measuring irrigation rate was 23.6 mm, perhaps to conclude counter was measured 2.5 percent insufficient. Estimated sprinkler water loss for an 25,4 mm irrigation (Schneider and Howell, 1993) for spray sprinkler air and canopy total loss was determined 8.0 percent

(application efficiency coefficient 0.92). We used this characteristics and calculated the experiment results 0.25 mm water losses by evaporation, actual discharge were 23.85 mm. But amount of water for 30-40 cm deep of soil water amount variance 2.5 more than above that reason was environment temperature, soil character, specification of center pivot, crop growing stage and other a lot of factors relationships and necessary to study more detail.

## CONCLUSION

Determined some performance of utilization and agro technology of model Valley 8000 center pivot sprinkler irrigation in potato planted field with the sandy-rock soil, irrigation rate was low in average of 2.77 mm from the planned irrigation rate, it is depends on sprinklers was installed not correct and concerning mechanic losses of water.

1. To improve the utilization of sprinkler irrigation machinery installed nozzles by the instructions water discharge was almost 90 percent of length of

machinery and sprinkler uniformity was 89.5 percent. Therefore possible to provide irrigation rate to change only speed per revolution.

2. In order to increase irrigation efficiency of center pivot sprinkler irrigation, future necessary to determine mechanical losses of water and evaporation water losses accurately.

## **REFERENCES:**

1. ANSI.ASAE S436.1 DEC01. Test Procedure for Determining the Uniformity of Water Distribution of Center Pivot and Lateral Move Irrigation Machines Equipped with Spray or Sprinkler Nozzles.
2. Valley Classic Control Panel. 0997335\_G.Valmont Industries, Valley NE68064 USA.
3. Sabah Almasraf, Jennifer Jury and Steve Miller. (2011) Field evaluation of center pivot sprinkler irrigation systems. Department of Biosystems and Agricultural Engineering Michigan State University
4. Danny H.Rogers. (February 23-24 2016). Performance of Center Pivot Irrigation Systems. Kansas State University.
5. Danny H.Rogers, Mahbub, Using Evapotranspiration Reports for Center Pivot Irrigation Scheduling, Kansas State University.
6. Wenting, Han and Pute, Wu. (2011) Evaluation model development for sprinkler irrigation uniformity based on catch can data. African Journal of Biotechnology Vol.10(66), pp. 14796-14802,26 October, ISSN1684-5315.
7. Abdelrazaq, (2014) Improving The Performance of Center Pivot Irrigation System. *Journal of Engineering and Development*. Vol.18, No.4, July ,ISSN 1813-7822.
8. T.A.Howell. (2000) Water losses associated with center pivot nozzle packages, Bushland, Texas

## **STUDYING TECHNICAL THINKING OF THE ENGINEERING STUDENTS**

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### **ABSTRACT**

*In the official documents such as “Master plan to develop Science and Technology in Mongolia between 2007-2020” it has been presented that to pay more attention to prepare engineers who are highly educated and skilled, fitted to the requirements of the market demand and attitude and accepted to internationally and to develop sustainable and unremitting cooperation of Education-Science-production, that the percentage of students who study in the field of engineering and technology reaches from 13.0% to 25%. It shows that demand and needs of engineers and technicians will grow and they will become one of the guides for the development of the country.*

*We selected accurate test for estimating technical thinking ability of engineering students, and by using the test, we carried out study to estimate engineering students’ technical thinking ability, basic understanding of technique and knowledge of physics laws.*

**KEYWORDS:** Test, engine, density, centrifugal force, pulley systems.

### **INTRODUCTION**

Technical thinking is defined as an aptitude, ingenuity, and affliction for solving practical problems through experience (Autio, Hansen, 2002)[1]. From the beginning of civilization such thinking has been a significant part of human existence (Burke & Ornstein, 1995; White, 1962)[2].

In the work of Dyrenfurth (Dyrenfurth, 1990) and Layton (Layton, 1994), measurement and description form of technical thinking were focused. They paid more attention on measurement of technical thinking and established 3 parts of it. The 1<sup>st</sup> is technical knowledge.

Dyrenfurth said, “In democratic society, person have to know about history of nature and technology, their relations, trends and principles of the technology. Knowing always relates to education and science”. The 2<sup>nd</sup> measurement of thinking is capacity or potential. Capacities of techniques and technologies are the most important things for human survival. And it is the part of living actively for a long time. These capacities are the ‘psychomotor’ capacities and important piece of technical thinking. These capacities are described by skills and practical knowledge. The 3<sup>rd</sup> is courage, enthusiasm and agility.

Technology is a driving force that builds personal emotion and values. And it is emotional part of technical thinking.

As you can see, technical thinking is an expression of capacity, emotion and balance of knowledge [3].

Mechanical comprehension tests measure knowledge of mechanical and physical concepts including: Levers, Pulleys, Gears, Springs, Simple Electrical Circuits and Tools.

Test developed by American psychologist J.K. Bennett (Bennett Mechanical Comprehension Test) [4] is based on physics law and test assignments contain physics fundamental concepts such as forces (gravity, weight, friction force and centrifugal force), motion (linear motion, thermal, and mechanical movement), pressure, inertia, water, temperature, leverage, plane, rotating motion and equipment. There are some daily life experiences given in physics terminology:

- Pushing the roller over a step requires a larger force than pulling the roller over the step
- Inertia of body is the inability of the body to change by itself the state of rest or of uniform motion
- A person on frictionless surface can get away by blowing out the air from

## STUDY MATERIALS AND METHODOLOGY:

There are 70 assignments which will be completed by the students. In order to complete those assignments, students have to observe the figures and answer the questions. Every question has 3 choices. It requires students to select right choice. Test time is 30 minutes. Every right choice is 1 point. Technical thinking ability will be determined by using special table for assessment.

Table 1.

Engineering students	Level of technical thinking				
	Levels				
	Low	Lower than middle	Middle	Higher than middle	High
Male	26>	27-32	33-38	39-47	48<
Female	17>	18-22	23-27	28-34	35<

It converts right choice into percent and make explanation on the point. According to the explanation of J.K.Bennett, technical thinking ability is different for gender.

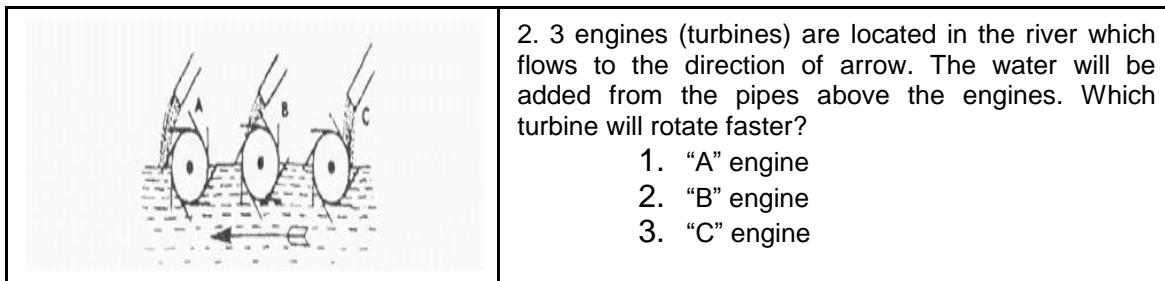
the mouth or by throwing away an object in direction opposite to the one in which he wants to move

- The forces acting on a point are concurrent forces and they are in equilibrium if resultant force is zero [5]

The first form of the Bennett Mechanical Comprehension Test (BMCT) was made in 1940, and test battery for assessing Differential Aptitude Tests was added in 1947. In 1969, the test was improved and made S and T forms of the test. The latest versions were published in 2008 and 2014 by American Psychology Corporation. According to the booklet published from this corporation, the test has parts of technical knowledge, imagination and understanding which measure technical thinking and skills in a complex way. The test is an official test which is accurate and appropriate.

Test reliability coefficient was 0.81-0.93 by Spearman-Brown prediction formula, standard error was 3.0-3.8, and median was 0.86. The test is designed "to measure and assess teenagers and adults' technical thinking, knowledge and understanding" [4].

Assignments result of Bennet's test was recorded in Mary Hegarty's study[6].

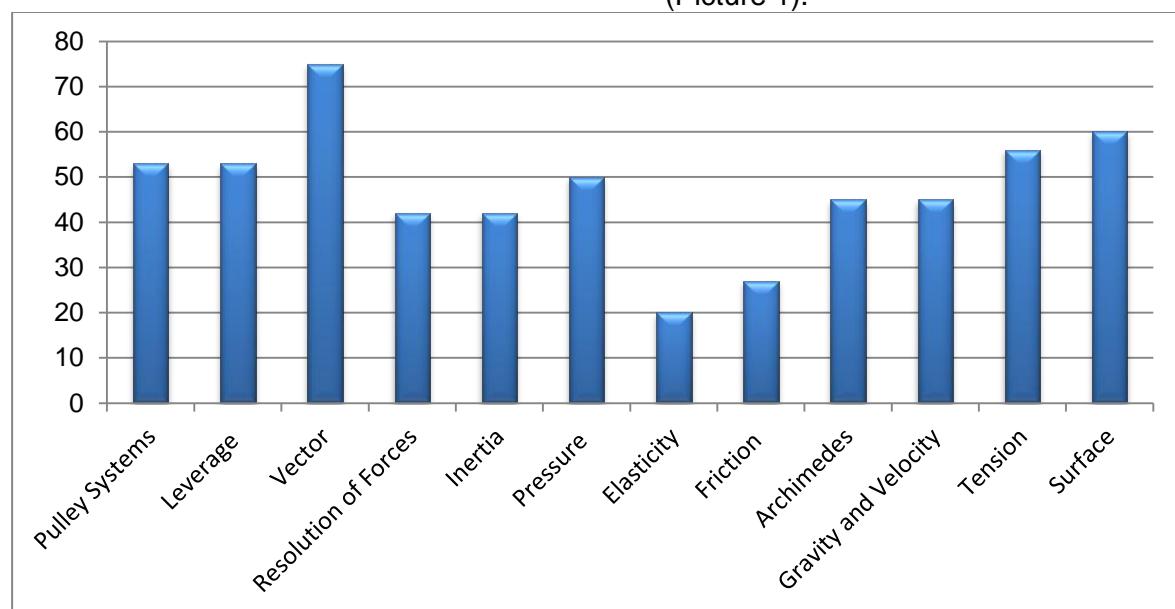


*Figure 1. Sample of Technical thinking assessment test:*

## RESULT

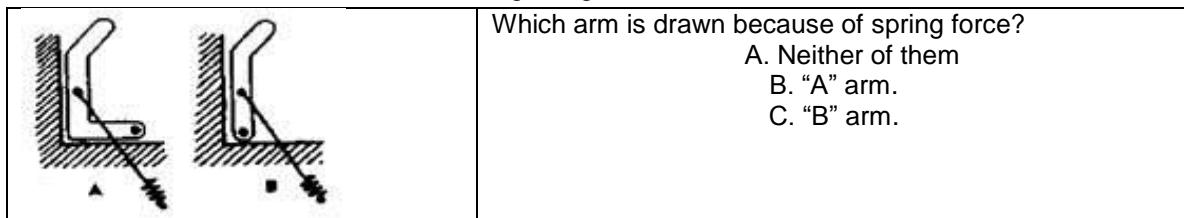
53 students from each university, including engineering class of MULS, light industrial automation class of MUST and army engineering class of DUM participated in this study.

According to the test results mentioned above, all students in this study were insufficient on assignments of elasticity. It can be seen from students' achievement (28%, 22%, 8.8%) on the test (Picture 1).



*Figure 2. Result of the study objects*

Most of the students failed on the following assignment:



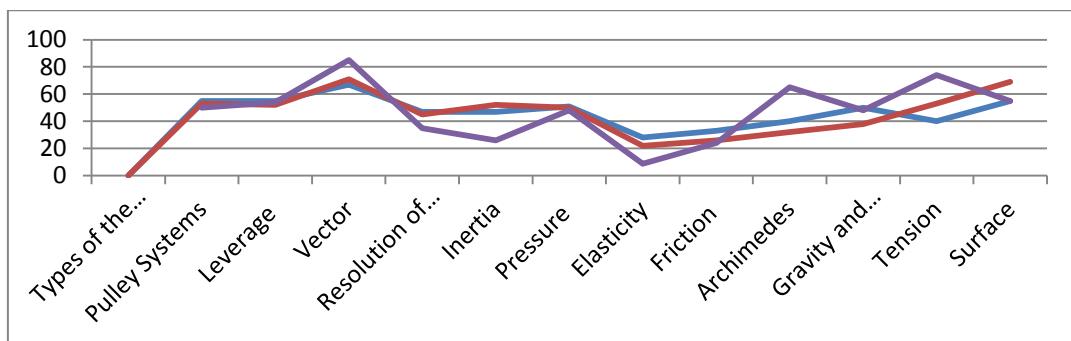


Figure 3. Result of assessment (school and percent)

As shown on the graph above, students performed insufficiently on

assignments of friction force and Archimedes law.

## CONCLUSION

As a result of the study, we conclude as below:

1. It would be effective for efficacious thinking and making if engineering students completely learn fundamentals of engineering sciences, physics. Teachers should pay attention on developing engineering students' thinking through studying.

2. There is a potential that we will prepare young engineers who possess high intelligence if we study engineering students' thinking ability by using reliable and appropriate test during the training period and do analysis on the positive changes.

## REFERENCE:

1. Autio, O. & Hansen, R. (2002). Defining and measuring technical thinking: Students' technical abilities in Finnish comprehensive schools. *Journal of Technology Education*, 14(1), 5-20.
2. Burke, J., & Ornstein, R. (1995). *The axemaker's gift: A double edged history of human culture*. New York: Putnam's.
3. Dyrenfruth, M.J. (1990). Technological literacy: Characteristics and competencies, revealed and detailed. In H. Szydlowski, & R. Stryjski (Eds.) *Technology and school: Report of the PATT conference* (pp. 26-50). Zielona Gora, Poland: Pedagogical University Press.
4. Bennett. George K. (2008) *Bennett Mechanical Comprehension Test*. San Antonio.
5. [www.Lotsofessays.com](http://www.Lotsofessays.com)
6. Mary Hegarty Marcel Adam Just, Ian R. Morrison. (1988) *Mental Models of Mechanical Systems: Individual Differences in Qualitative and Quantitative Reasoning*.
7. Гуревич К.М. (1985) Чтотакойпсихологическаядиагностика. –М.:Знание. -80с. – (Новое в жизни, науке, технике. Сер. “Педагогика и психология”; №4).
8. Пакетпсиходиагностическихметодик./Дляпрактическогометодикисистематизирован и подготовил к использованиюпрофессорВ.Г.Асеев/ (1991) Иркутск.
9. Анастази А. (1982) *Психологическое тестирование: Книга 1; пер. С англ. /под ред. К.М.Гуревича, В.И.Лубовского; -М.: Педагогика.*
10. Большая советская энциклопедия. (1976) В 30-ти т. / Под ред. А.М.Прохорова – М.: Советская энциклопедия. – Т. 24.
11. Ильин Е.П. (2008) *Дифференциальная психология профессиональной деятельности*. –СПб.: Питер. ил. –(Серия “Мастера психологии”)
12. Курилева Н.Л. (2007) *Развитие технических способностей учащихся при обучении физике в основной школе* Автореферат. М.
13. Ron Hansen. *The Roots of Technical Learning and Thinking: Situating TLT in Schools*. *Journal of Technology Education* Vol. 20 No. 1, Fall 2008

## **WHEAT CROPS FORECAST**

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### **ABSTRACT**

*The most important thing for the environment friendly crop production and the sustainable increase of agricultural crops is to intensify crop production for the improvement.[5]*

*The main principle to manage crop production in appropriate manner would be to process factors using economic and mathematical modeling techniques and to increase crop production of the business entities by e-calculation for especially selected fields and complex conditions for environment and climate. [1]*

*For this, programming of agricultural crop yields which is actually new trend and which uses many scientific fields has been developing as a scientific-based system.*

**KEYWORDS:** Wheat forecast, correlation analysis, computer programming

### **INTRODUCTION**

This research aims to create factors affecting wheat yields in the formation conditions of agricultural zone (weather-stripping analysis multilateral relationship of agro technical), yield prediction software. to the following objectives and research performed.

1. To determine the impact of the wheat harvest weather parameters.

2. Calculate detection wheat harvest brown soil characteristics and effects.
3. Wheat harvest study agro technical impact of quantitative research methods.
4. Plan design software optimized modeling methods to predict the wheat harvest.

### **THE NEW ASPECTS OF THE RESEARCH**

This research has the following new aspects:

1. Evaluated changes of time and distance of wheat crop, classified relative and random characteristics and conducted statistical analysis.
2. Studied correlation between external factors for wheat crop and evaluated characteristics of the

main zone of wheat fields by multi-dimensional analysis on nature and climate condition and agro technical characteristics.

3. Showed possibility to use statistical and econometrical modeling and method to the production after pre-calculation of wheat crop.

## PRACTICAL IMPORTANCE OF THE RESEARCH

Modified the modern trend of wheat production technology and gave an opportunity to find out and calculate crop yields for that year by using the program

with input of environmental and climate conditions, soil capacity and agro technical conditions.

## RESEARCH OBJECT

The following objects were chosen:

- Natural factors /1970-2015 year/
  - Wolf's number
  - Precipitation from May to August
  - Average monthly air temperature from May to August
- Soil information of 7644 ha of 36 fields with and without irrigation of

Tsagaannuur soum of Selenge province;

- Soil information of 62 fields of Khongor soum of Darkhan-Uul province and;
- Report of agro technical characteristics of State Agricultural Crop Institute of Darkhan-Uul province.

## RESEARCH METHODOLOGY

In order to increase wheat crop the factors are divided into 4 groups.

### 1. Natural factors /3 factors/

Correlation analysis

- Calculate the coefficient of correlation.
- Linear and non-linear regression

Harmonic functions forecasts

### 2. Agro technical indicators /mechanic, zero/

Correlation analysis /7 factors/

- Calculate the coefficient of correlation.
- Linear and non-linear regression

Variance Analysis

### 3. Soil parameters /irrigated, non irrigated/

Correlation analysis /11 factors/

- Calculate the coefficient of correlation.
- Linear and non-linear regression

Multi-dimensional analysis /62 crop cultivation areas /

- Calculate the coefficient of correlation.
- Linear and non-linear regression

### 4. Used language of Visual Basic programming

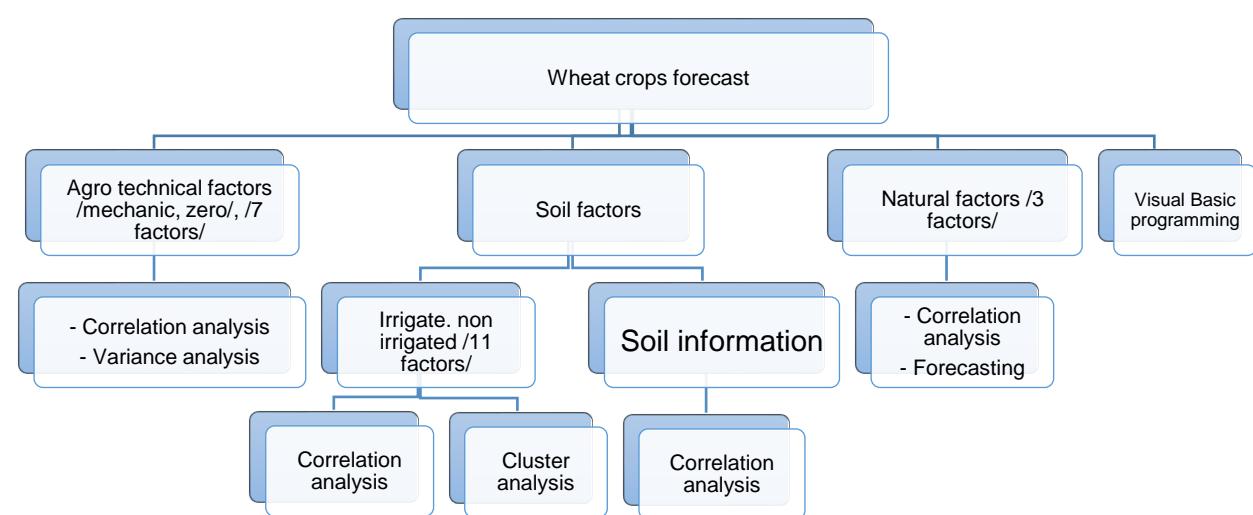


Figure 6. Research methodology

## RESEARCH FINDINGS

It is important to conduct pre-calculation of wheat production and find out the potential crop yields every year in order to avoid impacts of environment,

climate and soil risk factors for wheat production.

## VARIABLE COMMENT

$y$  – Wheat crops, cwt

$x_1$  - 5-8 months of precipitation, mm

$x_2$  - Number of wolves

$x_3$  - Average temperature of 5-8 months.  
°C

$x_4$  - Soil thickness of A, cm

$x_5$  - The reaction in the soil, pH

$x_6$  - The amount of salt in the soil, %

$x_7$  - Soil conductivity, ds/m

$x_8$  - Carbon dioxide in the soil CO<sub>2</sub>, %

$x_9$  - The concentrate content, %

$x_{10}$  - Total nitroge, %

$x_{11}$  - Nitrate NO<sub>3</sub>, mg/100 g

$x_{12}$  - Share basis, (Ca + Mg) mg/100 g

$x_{13}$  - Phosphorus pentoxide and 100 mg/g

$x_{14}$  - Mobile potassium, 100 mg/g

$x_{15}$  - Planting time

$x_{16}$  - Seed norm, million.unit

$x_{17}$  - The depth of fertility, cm

$x_{18}$  - 1000 seed weight (g)

$x_{19}$  - Seed germination, %

$x_{20}$  - Seed purity, %

$x_{21}$  - Depth of 0-30 cm, mm

## CORRELATION ANALYSIS RESULTS

Natural factors:

$$y = 1.82 + 0.05 * x_1 - 0.0061 * x_2 - 0.0004 * x_3; \quad (y \pm 1.9) \text{ cwt}$$

Soil factors:

*Irrigate:*  $y = -306.1 - 0.20 * x_4 + 34 * x_5 - 95.8 * x_6 + 255.5 * x_7 - 7.5 * x_8 + 29 * x_9 - 184.3 * x_{10} + 9.35 * x_{11} + 1.61 * x_{12} - 0.72 * x_{13} - 0.89 * x_{14}; \quad (y \pm 3.9) \text{ cwt}$

*non irrigated:*  $y = 10.26 + 0.177 * x_4 - 0.64 * x_5 - 232.2 * x_6 + 19.69 * x_7 + 0.65 * x_8 + 85.49 * x_9 - 1177.7 * x_{10} - 5.44 * x_{11} + 0.13 * x_{12} + 2.24 * x_{13} - 0.10 * x_{14}; \quad (y \pm 2.21) \text{ cwt}$

Agro technical factors:

*mechanic:*  $y = 4.4912 + 0.0392 * x_{15} + 0.20 * x_{16} + 0.975 * x_{17}; \quad (y \pm 0.93) \text{ cwt}$

$$y = 59.03 - 1.611 * x_{18} + 0.0418 * x_{19} + 0.217 * x_{20}; \quad (y \pm 1.54) \text{ cwt}$$

$$y = 1.759 + 0.241 * x_{21}; \quad (y \pm 0.33) \text{ cwt}$$

*zero:*  $y = 4.5868 + 0.1247 * x_{15} + 0.0923 * x_{16} + 1.125 * x_{17}; \quad (y \pm 1.13) \text{ cwt}$

$$y = 190.1 - 6.606 * x_{18} + 0.63 * x_{19} + 1.07 * x_{20}; \quad (y \pm 1.74) \text{ cwt}$$

$$y = -0.09 + 0.195 * x_{21}; \quad (y \pm 0.62) \text{ cwt}$$

The traditional method of programming wheat crop requires a lot of research materials and calculations. In order to facilitate this, a model was prepared by statistical and econometric

method for programming and then the amount of harvest can be determined after including impacts of many collective factors.

## RESULTS

The three factors that irrigation thick humus content of the soil, and the reaction environment are now marginal increase grain yield and harvest up 56 percent of soil parameters.

Agro technical performance mechanical and separately calculate the wheat crop seed germination at zero

technology in the most powerful factor affecting technology ( $r = 0.75$ ) and 1000 seed weight ( $r = 0.74$ ), seed purity ( $r = 0.65$ ) during the mechanical technology, seed germination ( $r = 0.74$ ), seed purity ( $r = 0.64$ ) and depth ( $r = 0.34$ ) is the most important quality factors of

wheat sowing seed into the permit is showing that.

This research gives an easy method, suited for the use and linked with statistical and econometric modeling and IT technology with agricultural science.

CROPFC.exe software shall be prepared for farmers, business entities and individuals and the database will include in 25 different types.

## REFERENCES

- [1]. Tovuu.L, “Crop”, 2005
- [2]. Galt.L, “Soil microbiology”, 2000
- [3]. Usukhbayar.B, “Agricultural data processing”, 2014
- [4]. Nyambat.L, “Economical”, 2014
- [5]. Altansukh.N, “Crop Science”, 2008
- [6]. Naranchimeg.Ch “EViews program”, 2005
- [7]. Nyambat.L, “Agricultural land use mathematical modeling”, 2013
- [8]. Zolzaya.G “Using the land quality assessment Eviews program”, 2008

## **ADVANTAGES AND DISADVANTAGES OF ASSESSING STUDENTS' KNOWLEDGE AND SKILLS IN ELECTRONIC FORMS**

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### **ABSTRACT**

*There are many methods to evaluate the knowledge, ability and skills of students taking courses from the Curriculum. For example, currently assessing students' knowledge and skills in academic environments is used in many ways, such as oral, written or test, or to discuss and present the findings. In this study, to assess students' knowledge, ability, and skills of the course, we applied online testing by using the internet. Students earning bachelor's degree in engineering are participated to our survey and an evaluation of the Midterm examination of the core course of Machine elements using the internet has been analyzed.*

**KEYWORDS:** Assessing learning outcomes of students, electronic exam

### **INTRODUCTION**

A total of 56 students who were taking a course of Machine elements have been participated to the study. We evaluated our students electronically through the fundamental subjects such as spur gear drive, bevel gear drive, worm gear drive, chain drive, belt drive, shafts, bearings, torque coupling, connection, and links [1] by using the internet (see Figure 1). In our research experiment, we have been used online evaluation system the

socrative system [2]. Each topic had 10 evaluation points (Figure 2). For the first five groups of subjects, such as spur gear drive, bevel gear drive, worm gear drive, chain drive, belt drive answer was shown to the student in the electronic exam materials. One of the advantages of this evaluation system was that it enables to fully monitor the testing process during the testing period (Figure 3).

Figure 1. Preparation of testing materials in 9 main chapters

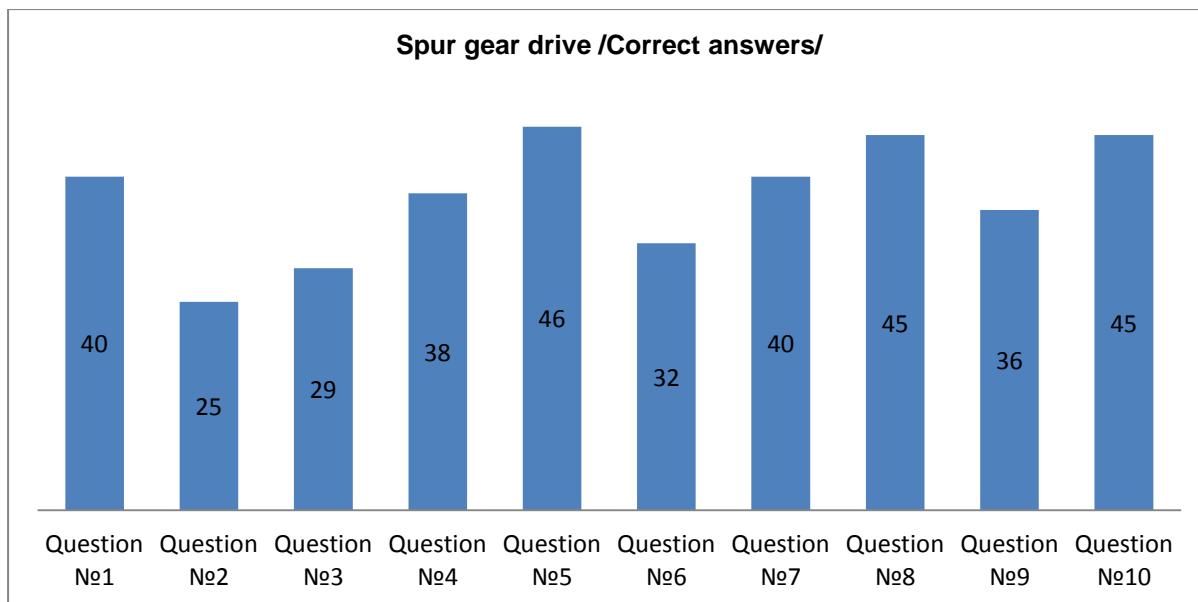
Figure 2. Each topic had 10 evaluation points

Figure 3. Examination results of students

*Figure 4. Preparation of testing materials in 9 main chapters.*

A total of 46 students have been participated in the examination of the spur gear drive and the results of the test were summarized in Figure 5. As shown in

Figure 5, students have answered correctly to Question #5 while the majority of students could not answer to the Question #2 correctly.



*Figure 5. Testing results for each assignment.*

This e-evaluation system was useful for assessing the knowledge, ability and skills of students' academic studies and saving time as well as useful for improving learning process and getting feedback. For example, the results of the above graphs

can be used for the feedback process of the learning process and provide an overview of the answers to each topic and allow them to explain and brush up the subjects that are not understood well during the next lesson.

TABLE 1  
TEST RESULTS (BY 5 CHAPTERS) – OPEN FORM EXAM

Test #	Average of success of assignments										Average
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	
Cylindrical transmission	87.7%	54.4%	64.9%	78.9%	98.2%	68.4%	80.7 %	96.5 %	71.9%	89.5 %	79.11%
Cone transmission	66.7%	84.8%	65.2%	66.7%	69.7%	80.3%	72.7 %	77.3 %	68.2%	74.2 %	72.58%
Snake transmission	81.6%	87.8%	73.5%	83.7%	87.8%	91.8%	77.6 %	79.6 %	79.6%	83.7 %	82.67%
Straps transmission	75.5%	55.1%	89.8%	71.4%	79.6%	69.4%	83.7 %	71.4 %	73.5%	77.6 %	74.70%
Chain transmission	87.0%	69.6%	78.3%	95.7%	91.3%	82.6%	56.5 %	78.3 %	87.0%	73.9 %	80.02%

TABLE 2  
TEST RESULTS (BY 4 CHAPTERS) – CLOSED FORM EXAM

Test #	Average of success of assignments										Average
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	
Main axis	56.4%	73.1%	30.8 %	48.7 %	50.3 %	63.1 %					53.07 %
Rivet	65 %	62 %	57 %	64 %	68 %	50 %	61 %	45 %	58 %	75 %	61 %
Bearer	42 %	41 %	55 %	17 %	43 %	57 %	53 %	23 %	14 %	21 %	36.6 %
Links	48 %	60 %	56 %	36 %	96 %	70 %	84 %	88 %	28 %	16 %	58.2 %

On the other hand, the evaluation score of the open form exam which shows the right answers was relatively high because students were able to communicate with each other and to find out the right answers. Therefore, tests were taken as the correct answers were hidden from the students during the exam on subjects of the main axis, rivet, bearer, and links. The evaluation score was low when the results of the answers are closed, however the evaluation of the assessment was more realistic and effective. Table 1 and 2 show the comparison result of the examination when test answers were open and closed.

## CONCLUSION

There are many tools to evaluate students' knowledge and abilities in academic environments. In this work, we examined the students' knowledge and skills and compared the advantages and

The following progress has been made in obtaining a survey of students who have been trained and examined their knowledge and skills electronically:

- Provides more activeness as a re-examination of their textbooks to reinforce their knowledge in the course of the test and find answers to the test questions;
- The examinations are continuously carried out so students are encouraged to learn;
- The class notes are well-kept;
- It is easy to check any time during staying at home, so this saves the time and effort.

disadvantages of taking the exam online in electronic form.

We used the *socrative* e-evaluation system to analyze the students' knowledge and skills by the subject of

Machine elements. The results of the questionnaire were summarized in the survey. As a result of the survey, the following advantages and disadvantages were the following:

#### *Advantages*

1. It is possible to know for a teacher whether the student is a lag behind lesson;
2. Save time;
3. Examine anywhere if connected to the Internet;
4. Able to build database for testing material;
5. It is helpful to reinforce the subject;
5. ;

6. Classrooms are not required;
7. Fully independent opportunities to work.

#### *Disadvantages*

1. When students know the correct answers, students are able to connect to each other and get answers;
2. Since there is no teacher or supervision, students can get help from someone else to pass the exam or retake the exam
3. Not able to take an exam without the Internet access;
4. It is not possible to include a formula during preparation of the test, so it is possible to include only the image

## **REFERENCES**

Chimed-Ochir G., Namnan T., Ulziisaikhan. "Machine elements", National press.  
Ulaanbaatar.: 2009. c.49x  
Online evaluation website: <https://b.socrative.com>

## **STUDY ON POISSON'S RATIO CHANGES OF WOODEN STRUCTURAL ELEMENTS**

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### **ABSTRACT**

*There are many Buildings and Engineering structures with wooden structural members and they have been in use for many years, and are still being used now days. But there are not enough information on the changes occurred in wooden structural members' physical and mechanical properties while they are widely used for several centuries. Determining the properties and strength of wooden structural members should play an important role on doing strength analysis, increasing durability, renovation, and satisfying reliability of wooden structures. Thus this paper introduces our research results on the properties of the load bearing structural members of wooden buildings and structures that have been used for long time period in Mongolia, and specifically results of laboratory test results and investigation on change of Poisson's ratio of wooden structural members of those buildings.*

**KEYWORDS:** Density, moisture, compressive strength, durability, poison's ratio

### **BACKGROUND**

Since the time humankind is emerged, wooden material's consumption history began. Wood is the earliest, closest and very first construction materials, because ancient people used timber as tools and weapons, and for their shelters as woods are widespread in the nature. Because of this reason, buildings and structures with wooden structural members that have many centuries' history are still being used today and they have been kept as valuable cultural and historical heritages.

In order to keep these buildings and structures' original designs and to make renovations, it is necessary to evaluate state of those buildings and

structures' properties, and to make engineering investigations. Investigation of change of mechanical properties of wooden structural members of the buildings and structures that have been used for a long time period is basis for the increasing durability and satisfaction of reliability of those buildings [2].

Thus we conducted laboratory experiment in order to determine modules of elasticity and Poisson's ratio of wooden specimens including fresh wood and samples from around 20 buildings which have been used for different time periods, as a part of our research. Experimental research results on Poisson's ratio are presented in this article.

## 1. Experimental research for determining modules of elasticity and Poisson's ratio

In order to determine modules of elasticity and Poisson's ratio, "Video Gauge" program was used. It uses a video camera and conduct experiments and the results are processed simultaneously.

"Video Gauge" program works in two stages.

- LIVE or direct processing /processing from a video camera simultaneously
- Post processing or review processing /review processing from saved video files/

## METHODOLOGY:

We have conducted our tests following the standard named as "ГОСТ 21523.8-93 "Метод определения модуля упругости при сжатии" [4] and determined modules of elasticity and Poisson's ratio:

1. Number of experiment specimens should be selected in accordance with ГОСТ 16483.0-89 standard.
2. 30x30x60 мм sized specimens were prepared. The compressing load direction options include fiber longitudinal, radial and tangential to the tree ageing rings; in this case longitudinal option is selected.
3. Specimen size tolerable error was  $\pm 1$  mm, this met the standard requirements.

The experiment was conducted in the Biomechanical laboratory of Mechanical Engineering School of Mongolian University of Science and Technology.

"Video Gauge" program processes retrieved data directly and determines modules of elasticity and Poisson's ratio on each sample.

Let us determine how age of structure, moisture, density and compressive strength are affecting the Poisson's ratio of wood.

The specimen sizes were measured by electrical calipers.

4. Specimens will be loaded from 5000 N to 20000 N. It is repeated 6 times. Loading speed is  $170 \pm 30$  N/sec

## Number of tests to determine modules of elasticity and Poisson's ratio:

Number of required tests is determined in accordance with ГОСТ 16483.0 – 89 standard.

Measured parameters of tested wooden specimens for use in determining Poisson's ratio are shown below in the Table-1.

Table 1.

Parameters for determining number of tests to define Poisson's ratio

№	Object Name	Age, year	Parameters of samples		
			Moisture %	Density gr/cm <sup>3</sup>	Strength kN/cm <sup>2</sup>
1	Tsogchin Temple	385	7.48	0.59	5.46
2	First Telecommunication Building	98	5.84	0.45	5.36
3	Government Palace	55	7.12	0.58	6.14
4	Goyo building	7	6.73	0.51	4.78
5	Fresh larch	1	6.78	0.71	6.77

$$\text{Required number of tests is determined as: } n = \frac{V^2 \cdot t^2}{P^2} \quad (1)$$

Here,  $V$  - Variation coefficient

$P$  - precision parameter of average value or relative error

$t$  - probability rate, it is taken from Table 2 depending on the test confidence rate [1].

In the test for determining Poisson's ratio of wood, confidence rate is assumed to be 95% and  $t = 1.96$  value is used.

Number of tests for determining Poisson's ratio is as below:

- From Specimen Moisture:  
 $n = 20$
- From Specimen Density:  
 $n = 18$
- From Compressive strength:  
Specimen  
 $n = 20$

Thus number of test was chosen to be 25. Poisson's ratio and modules of elasticity express elasticity for materials and Poisson's ratio is determined by the ratio of deformations in longitudinal and transverse directions [2].

Poisson's ratio or transverse deflection

$$\text{ratio: } \mu = \left| \frac{\varepsilon'}{\varepsilon} \right| \quad (2)$$

Relative deformation in tension and compression:

$$\varepsilon = \frac{\Delta l}{l} \quad (3)$$

Relative change of cross section of a rod:

$$\varepsilon' = \frac{\Delta b}{b} \quad (4)$$

Most of the materials have Poisson's ratio value between  $0 \leq \mu \leq 0.5$ . However, some species of trees have higher value than the above. Poisson's ratio for different species of trees is shown Table 2 [7] below.

Table 2.

Poisson's ratio for trees 7

Nº	Species	$\mu_{LR}$	$\mu_{LT}$	$\mu_{RT}$
Hardwood				
1	Aspen, quaking	0.489	0.374	-
2	Balsa	0.229	0.488	0.665
3	Birch, yellow	0.426	0.451	0.697
4	Cherry, black	0.392	0.428	0.695
5	Cottonwood, eastern	0.344	0.420	0.875
6	Mahogany, African	0.297	0.641	0.604
7	Mahogany, Honduras	0.314	0.533	0.600
8	Maple, sugar	0.424	0.476	0.774
9	Oak, red	0.35	0.448	0.560
10	Yellow-poplar	0.318	0.392	0.703
Softwood				
11	Cedar, northern white	0.337	0.340	0.458
12	Douglas-fir	0.292	0.449	0.390
13	Fir, subalpine	0.341	0.332	0.437
14	Larch, western	0.355	0.276	0.389
15	Pine	0.328	0.292	0.382
16	Redwood	0.360	0.346	0.373
17	Spruce, Sitka	0.372	0.467	0.435



Figure 1. Video Camera



Figure 2. Test Process



Figure 3. Test Specimens

Specimens to be tested were prepared in accordance with ГОСТ 21523.8-93 “Метод определения модуля упругости при сжатии” standard and the sizes were 30x30x60 mm.

In the middle of height and width of specimens, 3x6 mm sized marker /reflector/ was placed in the same distance. Specimens with marker are placed on the MTS Universal Testing

Equipment. While this testing equipment is operating laser light is pointed and a video camera will be recording and results will be transmitted directly to the computer. Specimens are loaded 6 times and last three test results are taken for calculations. The load will be given from 500 N to 20000 N and results will be recorded [4].

Test Results to determine Poisson's ratio

No	Object Name	Age, years	Specimen Density, gr/cm <sup>3</sup>	Compressive Strength	Poisson's ratio	Average Value
1	Fresh larch	1	500	53.5	0.26	0.34
			490	53.5	0.36	
			490	53.5	0.27	
			480	53.5	0.38	
			500	53.5	0.41	
2	Goyo Building	7	430	45.7	0.56	0.46
			440	45.7	0.44	
			440	45.7	0.4	
			490	45.7	0.44	
			500	45.7	0.45	
3	Government Palace	55	480	49.3	0.38	0.51
			490	49.3	0.51	
			480	49.3	0.49	
			480	49.3	0.5	
			500	49.3	0.65	
4	Telecommunication Building	98	470	40.4	0.6	0.62
			470	40.4	0.5	
			460	40.4	0.57	
			450	40.4	0.74	
			450	40.4	0.65	
5	Tsogchin Temple	385	570	41.8	0.63	0.61
			570	41.8	0.58	
			550	41.8	0.56	
			560	41.8	0.64	
			550	41.8	0.62	

We can see increasing trend of Poisson's ratio with increase of usage period/age from the above table. Test results were analyzed by using “SPSS 21” software.

## 2. "SPSS 21" PROGRAM ANALYSIS OF TEST RESULTS FOR DETERMINING POISSON'S RATIO

Analysis of obtained experimental results was done using SPSS 21 software, which is for the statistical analysis.

Correlation analysis results are shown graphically in the following figures.

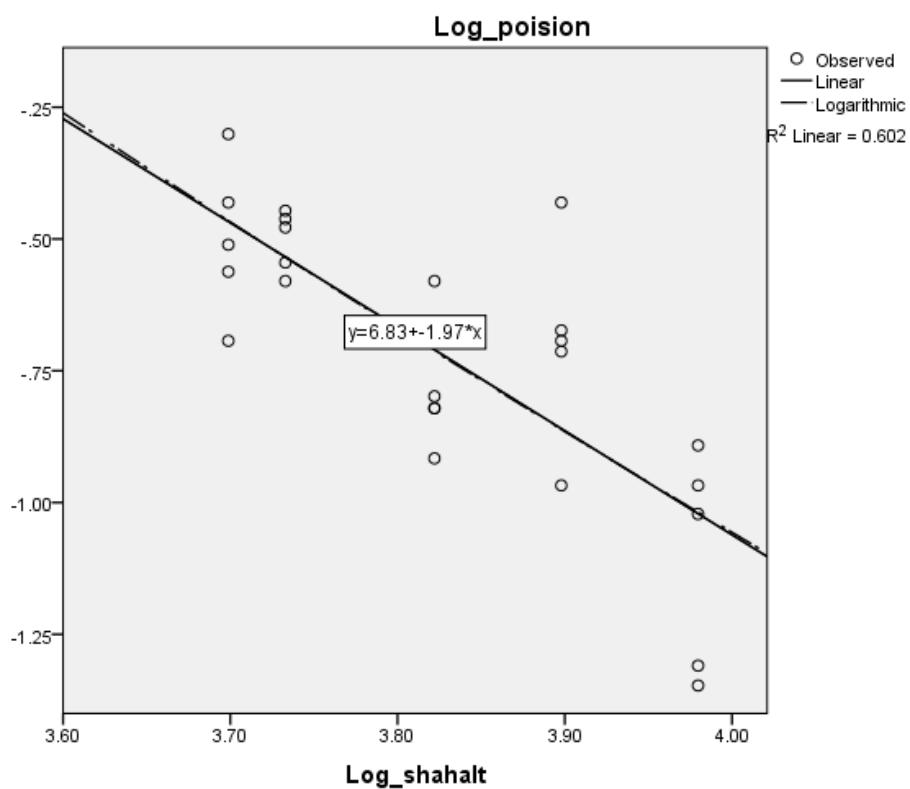
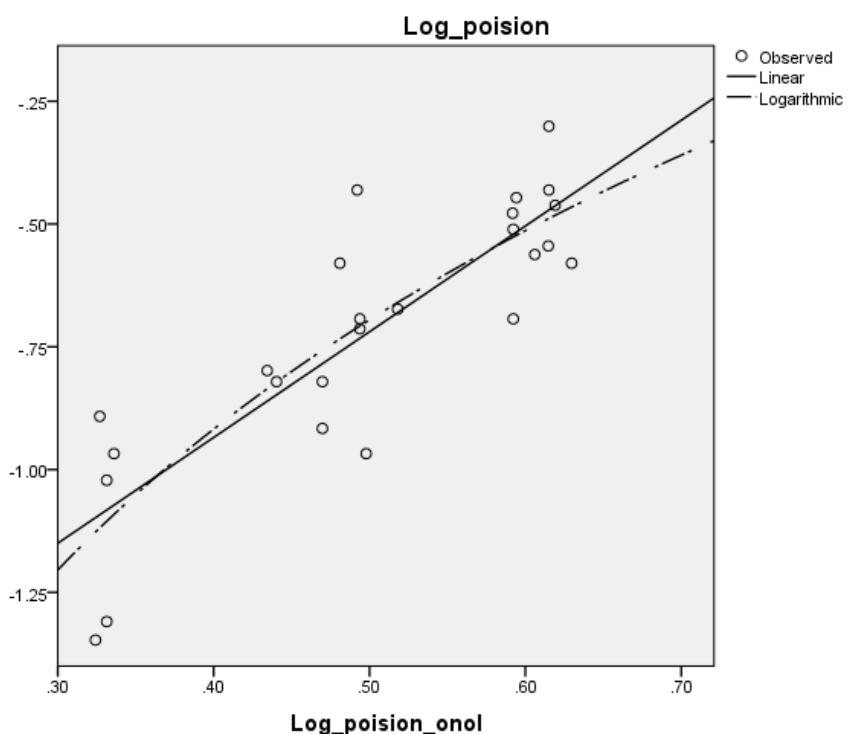
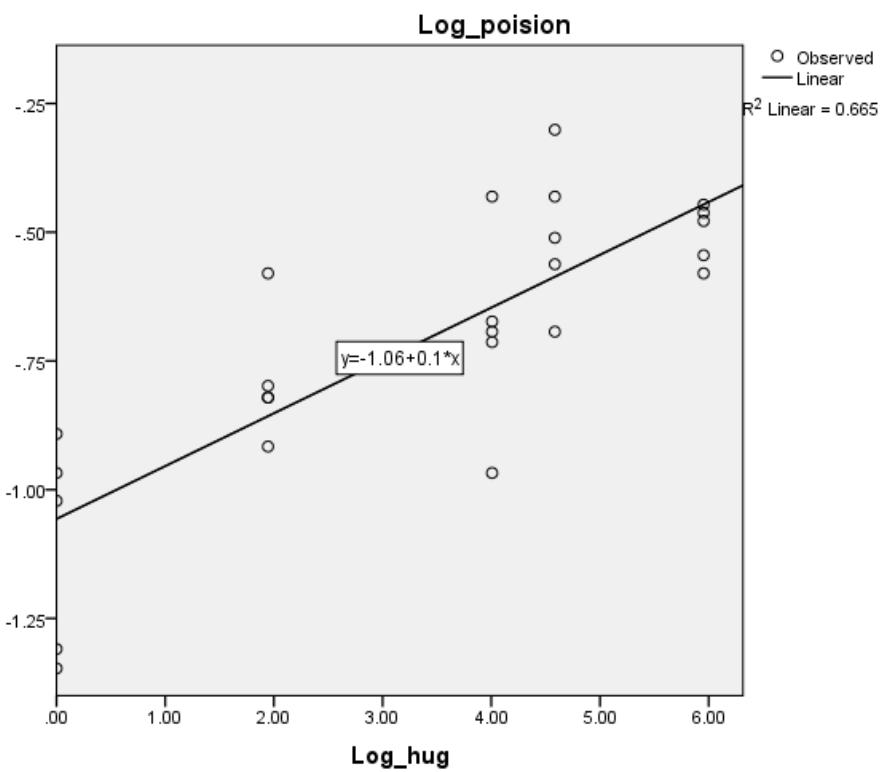


Figure 4. Relationships between Poisson's ratio and Usage Period



*Figure 5. Relationships between Poisson's ratio and compressive strength*



#### *Model Summary and Parameter Estimates*

*Figure 6. Relationships between experimental and theoretical Poisson's ratio value*

Dependent Variable: Log\_poisson

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.725	60.737	1	23	.000	-1.796	2.153
Logarithmic	.732	62.912	1	23	.000	-.004	.997

The independent variable is Log\_poisson\_onol.

## MODEL ANALYSIS:

Usage period and compressive strengths are highly affecting Poisson's ratio and it was confirmed by Correlation analysis. It is seen from correlation analysis that Poisson's ratio for Larch ( $r = 0.816; P = 0.000$ ) had a positive and very strong correlation with usage period, while wood compressive strength had a negative and strong correlation ( $r = -0.776; P = 0.000$ )[3].

We have performed regression analysis in order to clarify principles of trend and change of above mentioned correlations once we already confirmed

Model equation:

$$\ln \mu = A_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 \quad (5)$$

$$\ln \mu = 0.219 + 0.82 \cdot \ln x_1 + 0.511 \cdot \ln x_2 - 0.676 \cdot \ln x_3 - 0.688 \cdot \ln x_4 \quad (6)$$

$$\mu = e^{0.219+0.082X_1+0.511X_2-0.676X_3-0.688X_4} \quad (7)$$

Here,  $\mu$  - Poisson's ratio,  $x_1$  - usage period/age,  $x_2$  - specimen moisture,  $x_3$  - specimen density,  $x_4$  - specimen compressive strength

## 3. CONCLUSIONS:

- Poisson's ratio determined from the experiments of specimens taken from old wooden structures with different ages was increased by 11-44% compared to the fresh larch wood specimen's ratio.
- Poisson's ratio of larch wood that has been used in buildings and structures with different ages is dependent on the compressive

that there exist effects of usage period and compressive strength to the Poisson's ratio. Regression analysis results are shown below:

Poisson's ratio of larch wood that has been used in buildings and structures with different ages is dependent on the compressive strength and age of timber ( $R = 0.856$ ), and their determination coefficient was 0.732. Therefore, 73.2% of the Poisson's ratio change in larch wood with different ages could be explained by the usage period/age and compressive strength [3].

strength and age of timber ( $R = 0.856$ ), and their determination coefficient was 0.732. Therefore, it is concluded that 73.2% of the Poisson's ratio change in larch wood with different ages could be explained by the usage period/age and compressive strength.

## **REFERENCES**

### **I. Papers and books printed in Mongolian**

1. AvdaiCh, Enkhtuya D. "Test, planning Mathematical methods, and using them for research works" UB. 2017.
2. Bazar G, DuinkherjavYa. "Wooden and plastic Structure" UB. 2009
3. Chimed D. "SPSSSocial Statistic Analysis and explanation of results" UB. 2014

### **II. Papers and books printed in foreign languages**

4. ГОСТ 21523.8-93 "Метод определения модуля упругости при сжатии"
5. ГОСТ 16483. 0 – 89 "Общие требования к физико-механическим испытаниям"
6. Стрельцов Д. Ю. "Напряженно – деформированное состояние деревянных конструкций при длительной эксплуатации" Москва. 2003.
7. David W. Green, Jerrold E Winandy and David E "Mechanical properties of wood" chapter 4.

## AGRICULTURAL ENTITIES IN MONGOLIA

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### ABSTRACT

*Agricultural cooperatives are therefore created in situations where farmers cannot obtain essential services from investor-owned firms, or when the services are available, but the profit-motivated prices are too high for the farmers. The latter drive the creation of cooperatives as a competitive yardstick or as a means of allowing farmers to build countervailing market power to oppose the investor-owned firms. [2]*

*Co-operative movement aims at all economic and social development of small and other farmers, have to play a vital and significant role.*

*The agricultural sector accounts for around 14.4 percent of Mongolia's GDP and is one of the main sector of the country's economy.*

*The research paper aims to demonstrate the potential role cooperatives can play in the development of agriculture in Mongolia.*

**KEYWORDS:** Cooperative, member of co-operatives, number of cooperatives, cooperatives principles, law

### INTRODUCTION

Several years have passed since first Cooperative law authorized in Mongolia, that cooperatives provide its members to improve their living standard with collecting agricultural raw material prepared by its members while supplying them to the market and in return supply consumer goods to members. Agricultural cooperatives have extended their activities by processing raw material such as felt and felt made products, wool, leather and diary production.

The number of cooperatives which are playing vital role in supplying consumer goods and producing various kinds of

foods stuffs at local area is increasing. In future, we aim to improve either economic capacity of cooperatives or the living living standard of its members. [1]

Cooperating with others has often proven to be a satisfactory way of achieving own objectives while at the same time assisting others in achieving theirs. People recognize that they are usually more efficient, by selling and buying in larger volumes they can achieve better prices.

The main way to solve the problems such as alleviation of poverty, reduction of unemployment, intensification of livestock

and crop production and changing gradually its dependence on nature and

weather is the development of cooperatives.

## BACKGROUND

Most families in livestock husbandry in Mongolia, are self-sufficient, creating enough meat, milk, diary products, cashmere, wool and skin for their subsistence and small amounts for trading. People who belong to cooperatives do so for a variety of economic and social reasons. Cooperatives are especially important to agriculture in country. In 2014, 6661 agricultural cooperatives provided roughly 102072 members households in Mongolia. To prosper, cooperatives must be well organized and progressive.

Definition of the International Co-operative Alliance: a cooperative is an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise. [4] Many types of cooperatives have been established worldwide to serve the interests of members, including consumer, producer, worker, and service cooperative.

- Consumer: owned by consumers who buy goods or services from their cooperative
- Producer: owned by producers of commodities or crafts who have joined forces to process and market their products
- Worker: owned and democratically governed by employees who become co-op members
- Purchasing: owned by independent businesses or municipalities to improve their purchasing power

Consumer cooperatives are established to sell the products of consumers and the consumer members interested buy quantity of goods and services with their income and this type of cooperatives developing in Mongolia.

The Cooperative Law, authorized in Mongolia in 1995, was a major development in the cooperative movement.

Table 1.

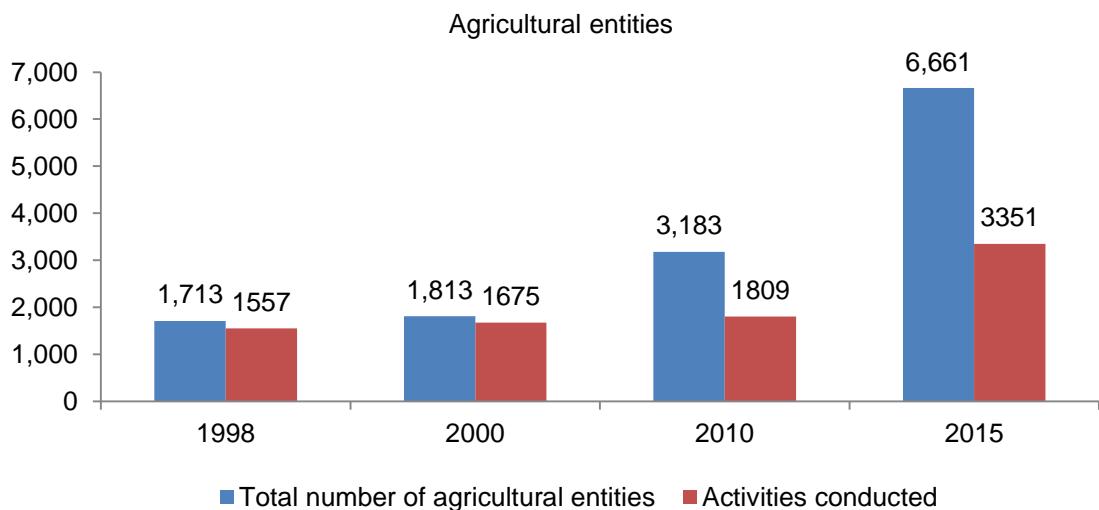
Agricultural entities share in total entities

	2014	2013	2012	2011	2010	1998
Total entities	113602	99603	90538	67409	73795	18950
Agricultural entities	6374	5360	4765	3514	3183	1713
Agricultural entities share	5.6%	5.4%	5.3%	5.2%	4.3%	9.0%

Source: Statistical database from National Registration and Statistical Office

The number of agricultural entities increased from 1813 to 6661 during the 15 years. But 50% are actively working. After 2011 many cooperatives established, it

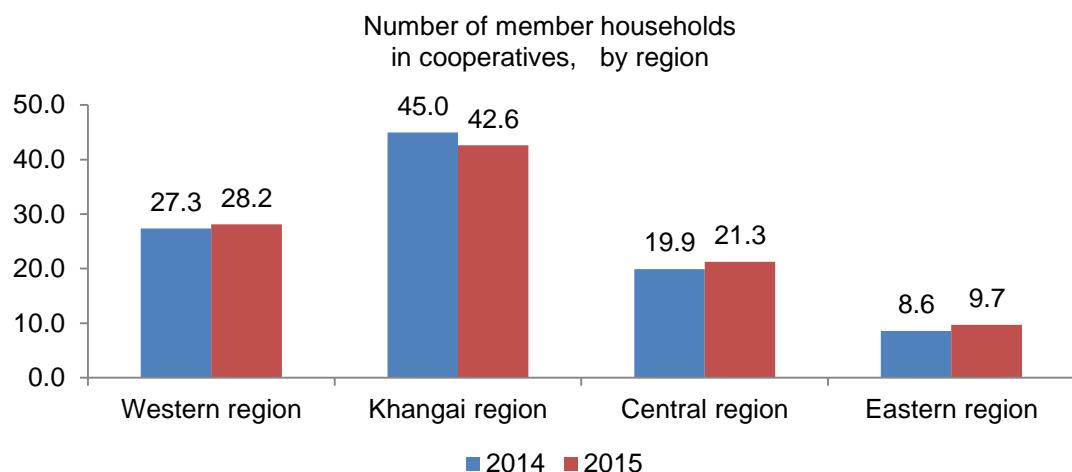
might be reflects the decision of Government, allowed cooperatives to pay patronage refunds on purchases.



*Figure 1. Agricultural entities*

In the case of Khangai region and other region with relatively high member households in cooperatives, this situation typically reflects the existence of

numerous local aimaks. More cooperatives do not running actively, that cooperative sector as a whole is stronger or more competitive, however.



*Figure 2. Number of member households in cooperatives, by region*

There are three main links between the member and the co-operative: the product, the capital and the democratic power structure. [3]

The co-operative principles are guidelines by which co-operatives put their values into practice.[4]

#### 1. Voluntary and Open Membership

Co-operatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.

#### 2. Democratic Member Control

Co-operatives are democratic organizations controlled by their members, who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the membership. In primary co-operatives members have equal voting rights (one member, one vote) and co-operatives at other levels are also organized in a democratic manner.

#### 3. Member Economic Participation

Members contribute equitably to, and democratically control, the capital of their

co-operative. At least part of that capital is usually the common property of the co-operative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing their co-operative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the co-operative; and supporting other activities approved by the membership.

#### 4. Autonomy and Independence

Co-operatives are autonomous, self-help organizations controlled by their members. If they enter into agreements with other organizations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their co-operative autonomy.

## RESULT

The survey conducted in 2014, has revealed the implementation cooperative principles of 54 agricultural cooperatives. The importance of this study is the first-hand experience through interviews with members of cooperatives.

1. 96.2 % of members followed voluntary and open membership states. This concept can serve to increase member engagement and satisfaction.
2. 75 % of members recognized co-operatives democratic organizations controlled by their members, who actively participate in setting their policies and making decisions.

## CONCLUSION

1. Members can better defend their interests and understand co-operatives are tendentiously more stable than individual enterprises.
2. Increasing in membership of co-operatives and people using cooperative services and products.
3. To establish good mechanism for co-ordinating Provincial Government support for co-operative development and management.
4. Need a clear policy, methodology and criteria should be develop on financing of housing co-operatives.

#### 5. Education, Training and Information

Co-operatives provide education and training for their members, elected representatives, managers, and employees so they can contribute effectively to the development of their co-operatives. They inform the general public - particularly young people and opinion leaders - about the nature and benefits of co-operation.

#### 6. Co-operation among Co-operatives

Co-operatives serve their members most effectively and strengthen the co-operative movement by working together through local, national, regional and international structures.

#### 7. Concern for Community

Co-operatives work for the sustainable development of their communities through policies approved by their members.

## **REFERENCES**

1. Bayartsaikhan N. Namac speech at the 17<sup>th</sup> EAOC Top level meeting
2. Cobia, David, editor, Cooperatives in Agriculture, Prentice-Hall, Englewood Cliffs, NJ (1989), p. 50.
3. Gabor Szabo G., "Co-operative identity": A theoretical concept for economic analysis of practical co-operation dynamics Studies in Agricultural Economics No. 105. p. 5-22. (2006)
4. Suleman Adam Chambo., Agricultural co-operatives: Role in food security and rural development
5. Ronald W., Agricultural cooperatives: A unified theory of pricing, finance and investment
6. <http://ica.coop/>

## THE STUDY RESULT OF PREPARING BRIQUETTE FUEL BY WASTE MATERIALS

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### ABSTRACT

*The preparation of briquette fuel which is combined with coal powder is to provide the “Ger” district households by fuel as well as the advantage of reducing air pollution and soil pollution.*

**KEYWORDS:** Agglomerated fuels, screw pump, moisture of fuel, calorie of fuel, mixture, briquette fuel

### INTRODUCTION

In Ulaanbaatar, 1300 herder households and the large number of households with private livestock are existed, therefore, cow dung is exuded in their yards and nearby places in cold season.

Raw coal is burnt by over 180 households which are lived in capital city due to it is accumulated in their yards.

Raw coal's dump is formed in district's fuel market and yard of power plant.

### STUDY METHODOLOGY

Equipment:

- Screw pump (pressure 5.3 MPa, efficiency 900 kg / h, external diameter of screw 140 mm)
- Powder coal of Baganuur (Calorific value 2700 kcal / kg)

- Manure

Assay office: Garage of MULS, Mining Institute

### METHOD AND MATERIAL OF RESEARCH STUDY

The following two methodologies were developed and followed.

1. Determine the physical and mechanical properties of mixture

2. Determine physical and mechanical properties of briquette fuel

## RESULTS OF RESEARCH STUDY

$2^3$  kind of experiment, rotatable layout and statistic program are used.

Caloric value of briquette fuel is determined by experiment of the relationship between content of cow muck

( $X_1 \%$ ), moisture of pellet fuel ( $X_2 \%$ ) and density of briquette fuel ( $X_3 \text{ кг/ м}^3$ ). The result is formulated by statistic program and regress equation with many factors is formed.

$$\hat{y} = 201.3x_1 - 9.1x_2^2 - 0.222x_2x_3 \quad (1)$$

Optimal values which are affected to caloric value of briquette fuel:

$$x_1 = 39.874, \%$$

$$x_2 = 7.796, \%$$

$$x_3 = 1011.327 \text{ кг/м}^3$$

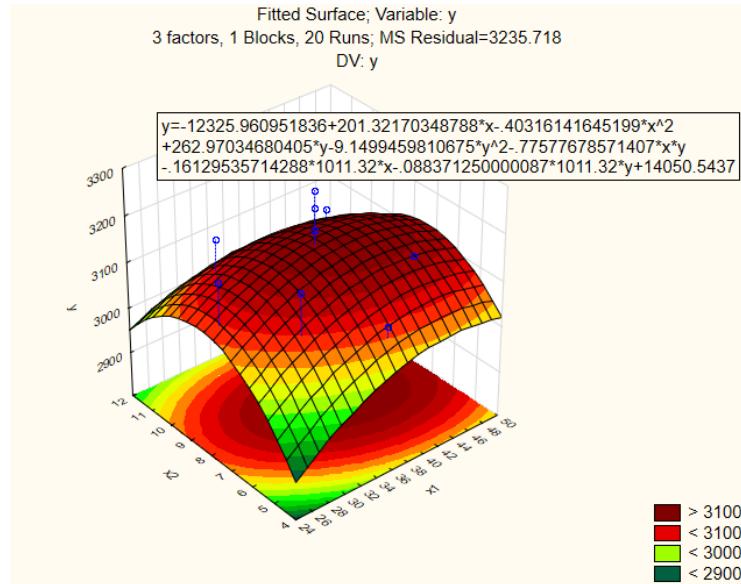


Figure 1.a. 3D Surface Plot of  $y$  against  $x_1$  and  $x_2$

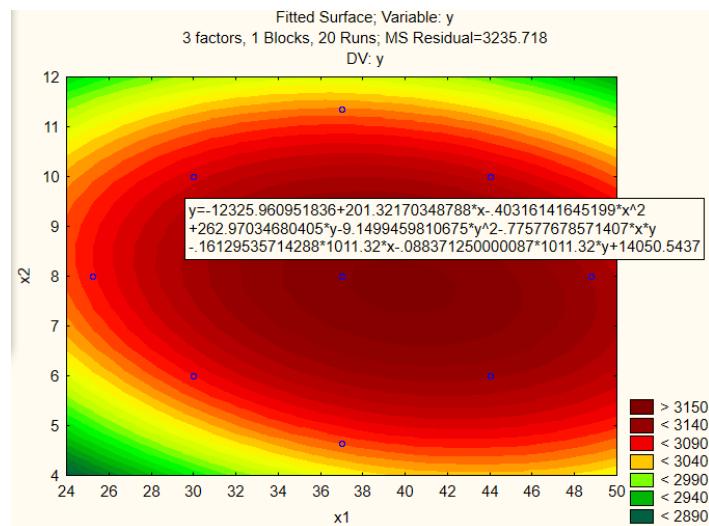


Figure 1.b. 3D Contour Plot of  $y$  against  $x_1$  and  $x_2$

## **DISCUSSION**

Raw materials that are cow muck, which is accumulated everywhere, and coal powder are rich reserve and plentiful. It is full opportunity to prepare briquette fuel which is combined them and is squeezed by pressure. The proposed issue will be solved by foundation of briquette fuel facilities among city's households with livestock.

## **CONCLUSION**

- The method which is optimal and no waste of utilizing cow muck and coal powder is preparing briquette fuel by their mixture.
- The condition which briquette fuel with high strength and high calorie is comprised when the weight ratio of cow muck and coal powder is 60:40.
- When using cow muck as a binder substance, calorific value of coal powder was 2700 kcal/kg and it was increased, briquette fuel with calorific value of 3163 kcal/kg was generated.
- When using cow muck as an adhesive substance, it is possible to use screw pump which is worked with low pressure until 5Mpa.

## **REFERENCES**

1. Dorjsuren D. "Research study on developing an optimal parameter of a screw press for preparing briquette-fuel". Ulaanbaatar, 2016.
2. Coal Mongolia - 2014. Ulaanbaatar, 2015.
3. Nalmov B.B. "The theory of experiment". Science Publ. Company. Moscow, 1971.

## **CURRENT STATE OF PASTURE IRRIGATION (EXAMPLES FROM ERDENETSOGT SOUM OF BAYANKHONGOR)**

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### **ABSTRACT**

*Water supply for livestock is planned based on size of pasture land and grass. It is defined that average of 62 sheep per hectare is ideal grazing capacity in Mongolia. During 2000s when number of livestock increased sharply, Mongolia had 156 sheep per hectare which was obviously not a good indicator. However, the number varies region by region as 51.2% of the country's total grazing area falls in forest-steppe zone and steppe zone where rate of harvest and irrigation are comparatively higher and thereby where animals per hectare is larger than other areas.*

### **GOALS AND OBJECTIVES**

The goal of this work lies in finding ways to start irrigating existing pasture lands and improve water supply methods that suites seasonal characteristics. In order to reach this goal, the following objectives are set:

1. Determine current state of pasture irrigation
2. Identify impact of water supply on pasture usage.

### **INNOVATIVE ASPECTS OF THIS RESEARCH**

By creating a map of irrigated pasture and pasture land usage, this work will become a foundational study based upon which short and mid term livestock growth and pasture management plan and ecological balance policies can be developed.

Research significance:

The results of this study and pasture irrigation mapping will enable local government, people and entities to manage short and long term usage and/or ownership of pasture lands, monitor their components using the foundational research outcomes.

## **NEW FINDINGS OF THE STUDY**

Map of pasture watering and pasture use which developed within this study can serve as baseline inputs to development of policy on preservation

ecological balance, near future and strategical planning of pasture use and growth of livestock heads.

## **RESEARCH METHODS**

Studies on pasture usage and water spots were undertaken with involvement of bag governors, authorities and herders who possess deep knowledge of the area.

- Pasture usage determined by each quarter
- Pasture land type and size.

- Average harvest from 1 hectare pasture land
- Grazing capacity during hot and cold seasons, feeding capacity, grass resource, livestock capacity determined through sheep per hectare method
- Usage of water resource spots.

## **CURRENT STATE OF THE REGION COVERED BY THIS RESEARCH**

- Erdenetsogt soum locates in east north of the province, 28 km from the center Bayankhongor.
- The soum is connected with its own bags and the provincial capital through permanent road and communication network. The climate is very extreme with dry air, low precipitation and sunny days.
- Annual temperature variance is very high and seasonal changes are dramatic.
- In average, 75 out of 365 days are warm. The greatest temperature variance is 29.8C and the lowest is -36.6C. The highest wind speed is 24 m/s. The wind is usually from north and west north to south

## **RESEARCH ON WATER RESOURCES**

As per latest water census of 2015, the soum has 75 rivers and streams that stretch 1073 km in total but 7 of them are no-flow rivers. 3 out of 55 springs are no-

flow springs. There are also 2 lakes, 2 mining wells, 11 deep drilling wells and 146 water resources spots counted.

## **PASTURE TYPES**

The soum territory is 409.7 thousand hectare including 405.3 thousand hectare pasture and 4.4 thousand hectare non-pasture lands.

Erdenetsogt soum falls into mountainous region of Khangai.

## **USING SOURCES OF WATER FOR PASTURE WATER SUPPLY**

We used PhD Chogdon J's efficient radius determined by each soum and province of Mongolia for calculating traditional sources of rivers and streams. Ideal size of field that can be irrigated from one water spot is calculated as below: number of animals per hectare field is determined by comparing grazing fields with current sheep head units.

- Average pastureland irrigated by one well is 3847 hectare and total pasture field irrigated by current

available 11 wells is 42.317 hectare.

- Average pastureland field irrigated by one river is 2826 hectare and total pasture field irrigated by 75 rivers throughout the four seasons is 211.950 hectare.
- Average pastureland irrigated by one spring is 1256 hectare and total pasture field irrigated by 55 springs throughout the four seasons is 69.080 hectare.

- Grand total pastureland with irrigation is 323.347 hectare.

## PASTURE HARVEST AND SUFFICIENCY

One of the important methods to maintain appropriate balance of pasture and improve its fruitage is to manage livestock population suited for grazing capacity.

Thus, we calculated the grazing capacity by looking at total number of soum livestock, harvest from one hectare pasture, harvest for feeding livestock and total grass resources. Please see the table 1.

Table 1.

Grass resource balance

Indicator	Erdenetsogt	Ratio
Current pasture grass resource (100 kg)	2085900	480802*100 kg grass resources available.
Required grass resource (100 kg)	1605098	

Table 2.

Grazing potential

Total pasture land Thousand hectare	Average harvest per hectare for feeding livestock, 100 kg	Grass resources Thousand, hundred kg	Livestock/sheep per hectare	Pasture hectare per sheep unit	Grazing capacity thousand sheep head
405.3	5.5	2108.0	0.72	1.4	383.3

Table 3.

Types of pasture use

Unused pasture	Pasture without water source and much remote area from soum center
Less used pasture	Same as above remote from soum center and also without water source, however, camels and horses are still could graze in this area. Also grazing could become possible after arising of temporary open water sources such ponds and snow cover etc.
Moderate use	Limited grazing accounting number of livestock in accordance with pasture capacity and seasonality (otor- grazing and moving from regular pasture)
Excess used pasture	Pasture around wintering place and pasture used for long periods due to droughts.
Degraded pasture	Degraded pasture to concentration of too much livestock around few wells and as well as concentration of wintering camps in small area

During and after transition to the market economy, many wells for pasture watering is damaged and stolen and due to this situation have increased area of unused or less used pasture. Thus, have been observed increasing trend of excess use of pasture in the margins of unused pasture.

## LIVESTOCK POPULATION INCREASE

Please see the below livestock population increase by each of its 6 bag: 2.Bag livestock population (As of 30 December 2015)

Table 4.

No	Bag	Number of households	Livestock population	Number of livestock (by thousand)				
				Camel	Horse	Cattle	Sheep	Goat
1	Senjit	159	30305	5	1932	4124	13840	10404
2	Yamaat	187	23430	-	1127	8351	7022	6930
3	Uvurjargalant	147	16237	-	823	5440	5960	4014
4	Janjin	160	32074	-	1660	5533	12496	12385
5	Erkhet khairkhan	117	15555	-	1146	5949	4336	4124
6	Tsagaan denj	156	13637	-	567	2766	4576	5728
TOTAL		927	131238	5	7255	32163	48230	43585

Table 5.

Grazing capacity compared with current livestock population

Indicator	Erdenetsogt	Ratio (sheep unit)
Livestock population suitable for grazing capacity (sheep unit)	383274	+ 91438. This number indicates that there is sufficient grazing capacity
Current (2015) livestock population (sheep unit)	291836	

## LIVESTOCK WATER SUPPLY

We calculated required amount of water supply for current livestock population using soum's livestock number,

water resource spots and water use norms.

## LIVESTOCK WATER SUPPLY CALCULATION

Animal type	Livestock population	Water norm for 1 animal per day, (liter)		Amount of water required per day, (cubic meter)	
		Summer- Fall	Winter- Spring	Summer- Fall	Winter- Spring
Sheep & Goat	91.8	5.0	3.0	459	275.4
Cattle	32.2	40.0	30.0	1288	966
Horse	7.3	40.0	30.0	292	219
Camel	0.005	55.0	40.0	275	200
TOTAL	131.2			2314	1660.4

We complied with existing water norms of 1 animal per day, developed by Ministry of Environment, Green Development and Industry.

Using sources of water for pasture water supply

We used PhD Chogdon J's efficient radius determined by each soum

and province of Mongolia for calculating traditional sources of rivers and streams.

Ideal size of field that can be irrigated from one water spot is calculated as below: number of animals per hectare field is determined by comparing grazing fields with current sheep head units.

## PASTURE MANAGEMENT:

Within the pasture use, pasture management measures, the following key measures should be implemented as combination and interrelated: "Establishing of System of pasture monitoring", "Improvement of winter and spring camps environment (surrounding area)", "Creation of pasture watering facilities in the unused or less used pasture area".

- Importance of creation of pasture system (framework)

Interrelationship between capacity of watering, livestock number and pasture capacity, aims of pasture management to

be defined in relation to well construction, role of methods and technologies of pasture management are presented.

- Planning of well construction and pasture management

Plan of pasture management related to development of watering well network consists of two following parts: Improvement of environment of winter and spring camps and owning of unused and less used pasture area. Measures which recommended to take in both meanings, body and intellectual for each part are presented in the Table below.

Table 6.

Pasture management

Indicators	Watering facilities (body meaning)	Pasture use (intellectual meaning)
Improve environment (surrounding area) around wintering camp and spring grazing place (camp)	Improvement and newly installation of watering facilities around winter camp and spring grazing places (tank, feeder )	Improve the pasture use around pasture watering wells (manual for use of wells etc)
Owning (using) of unused or less used pasture	installation of watering facilities in the less and unused pasture around fall camp and summer grazing places (wells, tanks, accumulation ponds etc)	Improve the technology and methods of well utilization

Table 7.

Measures and mechanisms of water source improvement and construction and pasture management

Indicators	Improvement of environment (surrounding area) of winter camp and spring camps	Owning (using) of unused or less used pasture
Results	Improver the watering capacity Improve the watering methods and technology Livestock wintering facilities and capacities	Extending of area of otor (grazing in pasture with better yields far away from regular pasture) Improver the watering capacity Improve the watering methods and technology
Measures	Maintenance of wells Drilling of new welss Improve the watering facilities around winter camp and spring grazing places Regulating watering timing, rotation and sequences of watering etc Establishing of herder's group	<ul style="list-style-type: none"> <li>• Repairing new wells and drilling and construction of new wells</li> <li>• Improving of auxiliary facilities of watering</li> <li>• Establishing of herder's group</li> </ul>

- Plan for Improvement of environment of winter and spring camps

Measures which implement herder's group, local and central government and donor organizations review in the Table below.

Table 8.

Plan of the improvement of surrounding area of winter and spring camps

№	Indicators	Mainstream (Direction) of measures		
		Establish herder's group, duties for well maintenance	Establish herder's group	Repairing of wells, drilling of new wells
1	Repairing of wells, drilling of new wells			

2	Regulating watering timing, fixing rotation and sequences of watering	Issuing regulation for well utilization and implement	Regulation of well utilization and control for implementation	Introducing and instructing of regulation of well utilization
3	Improving winter and spring camp's facilities	Repairing of fence and barrack for livestock Construction of shelters and fences for storage of fodder	-	-

## CONCLUSIONS

1. Looking at plant coverage of the soum territory, pasture of tall mountain meadow is 150.7 thousand hectare and grazing grass is 223.9 thousand hectare.
2. As of 2015, average pastureland harvest is  $5.2 \times 100$  kg/hectare in 405.3 thousand hectare pasture land and average non-pastureland harvest is  $5.0 \times 100$  kg/hectare.
3. Erdenetsogt's grass resource reserve is 2108.0 thousand ton that can feed 383274 sheep head units. The current livestock population of 291.8 sheep head units demonstrates that there is sufficient grazing capacity.
4. As of 2015, 347.8 thousand hectare of 85.8 % of the soum's pasture land is irrigated. According to our studies, 3 wells need to be built to ensure water supply in the remaining 11.0 thousand hectare or 14.2 %.
5. Compared to gobi-steppe region, the soum has less water spots, higher grazing capacity, and higher flexibility to move and change pastureland regardless of water spot location which is an advantage for the soum.

## REFERENCES

1. Dagvadorj B., "Pasture watering of PRM", Ulaanbaatar, 1961
2. "Report of the State inventory for surface water of Mongolia", MNEGD, Ulaanbaatar, 2003
3. Chagna N., "Irrigation and water supply of Agriculture", Ulaanbaatar, 1986
4. Chogdon J., "Pasture watering of PRM" Ulaanbaatar, 1969
5. Yadamsuren G., "Water supply of livestock", Ulaanbaatar, 1981
6. Baranchuluun Sh., Chandmany D., Dugarmaa M., "Pasture watering", Darkhan, 2004

## **EVALUATION OF TECHNICAL THINKING OF THE STUDENT BY ENGINEERING DRAWINGS**

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### **ABSTRACT**

*On the one hand, technical labor requires development and characteristics of human intelligence and on the other hand, it demands engineers who are technical workers having technical knowledge and capacity to process detailed and complicated information and to make the right decision at the moment. We confront the necessity to understand techniques comprehensive deeply while the content and form of the human active action have been becoming complicated and precise. In order to manage and use wisely limited resources and guide increasing demand rightly in the market system, activities and operations of the engineers have to be productive and accurate. To create more recourse at less expense, to work productively in a less time and to obtain new techniques and technology successfully, specialists of engineering and technology need developed technical thinking.*

**KEYWORD:** Comprehension, imagination, practice, technical language, operative

### **INTRODUCTION:**

T.Kudryavtsev [1] (1971) was considered that the structure of technical thinking is composed of following three components: "comprehension, imagination, and practice. However, Ossi Autio, a lecturer of technology education at Helsinki University of Finland and Professor Ron Hensen of Ontario University of Canada were considered that technical thinking is contained following parts: 1) Psychomotor (competence / motor skills), 2) cognitive skills (technological knowledge), 3) emotional engagement, while M.V.Muhina concludes that comprehension,

imagination, practice, technical language and operative.

Looking at the complexities of the technical thinking, the concept of *comprehension* will provide the technical basis of the concept.

The part of *imagination* can be used to help creating integrated viewing system. Imagination is a mental process that focuses and integrates imaginations which reflecting real life, and creates a new psychological process and new images that have not been captured. Any form of

imagination consists of things that were past human experience.

The portions of the picture can be used to help create an integrated image system. A mental process that creates, integrates, and integrates imaginations reflecting real life, and creates a new psychological process that creates new images that have not been captured. Any form of representation consists of things that were past human experience.

In order to gain some knowledge, students will be able to integrate their needs into the imagination of something they have learned. There are three ways to convert the imaginary form into space. First, to modify the position only by adjusting the generated imagination. The first scene does not change at this action. Second, the character created by the problem of solving is not only converted to spatial position but also the structure.

## STUDY MATERIALS AND METHODOLOGY.

There was used "Cognitive framework of technical thinking" drafted by Mariya Mukhina, a lecturer of the Pedagogical University in Nizhny Novgorod based on the "Cognitive framework of "Taxonomy of educational objectives" of

Third, it creates an entirely new image by converting the resulting from several times in succession. The education of classical geometry and engineering drawings influence to the development of the representation thinking.

There must use the technical terms, languages, diagrams and lines in technical solutions. Any scientific knowledge is in the form of language. The *technical language* is the link between theory and practice.

The consumption checks and represents issued decision. While solving the task contains technical contents both the analysis of the task conditions and the reflection of the image are alternatives to the practice of solving the task as a whole.

The *operative* is a limited-time mindset to give a full answer to the issues raised.

the U.S. Professor Benjamin Bloom. While we have been certifying and analyzing rates of technical thinking of the student. Also, we have modified this taxonomy regulating to the content of engineering drawings.

Table 1.

Criteria and factors of the development of technical thinking

Component of technical thinking	Factors		
	1 <sup>st</sup> level	2 <sup>nd</sup> level	3 <sup>rd</sup> level
comprehension	To know purpose of the line in picture. To draw geometrical shapes projection such as point, line and flat. To read epur and shapes. To know basic signs of figurative geometry.	To know purpose of the line in picture. Projection method: perpendicular, parallel, method of projection change, surface, to understand structure of axonometric projection	To understand the nature projection methods, perpendicular, parallel, method of projection change, surface, to understand meaning of axonometric projection
imagination,	To familiarize and name geometric shapes	To draw new picture and to make correction its:	To use removable geometrical shapes with in space
practice	Task on size and location (simple)	To solve task to change projection	The surface of the projector is a plane cutting projection
technical language	To know formulated symbol	To read formulated symbol	To use formulated symbol
operative	To know compile when you need information	Optimize search information, develop short-term and efficient technical work	Be able to rationalize and evaluate technical issues; define more and less data on technical issues

The cognitive framework of taxonomy is becoming main theoretical basis which explains cognitive structure of modern training system.

There was regarded the cognitive process is conducting by 6 level: education and perception contain to the lower order thinking skills, consumption, analyzing, summarizing and evaluating contain to the higher order of thinking skills.

The taxonomy explains that the precise steps of the intellectual activity take place in a certain way until human reasoning is received and assessed.

There was included the content of the lesson program EGD-201 "Engineering drawings" which is being thought to the students of the School of Engineer and

Technology, MULS and drafted by the lecturers of Nijnegorod. (table 1)

We have used training result in the test task based on this taxonomy without teaching methodology of engineering drawings.

There was included following requirements: task content and form is satisfied the instruction; task must be concise. Understandable, without ambiguous meaning; must be in right order from hard to easy; with space for answer, have good explanation of evolution rule and completion term.

Following must be included in test:

1. Choose content frame work
2. To choose structure of the task
3. To draft the task
4. To use drafted task

Table 2.

Evaluation average of level of technical thinking of the students

number	level	of technical thinking				
		comprehension	imagination	practice	technical language	operative
		Evaluation				
<b>32</b>	1.	89.5	89.0	81.5	77.0	78.5
	2.	78.0	76.0	75.0	73.0	66.5
	3.	69.5	68.0	-	60.0	51.4
<b>average</b>		79.0	77.6	78.3	70.0	65.4

## CONCLUSION

The test used for the study is to use the linear picture illustration, to formulate the symbols and the technical scheme and to assess technical thinking and to assess the technical thinking.

1. According to the results of the survey (Table 2), the average of the students who are studying in the field of engineering studies are at the level of 65.4-79.0%. 83.7% at level 1 of student technique and

73.7% at level 2 and 3; And 62.2% success.

When technical issues arise, technical issues should be addressed to the quality of the criteria set up. Students should also possess all the technical aspects of the technique. To do this, it is important to emphasize the development of the technical skills of various levels, to fully define and develop the skills of students to solve task.

## REFERENCES:

1. Гильбух Ю.З. (1986) Мир такое техническое мышление //Трудовое обучение.
2. Душков Б.А., Королев А.В., Смирнов Б.А. (2005) Энциклопедический словарь: Психология труда, управления, инженерная психология и эргономика.
3. Занфирова Л.В. (2008) Формирование технического мышления в процессе подготовки студентов агротехнических вузов. Автореферат. Москва.
4. Кудрявцев Т. В. (1975) Психология технического мышления. (Процесс и способы решения технических задач). М., “Педагогика”.
5. Airasian, Peter.W. (2005) Classroom assessment: concepts and applications, fifth edution. New York.
6. Allan C. Ornstein. (2001) Strategies for Effective Teaching.
7. An introduction psychology. (1997) Patricia M.Wallace & Jeffrey H. Goldstein.
8. Anderson L.W., & Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition, New York : Longman.
9. Autio.O. and Ron Hansen. (2002) Defining and Measuring Technical Thinking: Students` Technical Abilities in Finnish Comprehensive Schools /Journal of Technology Education/. №1.
10. Benjamin B. Lahey. (2007) Psychology: an introduction. -9th ed. Chicago.
11. Bennett, B., Rolheiser-Bennett, C. & Stevahn, L. (1991). Cooperative learning: Where heart meets mind. Toronto, ON: Educational Connections.
12. Bennett George K. Bennett (2008) Mechanical Comprehension Test. San Antonio.
13. Crawley, E. F., Malmqvist, J., Brodeur, D.R., Ostlund, S. (2007) Rethinking Engineering Education: The CDIO Approach. New York : Springer-Verlag.
14. Dyrenfruth M.J. (1990). Technological literacy: Characteristics and competencies, revealed and detailed. In H. Szydlowski, & R. Stryjski (Eds.) Technology and school: Report of the PATT conference (pp. 26-50). Zielona Gora, Poland: Pedagogical University Press.
15. Jensen, Arthur Robert. (1969) How Much Can We Boost IQ and Scholastic Achievement.
16. King F.J, Ludwika Goodson, Faranak Rohani. Higher order thinking Skills.
17. Nigmatov, Z. G. (2014). Methodic techniques of solving technical problems developing technical students' thinking. *Review of European Studies*, 7(1).
18. Parikka M. (1998). Teknologiakompetenssi: Teknologiakasvatukseen uudistamishaasteita peruskoulussa ja lukiossa [Technological competence: Challenges of reforming technology education in Finnish comprehensive and upper secondary school]. Psychology and Social Research Report No. 141. Jyväskylä, Finland: Jyväskylä Studies in Education.
19. Powell, A. Katzko, M., & Royce, J. (1978). A multifactor system theory of the structure and dynamism. *Journal of Motor Behaviour*, 10(3).

## **STUDY ON BUILDING HEAT LOSS REDUCTION BY DETERMINING THERMAL PERFORMANCE OF AN INSULATION MATERIAL MADE WITH MONGOLIAN SHEEP WOOL**

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### **ABSTRACT**

*Traditionally, the Mongolian have used sheep wool as insulation material in Gers or Mongolian traditional dwellings. In construction sector, which has been rapidly developing in recent years, there are opportunities to produce Mongolian brand insulating materials corresponding to local climatic conditions and use insulating materials made of sheep wool in construction fences, pipelines and structures [8]. Determination of sheep wool insulation material's required thickness, real thermal resistance, heat conductivity at Mongolian climate condition specifically at heating degree days is highly useful to reduce building heat loss. It enables to reduce heat loss, of the buildings at the various residential provinces in the Mongolia and to create healthy environment by reducing air pollution. It's health positive effect and effect on 45% of air pollution reduction were identified by this research.*

**KEYWORDS:** Energy efficiency; primary energy reduction; CO<sub>2</sub> reduction; hygrothermal simulation;

### **1. INTRODUCTION**

For our country, air pollution has reached to a serious and threatening condition due to long heating period caused by extremely continental climate, insufficiency of construction insulations, shortage in capacity of centralized heating system, high cost of energy spent for heating, and over usage of raw coals. Even though our national producers have commenced the production of sheep wool insulation materials, they have not been fully penetrated into market due to insufficient demand and consumption of such materials. The reason of this is the

fact that the producers fail to produce materials corresponding to quality standards as they are lack of knowledge on requirements of insulation materials to be used in construction lines[8]. Currently, only imported insulation materials not corresponding to hygienic and quality requirements are being used in Mongolia. Definite proportion out of these significant amount of imported insulation materials and their raw materials can be substituted by insulation materials made of sheep wool corresponding to quality requirements.

According to international trend, the consumption of ecologically friendly and useful for health products has been increased from day to day. Regarding the buildings being constructed in Mongolia, their heat loss is relatively high, and they

Sheep wool is a material that is highly suitable for producing insulation materials. Mongolian sheep wool has a number of advantageous properties such as high thermal storage, highly adaptable to extreme climate, durable, highly resistant to fire, low depreciation, etc. 96% out of Mongolian sheep have coarse wool. The average thinness of wool particles is 32 – 40 microns, and 35-60% out of total size is occupied by thick hairs. Currently, the use of sheep wool is insufficient in our country. Nationwide, a total of 20-26 thousand tons of wool are produced from 27.8 millions of livestock, and 51% out of them are used

are rarely based on energy, water and mineral resources economy and efficiency. Also construction materials used in interior decoration barely meet the requirements of corresponding to health and ecology [5].

domestically, especially 6% are used by processing plants [6]. Over 60% are used in production of felts and insulation materials, and 24% are in elementary level processing plants, respectively. As of today, 6 plants that produce sheep wool insulation materials have commenced their operation, and they have a capacity to produce 5000 m<sup>3</sup> insulation materials annually [7]. As a result of consuming import substituting products, there will be opportunities to reduce cash outflow, support domestic producers and create additional workplaces [8].

## 2. SHEEP WOOL STRUCTURE

Sheep wool is classified in to 4 categories such as thin, average thin, thick, average thick based on the breed.

Sheep Wool structure

Table 1.

Thin wool		Average thin wool		Average thick wool		Thick wool	
length	thickness	length	thickness	length	thickness	length	thickness
45-60MM	23-25MKM	55-80MM	25.1-30MKM	60-175MM	26.1-34MKM	60-200MM	34.1-67MKM

Wool consists of cashmere, fur, bristle, tip of fur depending on the wool structure. Wool consists of cashmere, fur, bristle, tip of fur depending on the wool structure. Cashmere content is 54.5-62.9% for ram, 53.6% for ewe, 55.9-

59.6% for the lamb, Tip of fur content is 22-35.9% for ram, 21.9-37.8% for ewe, 24.2-34.9% for lamb. Bristle content is 3.1-14.6 for ram, 2-11.3 % for ewe, 2-10.5% for lamb [4,9].

## 3. COMPARISON OF INSULATION MATERIALS

The aforementioned insulation materials have the following advantages and weaknesses:

Comparison of Insulation Materials

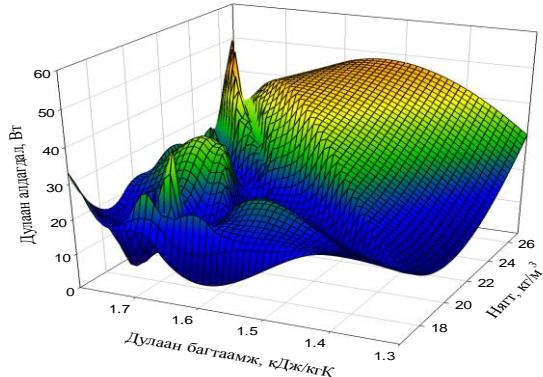
Table 2.

No	Isolation materials	Advantages	Disadvantages
1	Construction foam	- Light weight - High density - Quick assembly within short time in large area	- Easily subjected to mechanical damages - Low fire resistance
2	Fiberglass/glass wool	- humid and water resistant - high thermal isolation capability	- Expensive - Harmful to health

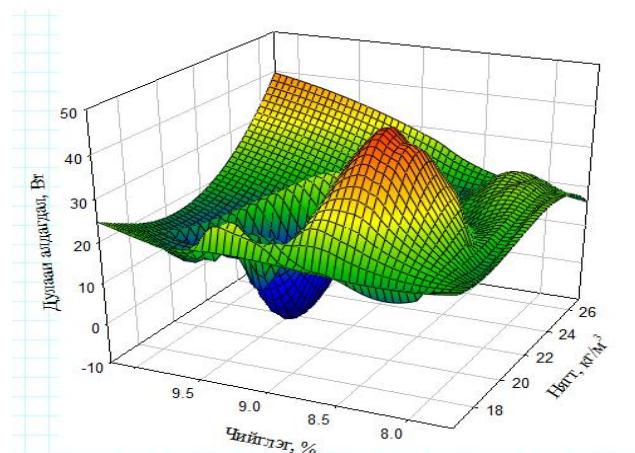
3	Stone wool	- state-of-the-art technology, low adverse impact on health - noise insulation	- Expensive - Non-eco friendly
4	Expanded clay aggregate	- Excellent heat and noise insulation - High durability - Wet resistance - Fire resistance - Light weight - Heat insulation	- Expensive - Non-eco friendly
5	Corundum	- Minimum labor consumption - High strength& durability	- Expensive - Need in significant amount

When heat storage is increased thermal conductivity of the wool fiber is reduced. It can be seen in the Figure 2. Heat loss

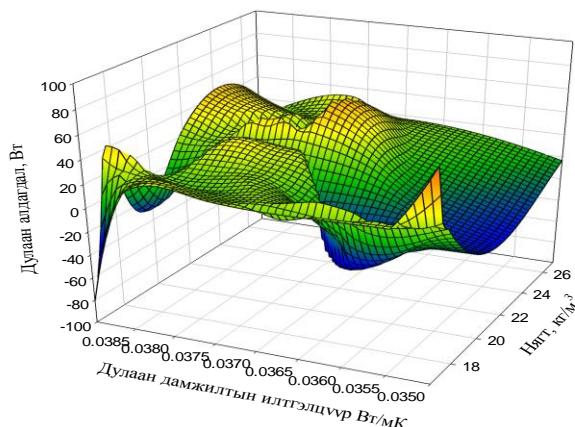
through material can be assessed once heat storage of the material is determined. Matrix analysis was done with SigmaPlot 13.0 software.



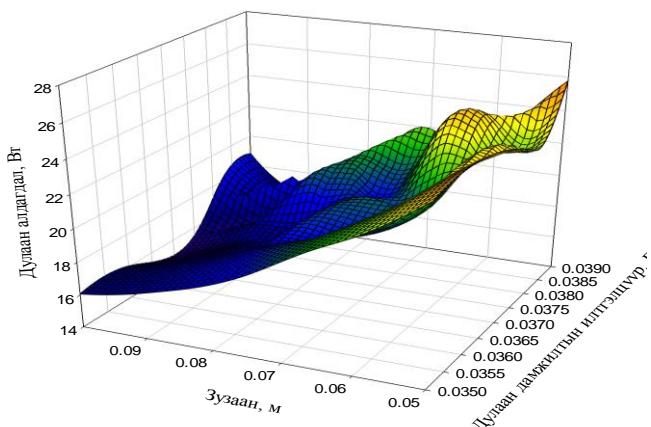
A. Correlation between density, specific heat capacity, heat loss



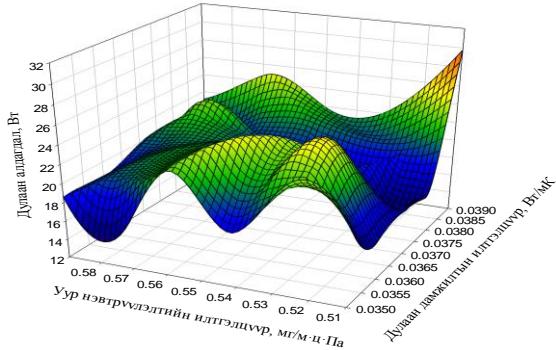
B. Correlation between density, moisture, heat loss



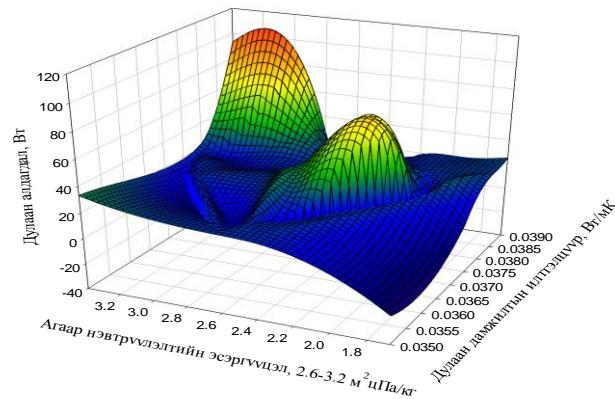
C. Correlation between density, thermal conductivity, heat loss



D. Correlation between thickness, density, thermal conductivity, heat loss



E. Correlation between vapor diffusion coefficient, thermal conductivity, heat loss



F. Correlation between air resistance, thermal conductivity, heat loss

Figure 1. Analysis of results was done with SPSS 22.0 software

#### 4. TEST RESULT WITH THERMAL CAMERA FOR BUILDING HEAT LOSS

While the selected building into the air temperature and relative humidity of 19 placed instruments at hobo u 10

(temperature relative humidity data logger) measurement obtained at 1 hour in the woods tool memory.

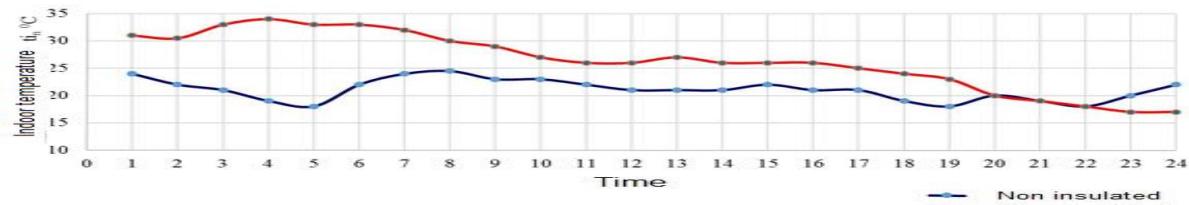


Figure 2. Indoor temperature of building insulation and no insulation

Indoor air temperature increases while heat loss through external envelope is reduced when the envelope is insulated with wool insulation. It is shown in the Figure 4. The study result shows that the

buildings shall be insulated and tightened as well as HVAC system shall be operated normally in order to keep indoor air temperature at optimal level.

Table 3.  
Test result of building heat loss

Before Insulation	After Insulated
BNbD 23-02-2009 normalized parameter are 6-9 times higher thermal conductivity. External wall $u = 1.99 \text{ BT/M}^2\cdot\text{K}$ Roof $u=1.88 \text{ BT/M}\cdot\text{K}$	Adult closer to the normalized BNbD 23-02-2009. External wall $u=0.33 \text{ BT/M}^2\cdot\text{K}$ Roof $u=0.23 \text{ BT/M}^2\cdot\text{K}$
Indoor temperature $t_{in} = 21.2^\circ\text{C}$	$t_{in} = 26.5^\circ\text{C}$
Air tightness was very bad, and met a column or wall sections and corner wall was the main part of the air caused significant spills.	Reached normal levels improved air tightness and decreased 4 times than before.
Outdoor temperature $-12^\circ\text{C}$ , while the frequency of 7 times the total of 25-30 pounds of carbon	$t_{out} = -12.5^\circ\text{C}$ while the frequency of 3-4 times the total of 5kg of carbon

Use of the fuel (coal) emissions ambient air decreased by 40 percent, but declined by the same amount.

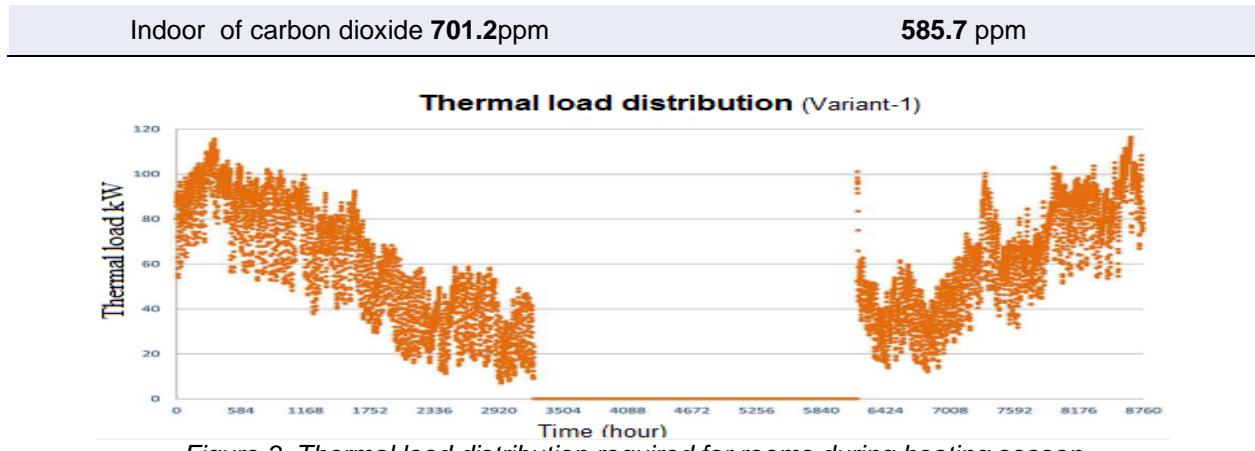


Figure 3. Thermal load distribution required for rooms during heating season (External wall, Variant-1).

Building exterior wall of the distribution of heat thermal load required for assuming a

sheep wool insulation of the heating season is shown in Figure 3.

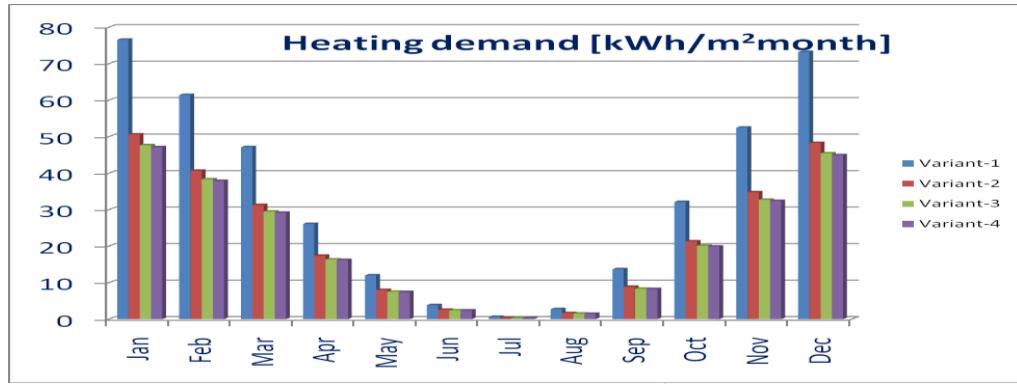


Figure 4. Heating demand, kWh/m<sup>2</sup>/month

The building selected as target object for the study was calculated with 4 options using design condition of the UB city: insulated with EPS, insulated with mineral wool, insulated with ship wool and

un insulated. Heating load required for per square area was calculated for all of the 4 cases. The case that is insulated with ship wool insulation material has lowest heating load. It is shown in the Figure 4.

## CONCLUSION

Mongolian sheep wool insulation material's parameters were newly determined as follows:  $\mu=0.5\text{--}0.59\text{mg/mh.Pa}$ , specific heat capacity is  $c=1.6\text{--}1.79\text{ kJ/kg K}$ , air resistance is  $R_a=2.6\text{--}3.2\text{m}^2\text{h.Pa/kg}$ , dynamic stability is  $s=11.6\text{--}14.81\text{mPa/m}$ , electric conductivity  $\sigma=4.61\text{--}4.80\text{m-1}$ , heat storage  $Q=26.6\text{--}32.3\text{ W}$ . This material

usage will be increased as a result of its determination of important parameters. Thermal performance factors and experimental matrices were used for statistic calculation. As a result formula to calculate thermal performance of Mongolian sheep wool was identified. It was proven that this material can be used in building from the solving below formula calculation.

$$S = A_1 \sqrt{\lambda_i \rho_i (C_i + 0.01 \cdot A_2 W)} ;$$

$$R_a^f = R_{a1} + R_{a2} + \dots + R_{an}$$

$$R_o^v = R_{in}^v + R_{x(1-2)}^v + R_{x(2-3)}^v + \dots + R_{x(n-1-n)}^v + R_{out}^v$$

Mathematical simulation was calculated using mathematical statistics, numerous variable experiment plan, and factors that influence thermal performance by SPSS 22.0, S-Plus 8.0, SigmaPlot 13.0 programms. Result shows that all sample materials have different thermal conductivity depending on their structure, property and it strongly influenced by the density and moisture. Moreover thermal performance has reverse relationship with thermal storage and thermal conductivity and direct relationship with material thickness and external

temperature. It has weak relationship with vapour conductivity and air resistance of it. Further wool insulation material technology shall be developed by attaching vapour resistant layer and forming its shape.

Optimized use of wool insulation material in the building envelope had been being proposed based on heat loss dynamic simulation done by ESP which considers newly determined material's parameters and climate data of the 21 provinces in Mongolia.

## REFERENCES

1. BD23-103-10 Thermal performance planning
2. BNbD23-01-09 Climate data for the building and geophysical data
3. BNbD23-02-09 Thermal performance
4. Batbayar D., "Sheep fleece characteristics and processing technology". UB., 2007,
5. Bayannasan S., "Dynamic research building heat loss" UB., 2015
6. Building sheep wool insulation materials –The Czech "People in need" project
7. UB.,2015
8. Dugarjav B., "Technology and equipment to produce building insulation material with sheep wool" innovation project 2012
9. Urantsetseg.Ts "Mongolian sheep wool insulation material" UB., 2016
10. Enhtuya D., "Technology development and method to handle Mongolian sheep wool"- UB 2012
11. Zach J., Korjenic A., Petránek V., Hroudova J., Bednar T. "Performance evaluation and research of alternative thermal insulations based on sheep wool". Energy Build. 2012

## CRUSHING DEVICE FOR SMASHING A ROAD SNOW

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### ABSTRACT

*In snowy regions, improving the efficiency of snow-removing machines has been called for so as to reduce the time and cost involved in clearing the roads of snow. As a means of efficiency improvement, it is possible to use low-cost, easy-to-use, snow crushing principle.*

*Extreme continental climate, it is extremely heavy in cold and winters, with ice-slick precipitation and sliding along roads. Nowadays, snowflakes and ice are processed with snow-ice and high-cost, fuel-efficient vehicles, as well as snow machines with adverse to cars and green areas. It is necessary to replace the above-expensive technique with a snow-crush device with reliable operation.*

*Therefore, it is possible to use low-cost, easy-to-use, crushing principle, rotation from the center of the stretch force, to test the hardened snow using the momentum power.*

**KEYWORDS:** Snow removal, efficiency improvement, momentum

### INTRODUCTION

Current conditions in the province of Darkhan-Uul

Road conditions:

- The number of road accidents increase in winter because of slippery roads after snow.
- Drivers have to drive slowly to avoid slipping which increases travelling time and the usage of fuel.
- This generates air pollution and leads to health and economic losses.
- Increase in traffic creates black ice.
- Because roads in Mongolia have uneven surfaces, scraping and sweeping is inefficient.

Environment and weather conditions:

- The temperature reaches +44 degrees in summer, and -49 in winter; precipitation is approximately 323 mm of rainfall annually; the coldest period, January, has an average air temperature of -28.3 degrees.

- It freezes during the first 10 days of November and melts during the first 10 days of April.

Working activity:

- Currently scraping, breaking and gridding equipment that uses large amounts of fuel and high cost is used. In addition, chemical substances that negatively influence the environment are used to melt snow and ice.
- The Municipal Road Service Department of Darkhan-Uul province is responsible for road clearing. The department has around 70 employees who have to clear a 223783,7M<sup>2</sup> area in which 160 vehicles run per day.
- One person has to clear an area of 3100M<sup>2</sup> and 21M<sup>2</sup>-30M<sup>2</sup> snow per hour, depending on the temperature. It takes 10-11 days to clear paved roads manually if it snows heavily.

- It takes 10-11 days to clear one snow fall. It recently snowed approximately 8

times; thus taking 80 to 88 days to clear. This illustrates the enormity of this task.

## RESULTS AND DISCUSSION

### 1. Physical and mechanical properties of snow

Although snow is originally light, it hardens after falling due to the friction of wheels and further melting and freezing conditions. This creates black ice.

The efficiency of snow plow equipment depends on the physical properties of snow. These properties are as follows:

- Fluffy snow: Light snow is soft and fluffy; it is non-cohesive. It can be swept.
- Hardened snow: Light, and non-cohesive, but its surfaces when melted because of running wheels become black ice. This needs to be removed by crushing. It is crushed when surfaces are broken, and so is easy to remove.

- Black ice, icy snow: It is hard, and bonded to the road. It has to be broken by heavy hammering from a perpendicular position. The cutting edge should be even.

When the hammer hits ice heavily, the hammer sticks to the ice and loses its momentum power and only weight power influences it and the position of the hammer's center of gravity goes to the circle radius of the driver swivel. It is called a bouncing hammer. While the hammer is bouncing, the shaft turns away from the hammer. The hammer then is moved to the outer edge again by the force of the centrifugal action.

Physical property of snow on the road surface

Nº	Physical and mechanical property	Fluffy snow	Black ice	Ice
1	Stickiness to the road	Low	Medium	High
2	Loosening with big pieces		Good	Bad
3	Breaking up	Bad	Good	Good
4	Density, g/cm <sup>3</sup>		0.4-0.6	0.9
5	Hardness and softness		Low solidity	High solidity
6	Heavy, light	Light	Heavier	Heavy

During the winter season the snowfall average is 13-18 cm. When it snows heavily, the average thickness of snow is 27-29 cm. When cars run on top of it, black ice is created which is about 7-20 mm thick. The most hardened snow is  $c8.5 \cdot 10^6$  Pa, 0.4-0.6 gr/sm<sup>3</sup> condensed. After several experiments it was found that whenever the snow cools down, it bonds to the road and 4 kg power with 1 m/second speed is needed to break it up by a pin that has a 45°-60° cutting edge if it is 25°C outside. In addition, 15-20 mm of snow can be broken by a cutting edge sized 1-4 cm. If the blade size is above 4 cm, it causes road damage and thus is not applicable.

#### *Recommended technology procedure for snow clearing*

Fluffy snow can be cleared by sweeping. But hardened snow cannot be

cleared by any single action. In other words, it has to be crushed, swept and then pushed out of the road.

#### Advantages and disadvantages of this procedure:

Repetitive action by heavy tools breaks the road surface. The tiny metal pin causes the snow to melt. The light pin works by both inertia and plasticity power. It needs to be very neatly adjusted in order to not damage the road surface. If scraping is used alone, it is hard to separate the snow and the road.

Theoretically, the cutting edge has to be light in order to avoid shaking the road surface heavily. Therefore, we a snow crushing mode is recommended. In other words, if a breaking mode on thick snow is used, damage to the road can be avoided (table 2).

Table. 2.

## Ways to remove black ice on road

No	Action type	Advantage	Disadvantage	Process
1	Sweep	Fast and easy	Only for cleaning sleet	More times by light string
2	Grind	Grinds well	Breaks paved surface of road	More times with metal string
3	Break	Breaks well if hard	Breaks paved surface of road	Heavy blade few times
4	<b>Crush</b>	<b>Able to adjust on surface condition</b>	<b>Accurate process</b>	<b>More times by light blade</b>
5	Cut	Clears the black ice well	Less possibility to adjust on surface condition	Few times by long blade
6	Scrape, push	High productivity	Requires even surface	Scrape with long blade evenly
7	Melt	Removes iciness	Refreezes	Remove using salt

**2. Estimation on design**

Considered hammer crusher width as 2 meter.

Table 3.

## Basic indicators of hammer crusher estimation

1	Hammer edge area	20 x 2 mm
2	Weight of hammer	100 gr
3	Impact on snow, P	0.8 kg.m/
4	Turning radius of hammer,r	10 cm
5	Linear velocity of hammer, V	628 cm/sec
6	Number of transmission,U	1
7	Number of shaft cycle,n <sub>3</sub>	600 turning minute
8	Speed of machine, V	4.32 km/hr

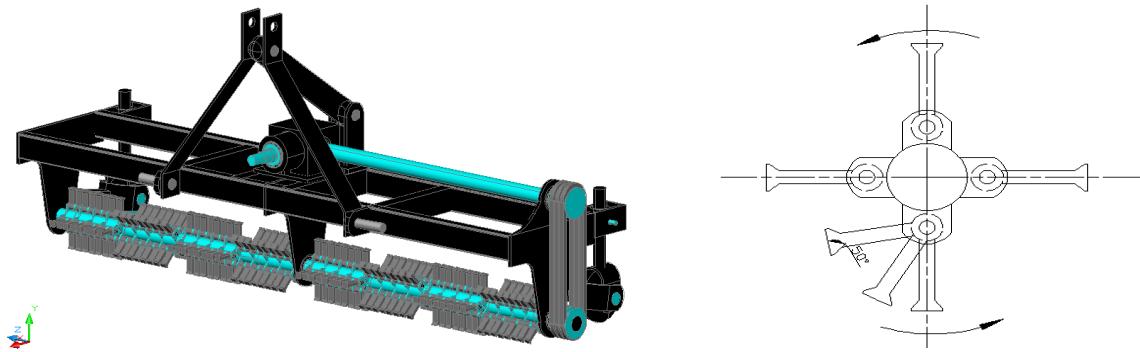


Figure 1. Hammer crusher

**3. Transmission estimation**

The plan is to fabricate a snowplow mounted on a medium-sized truck, using the following data:

- Truck power (approx.) P- 10W
- Power extend shaft cycle 500-1000 min<sup>-1</sup>

Table 4.

## The estimation of transmission basic indicators

1	Number of transmission, $U_3$ , $U_0$	1
2	General number of transmission , $U_{ep}$	1
3	Number of each shaft cycle, $n_1$	600 cycle/мин
4	Shaft capacity, $P_1$	10 kW

5	Shaft capacity, $P_2$	9.702 kW
6	Shaft capacity, $P_3$	9.4kW
7	Angle speed, $W_1$	6.28 $\text{c}^{-1}$
8	Twisting moment, $T_1$	159.2 Hm
9	Twisting moment, $T_2$	154.4 Hm
10	Twisting moment, $T_3$	149.7 Hm

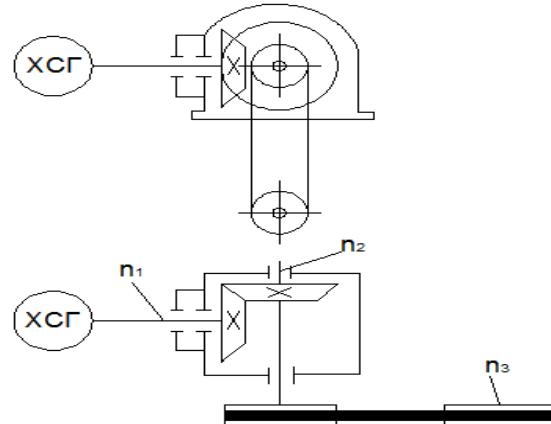


Figure 2. Transmission kinematic scheme

Table 5.

The estimation of bevel gear transmission parity indicators

1	Steering gear twisting moment $T_1 \text{ H}_\text{M}$	159.2 Hm
2	Steering gear twisting moment $T_2 \text{ H}_\text{M}$	154.4 Hm
3	Steering gear $\omega_1$	62.8 $\text{c}^{-1}$
4	Steering gear $\omega_2$	62.8 $\text{c}^{-1}$
5	Number of transmission	1
6	Steering gear $z_1$	33
7	Steering gear $z_2$	33
8	Cutting edge module $m_{tm} \text{ HM}$	2.61
9	Normal module $m_{nm} \text{ HM}$	2
10	Steering gear diameter, $d_m$	85.85 mm
11	Steering gear diameter, $d_m$	85.85 mm
12	Angle of steering gear, degree $\delta_1$	45°
13	Angle of steering gear, degree $\delta_2$	45°
14	Top of cone $R_e \text{ MM}$	70.7 mm
15	Width of gear b	20 mm
16	Circle impact $F_t$	3708 N
17	Axle impact $F_a$	2989 N
18	Radius impact $F_r$	681 N

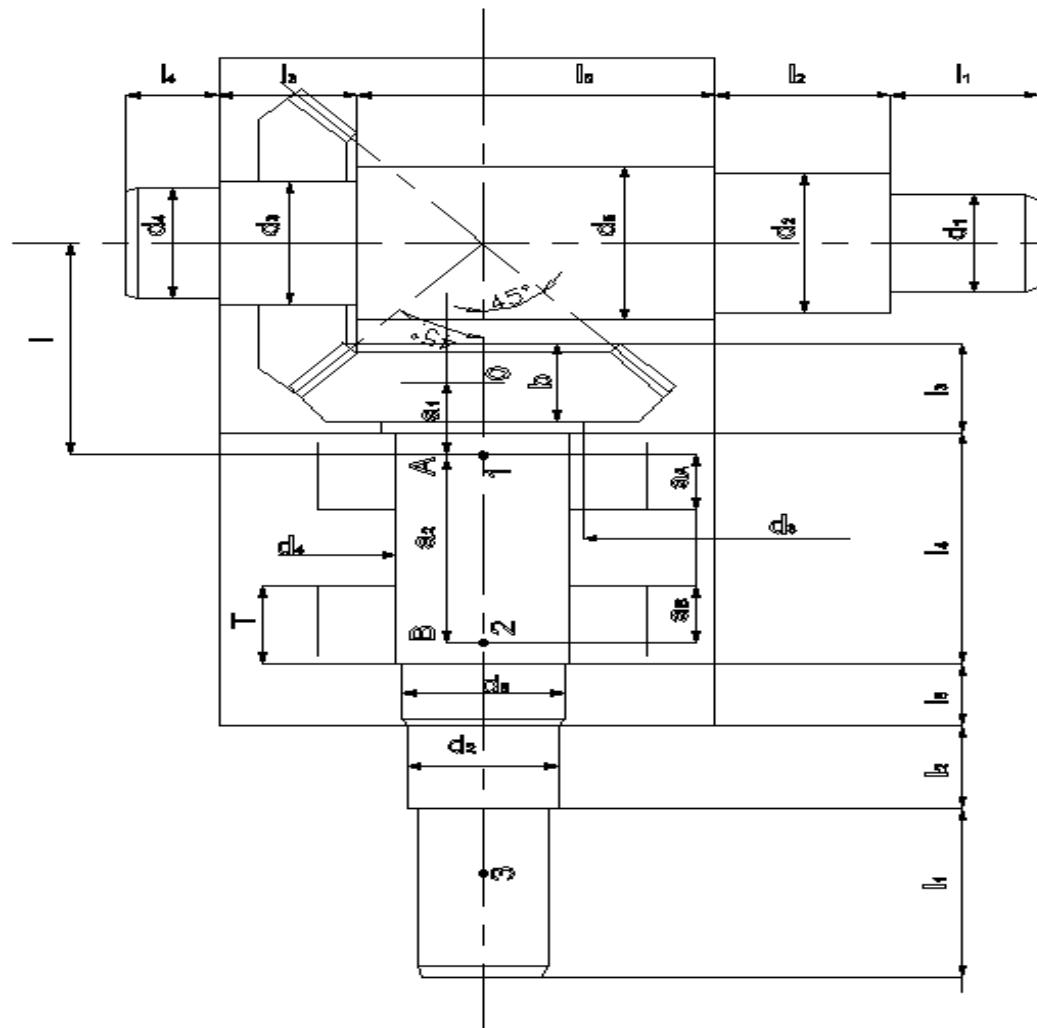


Figure 3. Bevel gear transmission median scales

Table 6.

The estimation of sling transmission parity indicators

1	Number of transmission	1
2	Angle speed, $W_2$	$62.8 \text{ c}^{-1}$
3	Number of shaft c, $n_2$	$600 \text{ мин}^{-1}$
4	Shaft capacity, $P_2$	9.702 kW
5	Twisting moment, $T_2$	154.4 Nm
6	Pulley diameter, $D_1$	100mm
7	Pulley diameter, $D_2$	100mm
8	Sling length, $L_p$	555
9	Sling saddle angle, $\alpha$	$180^0$
10	Transmission capacity of a single sling, $P_p$	4.427 kW
11	Number of sling, z	3
12	Sling speed, V	3.14 m/c
13	Advanced tightening power of a sling, $F_0$	997.8 H
14	Power in the middle transmission, $F_r$	5986.8 H
15	Width of pulley, B	63 MM
16	Outer diameter of pulley, $d_{e1}$	108.4 MM
17	Outer diameter of pulley, $d_{e2}$	108.4MM

#### 4. Determining hammering point

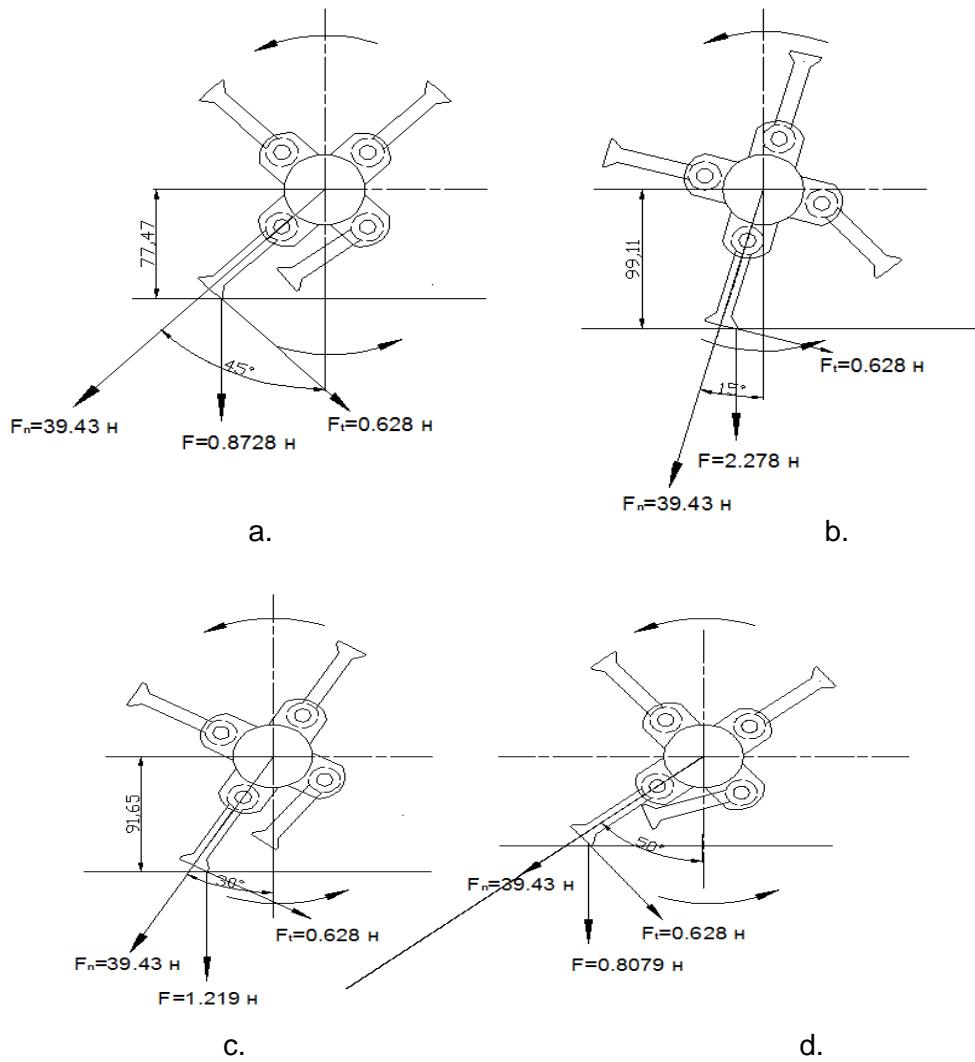


Figure 5. Hammer crusher direction and measurement

Above pictures shows the appropriate power which is 5-a and 5-d.

When it makes  $45^0$ - $50^0$  angle, the appropriate power appears.

Table 7.

Usage cost estimation		
Operation cost of crusher		
1	P Horse power of truck P	10-11 kW
2	G <sub>T</sub> Hourly fuel usage	3-4 kg/hr
3	Θ Fuel usage	40 l
4	Cost in per hour	10000 tugriks
Crusher productivity		
1	W Hourly production	7000 м <sup>2</sup> /цаг
2	V <sub>p</sub> Working speed	3000-4000 м/цаг
3	Π Productivity	6300 м <sup>2</sup> /hr
Productivity of the operator		
1	Hourly production	22-30 м <sup>2</sup>
2	Daily wage	19000 tugriks
Economic benefit of equipment		
1	Production per hour from 210 workers	6300 м <sup>2</sup>
2	Hour rate for 210 workers	498750 tugriks

## 5. Outcome

Cold weather creates many negative impacts such as on health, economy, time management and environmental pollution.

The challenge is to remove black ice and snow on roads quickly, economically and sustainably.

Table 8.

The comparison of the crusher equipment with manual work

№	Work type	Per hour		Per day		Note
		Expense, tugriks	Productivity, m <sup>2</sup>	Expense, tugriks	Productivity, m <sup>2</sup>	
1	Manually	159250	2100	1274000	16800	Wage of 70 employees
2	Crusher equipment	12840	6300	102720	50400	Fuel and operator wage
Comparison		-146410 Less than 10 times	4200 More than 3 times	-1171820 Less than 10 times	33600 More than 3 times	

If the utilization of the tractor cost is 10000 ₮ per hour (not including other services), the equipment productivity equals 210 people per hour, saving 488750 ₮ ( $498750 - 10000 = 488750$ ). Results show it will be economically and time efficient. It is possible to recover all expenses in a short time.

### Ecology:

- Less fuel usage due to regular car speed, which will lead to less air pollution.

➤ Clean road in shorter period of time.

### Society:

- It lessens lost time due to injuries and illness by decreasing working hours in cold weather.
- It replaces manual work by mechanical work, which will save time of many people in public areas.
- It prevents tragic accidents.

## CONCLUSION

1. The most hardened snow is c  $8.5 \cdot 10^6$  Pa, 0.4-0.6 gr/sm<sup>3</sup> condensed. The test proved that if the snow is broken by sized 15-20 mm thick, 10cm wide and 1-4 sm length, it needs to have 4 kg power with 1 m/second speed.
2. For the hardened snow, it is suitable to crush it by 100 g hammer with 6.28 m/second turning speed and 0.628 kg·m/second power.
3. The estimation made is based on the theoretical research and performance

test with an aggregated equipment to crush hardened snow using a variable turning shaft, and variable movement of the tractor.

4. For equipment material, 418840 ₮ was spent and the productivity per hour was 6300 m<sup>2</sup>. It was calculated that 210 workers' wages per hour is 420000 ₮. Thus, the expenses can be recovered in a short period of time and in an economically efficient way.

## REFERENCES

1. "Technical paper" 2001, [A reference to presentation at a conference ...]
2. "Komatsu technical report" 2011, pp.179-187. [A reference to a journal article ...]

## **ESTIMATIONS AND EVALUATIONS OF THE APPROPRIATE PROCEDURE FOR MAINTAINING BY STABILIZING THE GEOTECHNICAL CONDITIONS OF PERMAFROST SOIL OF MONGOLIA**

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### **ABSTRACT**

*According to the estimation of Lonjid N., scientist and researcher of permafrost, the perennial permafrost soil is spread in 61.7% of the total territory of Mongolia [2,3] and it covers the territory of 244 soums of totally 324 soums of our country. The event of great number of damages and breaks of buildings and facilities constructed in those soums was identified as those breaks and damages have happened because of wrong selection of the principle of planning to construct buildings on the frozen soil and insufficient survey of the temperature procedure of the frozen soil, physical, mechanical and thermo-physical states completely. The construction of several buildings with the ventilating hollows using the principle of maintaining the features of frozen soils of Mongolia was successful. Therefore, the main goal of this research work is to determine the thermal procedural  $k_0$  coefficient relating to the climate of Mongolia and the condition of frozen soil in order to truly and correctly determine the temperature of ventilating hollows of the buildings to be constructed in the frozen soils.*

**KEYWORDS:** Subsiding soil, Loess, freezing, defrosting, load bearing capacity.

### **INTRODUCTION**

The usage of the principle of maintaining the features of frozen soils of Mongolia in constructing several buildings and objects became successful. In 1979-1983, the Ulaanbaatar Building Projects Central Institute developed the project drawings of and constructed the small buildings with the pillar bases and ventilating channels and hollows in Nalaikh district of Ulaanbaatar city and 13 soums of Zavkhan, Arkhangai, Bayankhongor and Bayan-Ulgii aimags

and it became an important step in projecting the fundaments of the buildings in the condition with permafrost soils [1]. Thus, the main method for maintaining reliably the features of perennial permafrost bed soil in the climate of Mongolia and the engineering-geocriologic conditions is the method to ventilate and make hollows under the buildings.

When projecting the buildings and facilities in the permafrost soils, the values of the temperature of fundamental soil and

the procedures of temperature of underground part of ventilation are determined through making the thermal technical calculations using the formulae and tables put in the BNRM.2.02.01.94 / BNRM- Building Norms and Rules of Mongolia/. But, it is required to clarify the formulae (1) and (3) and the Table 1 of the appendix 8 of BNRM.2.02.01.94 that would determine the temperature and the size of the hollow of the building to be constructed with the ventilating hollows by adjusting to the climatic conditions of

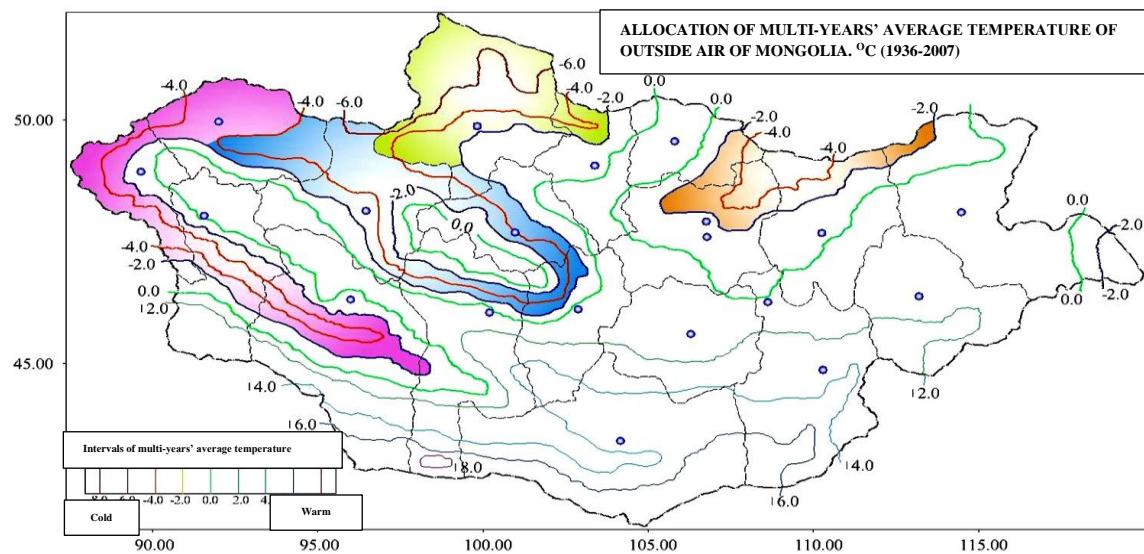
Theoretical and methodological bases for developing the engineering solutions to maintain the permafrost conditions in the regions with the perennial permafrost of Mongolia.

The annual average air temperature in our country with the continental harsh weather fluctuates between  $-8^{\circ}\text{C} \div +7^{\circ}\text{C}$ . In the regions of Mongolia where the perennial permafrost is spread, the annual average air temperature is between  $0\text{--}4^{\circ}\text{C}$  and below than this. The academician Dashjamts offered the idea to calculate by assuming the annual average temperature as more than  $-2^{\circ}\text{C}$  and/or assuming the principle of maintaining the permafrost conditions in the regions other than the occasional permafrost in choosing the projecting principle for building

Mongolia. Thus, the main goal of this research work is to determine the temperature of ventilating hollows that is required to calculate the buildings to be constructed in the perennial permafrost soils using the principle 1 using the climatic and soil conditions of Mongolia. This calculation would provide the possibility to calculate the possible changes of the frozen soil features. In order to do this, the building's thermal influence to be reflected to the frozen fundamant should be calculated.

fundaments in the regions where the perennial permafrost is spread.

We aimed at developing the above idea in details within the range of this research work, chose the 73 soums and communities situated in the area where the annual average temperature is below  $-2^{\circ}\text{C}$  and divided the territories with widely spread permafrost soils into the 4 zones such as Mongol Altai zone, Khangai zone, Khentii zone and Khuvsgul zone by assuming the annual air temperature and the peculiarity of the regions (Figure 1).



*Figure 1. Zonning for determining the coefficient of the procedures of ventilations in the perennial permafrost soils (Altantsersetseg J., 2012).*

We determined the  $k_0$  – coefficient of the procedure of temperature of ventilating hollows in the condition of Mongolia

depending on the continuation of cold days in those areas, thermo-physical indices ( $\lambda_h, \lambda_f$ ) of the soils, and

continuation of the summer season  $\tau_{th}$  by adjusting to the climatic situation of Mongolia using the formulae [6] of Fyodorovich M.R. and Gohman M.R and

showed them in the table-1 by uniting [3,141].

Table 1.

$k_0$  – coefficient of the procedure of the temperature of ventilating hollows

$\frac{\lambda_f}{\lambda_{th}}$	Number of days with minus temperatures, $t_f$ /days/							
	185	190	195	200	205	210	215	220
1.00	1	1	1	1	1	1	1	1
1.05	0.595	0.825	0.894	0.927	0.947	0.959	0.968	0.974
1.10	0.435	0.712	0.816	0.870	0.903	0.925	0.940	0.952
1.15	0.349	0.633	0.755	0.823	0.866	0.845	0.917	0.933
1.20	0.296	0.574	0.707	0.785	0.835	0.870	0.896	0.915

We have calculated the  $k_0$  – coefficient by the indices of the soums and communities where the continuations of the days with minus degrees is 185÷220 days. Herein: we have made the calculation and determined the  $k_0$  – coefficient of the thermal procedure by assuming the continuation of the days with the minus temperatures as 190, 195, 205, and 215 in Khuvsgul zone, 200 and 220 days in Mongol Altai zone, 185, 190, and 220 days in Khangai mountain range

zone, and 185, 190, and 210 days in Khentii mountain range zone. When comparing the results of above calculations to the indications stated in the table 1 of the appendix 8 of BNRM 2.02.01–94, the event of determining the continuation of winter months in the condition of our country with the intervals of 5 days or values such as 185, 190, 195, 200, 205, 210, 215, and 220 allows us to determine the temperature of ventilating hollows with more precisions.

### Calculation and results of the procedure of temperature of ventilating hollow in the situation of Mongolia

When calculating the  $T_{ca}$  temperature of ventilating hollow in the soums representing the Khangai, Khuvsgul, Mongol Altai and Khentii zones using the formulae (1) of the appendix 8 of the BNRM 2.02.01–94 that is currently in force, the calculation was made by comparing the value of  $K_0$  coefficient in the value shown in the table 1 which is newly offered by calculating in the condition of climate of Mongolia with the value in the table 1 of the appendix 8 of BNRM 2.02.01–94 and the module  $M$  of the ventilation that would meet the procedure of the temperature of ventilating hollow was estimated using the formulae (3) of the appendix 8 of the BNRM 2.02.01–94. We have made the calculation of the procedure of the temperature of ventilating hollows using the currently valid norm and rule BNRM.2.02.01-94 and the calculation modeling software TEMP/W.

The Table 2 shows the values that are calculated when the building has the

ventilating through hollows. In the norms and rules that are currently valid and followed, it is stated that the forced or

compulsory ventilation should be made when the value of the ventilation module is  $\frac{h_c}{B} < 0.02$  and thus, when making the analysis in the values of  $M$  of the table 4, the ventilation module is more than 0.02 in Undur-Ulaan of Arkhangai aimag, Telmen of Zavkhan aimag, Ulaan-Uul and Alag-Erdene soums of Khuvsgul aimag when calculating by the  $K_0$  coefficient of BNRM 2.02.01–94 which is currently valid and followed; the ventilation module is less than 0.02 when calculating by the table 1 which is offered newly. It shows that it is required to install the additional cooling equipment for cooling down the permafrost soils in planning the buildings with the ventilating through hollows in the above soums. For instance, the event that the annual average wind speed is 1.5 m/s in Telmen sum of Zavkhan aimag is relatively low than the annual average

wind speed of our country and thus, it is difficult to hold or maintain the temperature of ventilating hollows in minus degrees and on the other hand, the event that the temperature of permafrost soil is -0.4°C

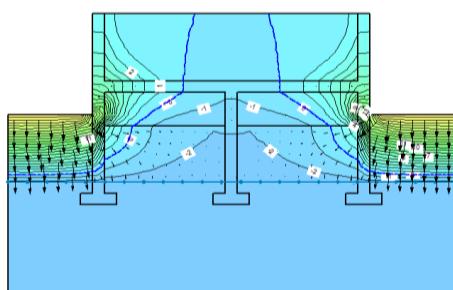
shows that the probability to unfreeze the permafrost bed soil due to the building influences.

**Value of the module M of ventilation that was determined when the building has ventilating through hollow**

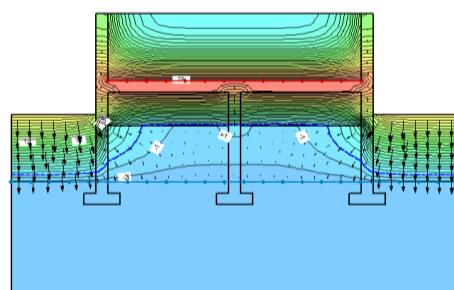
ZONES	AIMAG, SOUM	Width of building [B, m]		Average temperature of outside air, °C		Continuation of cold days, days	Temperature of permafrost soil, °C	Temperature of start freezing, °C	Average annual wind speed, m/hour		Temperature on the maximum limit of frozen soil, °C		Temperature of ventilating hollows, °C $T_{ca}$		$K_o$ coefficient		Height of hollow			
		B=12[m]	B=24[m]	$T_{out}$	$t_{fm}$				m/s	m/h	B=12[m]	B=24[m]	B=12[m]	B=24[m]	$h_z < 0.24$	$h_z < 0.30$	$h_z < 0.40$	$h_z < 0.48$		
																	B=12[m]	B=15[m]	B=20[m]	B=24[m]
1	KHANGAI	Arkhangai – Tariat	12	24	-3,6	202	-1,5	-0,1	2,8	10080	-3,6	-3,6	-2,851	-2,898	0,018	0,02	0,24	0,29	0,39	0,47
2		- Undur-Ulaan	12	24	-3,6	194	-1	-0,1	2,4	8640	-3,6	-3,6	-2,808	-2,449	0,02	0,014	0,16	0,21	0,27	0,33
3		- Khangai	12	24	-4,3	183	-1,9	-0,1	2,4	8640	4,3	4,3	-3,354	-1,273	0,017	0,005	0,06	0,07	0,1	0,14
4		Bayankhongor – Za	12	2+	-4,1	192	-0,3	-0,1	120	4320	4,1	4,1	-3,198	-2,572	0,086	0,021	0,25	0,31	0,41	0,3
5		- Bayanbulag	12	2+	-4,1	206	-1,3	-0,1	2,2	7920	4,1	4,1	-3,346	-3,452	0,024	0,023	0,33	0,42	0,56	0,67
6		- Gurvanbulag	12	2+	-7,9	221			2,5	9000	-7,9	-7,9	-7,157	-7,229	0,025	0,028	0,33	0,42	0,56	0,67
7		Zavkhan – Tosonts	12	24	-6,2	199	-0,3	-0,1	1,4	5040	-6,2	-6,2	-4,836	-4,77	0,022	0,021	0,25	0,32	0,42	0,3
8		- Telmen	12	24	-4,9	188	-0,4	-0,1	1,5	5400	4,9	4,9	-3,822	-2,268	0,025	0,009	0,11	0,14	0,19	0,23
9	KHOVSGUL	Khuvsulg – Khatga	12	24	-4,4	207	-1,5	0	2,9	10440	4,4	4,4	-3,617	-3,744	0,018	0,021	0,25	0,32	0,42	0,31
10		- Renchinilkhuu	12	24	-7,2	205			1,1	3960	-7,2	-7,2	-5,832	-6,012	0,029	0,034	0,41	0,51	0,68	0,82
11		- Arbulag	12	24	-5	212	-3	-0,1	1,5	5400	-5	-5	-4,26	-4,402	0,087	0,045	0,55	0,69	0,92	1,11
12		- Ulaan-Uul	12	24	-6,6	205	-1	-0,1	2,4	8640	-6,6	-6,6	-5,346	-5,511	0,014	0,017	0,2	0,25	0,33	0,4
13		- Alag-Erdene	12	24	-3,1	190	-0,5	-0,1	2	7200	-3,1	-3,1	-2,418	-1,779	0,028	0,014	0,17	0,21	0,28	0,33
14	KHENTII	UB – Nalaiikh	u	24	-3,7	196	-0,5	-0,1	1,5	5400	-3,7	-3,7	-2,886	-2,674	0,082	0,025	0,3	0,37	0,3	0,6
15		- Baganuur	12	24	-2,3	176	-0,6	-0,1	2,6	9360	-2,3	-2,4	-1,794	-0,681	0,028	0,008	0,1	0,12	0,16	0,2
16		Tuv - Zuuvod	12	24	-1,2	179	-0,4	-0,1	2,4	8640	-1,2	-1,2	-0,936	-0,355	0,055	0,017	0,2	0,25	0,33	0,4
17	MONGOL	Bayan-Ulgii-Tsagaannuur	12	24	-3	220	-0,8	-0,1	3	10800	-3	-3	-2,7	2,745	0,043	0,05	0,6	0,75	1	1,2
18	ALTAIN	Govi-Altaa-Erdene	12	24	-1,9	189	-0,3	-0,1	3,4	12240	-1,9	-1,9	-1,482	0,985	0,025	0,011	0,16	0,17	0,23	0,27

In order to check the above calculation, we made the calculation of the one stored building for the kindergarten with 50 beds that was broken right after giving the heating after the construction is finished in 2011 in Khangai soum of Arkhangai aimag using the modeling software TEMP/W of calculation. It is planned to have the cast ferro-concrete pillar fundament with the ventilating through hollows according to the principle I for planning the building fundament in the permafrost soil. When constructing the ventilating hollows, the version of the project drawing with the

penopolystyrol insulations underneath was changed and laid the volcano sediments with the thickness of 28÷30 cm on the ferro-concrete cover, put the foam polystyrol with the thickness of 2 cm on it by covering the heat reflecting plastic paper and placed the floors' heating straws in the smoothing concrete layer on it. The data of the kindergarten's building floors was put into the software with 2 versions. 1<sup>st</sup>, without the floor heating and 2<sup>nd</sup>, with the floor heating and made the calculation. The result of the software is shown in the figure 2.



a) Version 1. Without the floor heating



b) Version 2. With floor heating

Figure 2. Result of the software TEMP/W of the procedure of the temperature of permafrost soil under the ventilating hollows of the kindergarten building of Khangai soum of Arkhangai aimag

As looking at the Picture 2.a, the temperature of the soil under the bed of building fundament calculated using the software TEMP/W is less than the annual average temperature (-1.9°C÷-2.4°C) in the natural condition of the permafrost soil. It proves the conclusion of the

previous calculation that it is required to install the additional equipment in case of planning the fundament for building in Khangai soum with the ventilating hollows or according to the principle I. Moreover, another reason for breaking down of this building is the installation of floor heating system in the 1<sup>st</sup> floor.

## CONCLUSION

1. Some of the indices stated in the currently valid BNRM-2.02.01-94 is used according to the statements of the norms and rules of Russian Federation and thus, it is required to change them adjusting to the climatic and soil conditions of Mongolia.
2. The values of  $k_0$ - coefficient (in BNRM 2.02.01-94) of the heating procedure of the ventilating hollows are comparatively higher compared to the indices of climate of Mongolia and thus, it is insufficient to realistically determine the temperature of ventilating hollows. Therefore, the event of making changes and amendments to the building norms and rules by the values estimated by the  $k_0$  coefficient of the climatic and soil conditions of Mongolia will provide us with the possibility to truly and correctly calculate the temperature of ventilating hollows. In some cases (the continuation of cold days is less than 190 days), the newly estimated values of  $k_0$  coefficient is close to 0 and it shows that it is impossible to construct buildings by maintaining the permafrost features of the soil of fundament by increasing only the parts of fundament's supports and it is required to additionally cool down the permafrost soil using the forced cooling equipment.
3. We are raising the opinion to use in the project drawings as follows: When the width of the building is less than 15 meters, the height of ventilating hollows should be chosen as 0.3÷0.8 and 0.4x0.6m when it has the ventilating holes, 0.4÷1.0m when the building width is 15÷20m, 0.6x0.9m when it has ventilating holes and 0.5÷1.2 m when the building width is 20÷24 m and with the ventilations.
4. It is required to survey the formation and the natural rules of the perennial permafrost soils spread in Mongolia and establish many observation stations with the purpose of making the survey of temperature procedures.
5. Furthermore, it is required to develop the project drawings of the buildings and facilities to be constructed on the permafrost soils according to the experimental rules and make evaluations and draw conclusions for the situations of buildings at the result of having the regular observations during the process of constricting and using the buildings, and develop the versions to choose the types of designs and fundaments of the buildings to be planned in those areas.
6. Furthermore, it is possible to calculate the thickness of heating insulation materials on the floor above the ventilating hollows using the TEMP/W software when planning the fundaments of the buildings in regions with permafrost soils of Mongolia by the principle I.

## **REFERENCES**

- [1] Dashjamts D., Geotechnical condition of Mongolia. UB., (2009)
- [2] Lonjid H., Stony permafrost of Mongolia. UB (1969)
- [3] Lonjid H., Stony seasonal and perennial permafrost of Mongolia., (1969)
- [4] BNRM-2.02.01-94 Norms and rules of Mongolia for developing the projects of fundaments of buildings and facilities
- [5] СНиП 2.02.01-83 Fundaments of buildings and equipping. M.: Stroyiszad, (1984).
- [6] Fyodorovich M.P., Gohman M.P., Clarifying the estimated temperature of permafrost soils in the fundaments of buildings and equipping. (1984)

## **ADVANCED THERMAL-PRODUCTION AND -TRANSPORT TECHNOLOGIES FOR GLOBAL-WARMING SUPPRESSION**

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### **ABSTRACT**

*The aim of the present study is to introduce the thermal production from the biomass and higher efficiency thermal fluid transport method. It is found that (i) the production of CO<sub>2</sub> is suppressed in the lower mix ratio region, i.e., the mass ratio of air to biomass, (ii) thermal energy, i.e., hot water can be produced from the high combustion gas with the aid of plate heat exchanger, (ii) overall heat transfer coefficient for herringbone plate in plate heat exchanger is higher than the other of plate shapes and an amplification of frictional pressure drop is substantially suppressed for the separate herringbone plate, and (iii) enhancement heat transfer performance is caused by suspending nanoparticles in pure working fluid and the corresponding nanofluid can be applied to the high performance cooling devise.*

**KEYWORDS:** Biomass, Thermal Production, Plate Heat Exchanger, Nanofluid, Combustion, Convective Heat Transfer, Heat Pipe

### **INTRODUCTION**

Biomass is a renewable energy source because the energy that it contains comes from the sun. Through the process of photosynthesis, chlorophyll in plants captures the sun's energy by converting carbon dioxide from the air and water from the ground into carbohydrates, complex compounds composed of carbon, hydrogen, and oxygen. When these carbohydrates are burned, they turn back into carbon dioxide, a greenhouse gas and water and release the sun's energy they contain. The thermal production is transferred to the other material, i.e., the working fluid through the heat exchanger.

Plate heat exchanger (PHE) which is employed as evaporator and condenser, is widely used in many industrial applications, because its performance is comparatively higher among the existing various heat exchangers. Heat transfer performance of PHE is enhanced by using turbulence promoters in channel because of amplification of turbulence, while substantial increase in frictional pressure drop causes. Thus the plate surface patterns in PHE are required to promote heat transfer performance and simultaneously to suppress the frictional pressure drop. The thermal fluid exchanged by the heat exchanger is

efficiently transported to the other place through the channel etc.

Fluid including nanoparticles is referred to as nanofluid, which is a term proposed by Choi [1]. The term 'nanofluid' refers to a two-phase mixture with its continuous phase being generally a liquid and the dispersed phase constituted of 'nanoparticles' i.e., extremely fine metallic particles of size below 100 nm. In other words, the large surface-area-to-volume ratio also increases the stability of the suspensions. Thus, the nanofluid becomes a new promising heat transfer

fluid in a variety of application cases. For example, the thermal properties of such a nanofluid appear to be well above those of the base-fluid and particularly, the suspended nanoparticles remarkably increase the thermal conductivity of the mixture [2,3] and improve its capability of energy exchange.

In the preset study, the thermal production, i.e., high-temperature combustion gas from the biomass, its heat exchange to the working fluid, and higher efficiency thermal fluid transport are described.

## EXPERIMENTAL APPRATUS AND EXPERIMENTAL METHOD

### Combustor for Biomass:

In order to make the livestock wastes employ as a fuel, the corresponding moisture content is too high for combustion. Under the compost process, the livestock wastes are dried and its moisture content is reduced. In other words, the compost attenuates the moisture content of the livestock wastes, resulting in enhancement of combustion condition, i.e., heat release such as pulverized coal combustion. In this study, the moisture content of the livestock wastes that are produced in the real farm and its caloric value are measured. The water content meter (A&D MF50) and calorimeter (SHIMADZU CA-4AJ) are employed here. The fuels used in this study are made from solid wastes of pigs whose caloric value was about 2150 kcal/kg from the pre-experiment. The corresponding moisture contents are reduced to about 40% by the compost process. In this study, the moisture content of the fuels is adjusted from 10% to 40%.

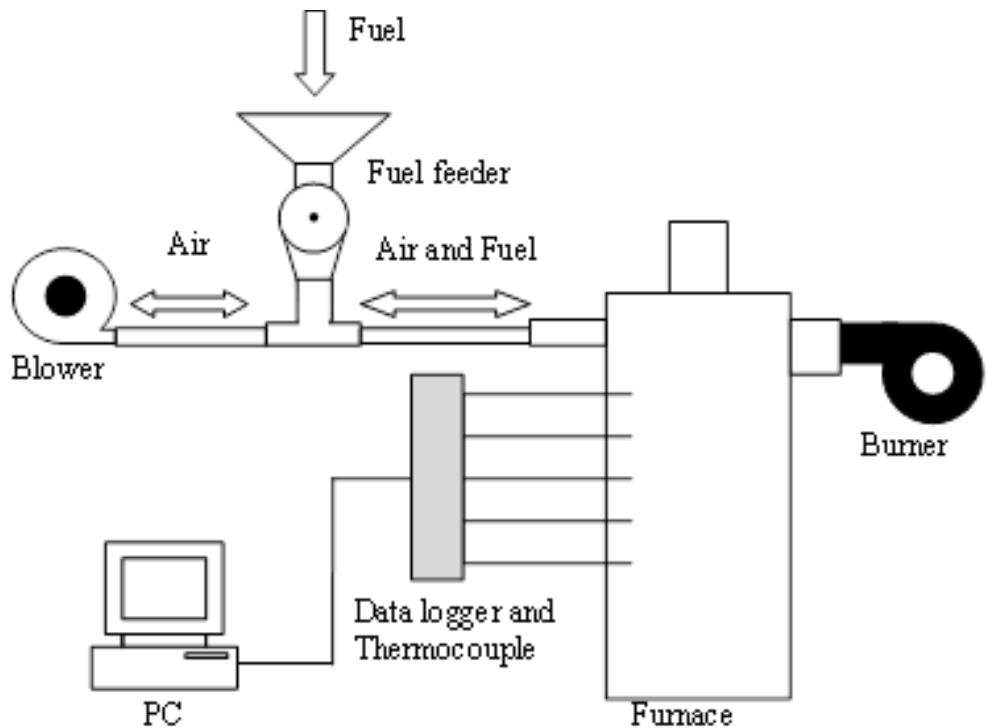
Figure 1 depicts the combustion system which consists of furnace, fuel feeder, burner, and blower. The combustor is preheated for 30 minutes by the burner. Here the pre-heating time is estimated by the pre-experiment. After 30 minutes, fuels, i.e., composts are injected into the combustor and at the same time, the burner is stopped. After that, the burner is used as the air-injection blower. Its air rate is 3.0 m<sup>3</sup>/min. Blower, fuel feeder and combustor are connected by the pipe. The fuels are fed by feeder and are transported to the inlet port located at

upper of the combustor. The fuel feeder can be adjusted feed rate from 1.0 kg/min to 4.0 kg/min by controlling the frequency of the current supplied to motor of the feeder. Here, the feed rate is fixed on the 2.5 kg/min. The air rate of the blower is fixed at the 3.3 m<sup>3</sup>/min. Thus, the total rate of the air by the blower and burner is 6.3 m<sup>3</sup>/s.

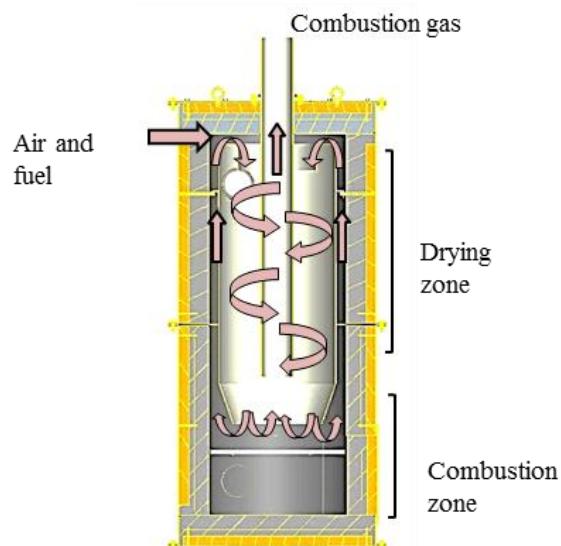
Figure 2 illustrates the structure of the combustor developed here. The fuel mixed with the air, a mixture of compost and air is injected to the upper inlet port of the combustor. The inlet pipe is fixed at the lateral face of the combustor and in the circumferential direction. Thus, the fuel-air mixing flow becomes spiral flow inside the combustor, resulting in amplification of combustion. This structure plays an important role in a fuel drying and an extension of combustion time of fuel. The swirling flow yields a sufficient floating time of the fuels and attenuates the deposition of unburned fuels at the bottom of the combustor. After the ash is separated from the combustion gas in the combustor like a cyclone separator, the high temperature combustion gas is ejected from the top port of the combustor and the ash is corroded in the bottom of the combustor. The combustion gas temperature inside the combustor is measured by the thermocouples whose tip is located at the center of the combustor. The corresponding gas analysis of the combustion gas, i.e., the gas components, i.e., H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO, CO<sub>2</sub> and N<sub>2</sub>O are analyzed with the aid of the gas chromatograph (SHIMADZU GC-8).

Emphasis is placed on the relationship between each flow rate (i.e., ratio of air to compost) and the production gas, particularly  $N_2O$ . Note that the experiment is carried out a few times at the same condition and all of the measured data are shown in figures. Thus the results at the

same condition are distributed due to the measurement uncertainty because of the measurement accuracy of the devices employed here. The overview of the energy production setup including the combustor and heat exchanger is depicted in Fig. 3.



*Figure 1. Combustion setup*



*Figure 2. Air and fuel flow in combustor*

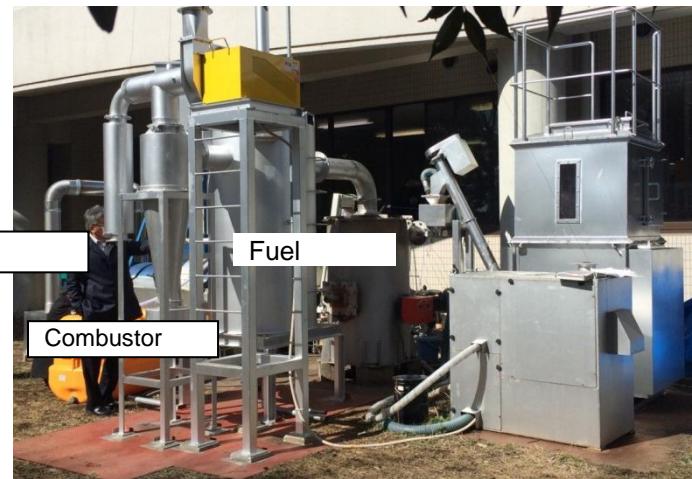


Figure 3. Overview of experimental setup

### OPTIMUM PLATE IN PLATE EXCHANGER:

Figure 4 depicts the experimental apparatus which consists of test section, hot water loop and cold water loop. Water is used as the working fluid in the single plate heat exchanger. Thermal energy of the hot water is transferred to that of the cold one through the titanium plate in the test section. Here hot and cold water is supplied by the independent loops, i.e.,

hot and cold water loops, respectively. The hot and cold water loops consist of a pump, a tank, three valves and a flow meter, respectively. The water tank in the hot water loop is heated by a pipe heater for adjusting the working fluid temperature, while the corresponding cold water loop is maintained at the constant temperature with the aid of the chillier-unit.

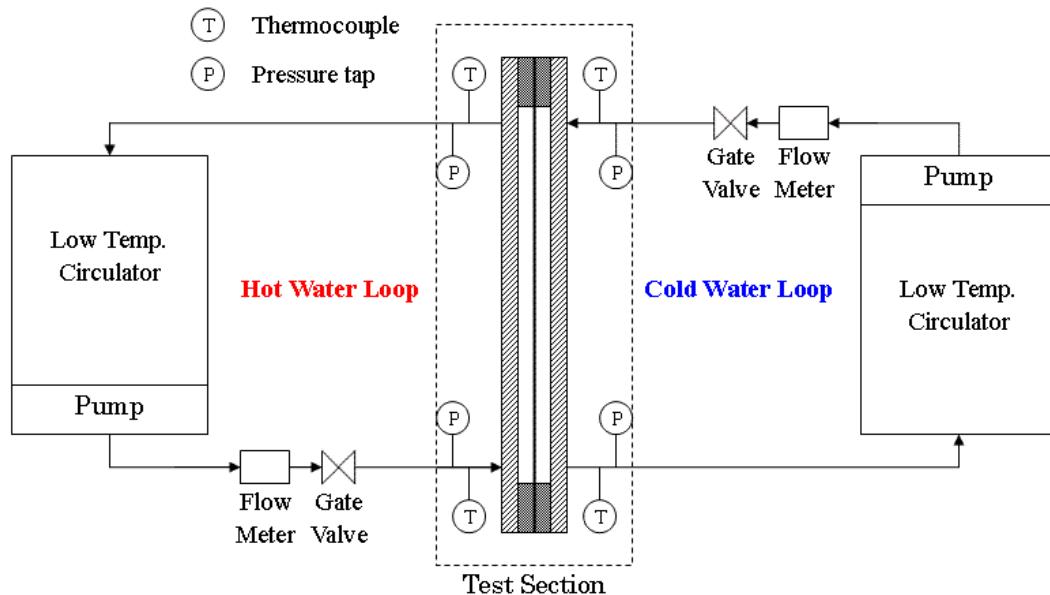


Figure 4. Experimental apparatus

The test section in Fig. 4 is sandwiched by two large side walls made of acrylic windows for illumination and observation. The downstream of cold water in one channel is heated by the upstream of hot water in the other channel. The test section is insulated to reduce heat losses. The test section including the inlet and outlet ports is 500

mm in length and 160 mm in width. The distance between the inlet port and outlet port centre is 360 mm and each connection port is 20 mm in diameter. The fluid temperature and pressure drop are measured at the test section inlet and outlet of each channel with the aid of K type thermocouples and pressure gauges, respectively. The overall heat transfer

coefficient and frictional pressure drop are estimated by measuring the water

## HEAT TRANSFER USING NANOFUID:

Figure 5 illustrates the experimental apparatus for measuring the convective heat transfer coefficient which consists of a closed flow loop, a heating unit, a cooling part, and a measuring and control unit. A straight stainless tube with 2000 mm in length, 3.96 mm in inner diameter, and 0.17 mm in thickness is employed as the test section and electrodes for the direct electric current heating are connected at both ends. The DC power supply (TOKYO SEIDEN CVS1-5K) is employed and its voltage is adjustable with the aid of the voltmeter (YOKOGAWA 2011) to control the heat flux at the pipe wall. The test tube is surrounded by a thick thermal insulation material to suppress heat loss from the test section. The twelve thermocouples (100 $\mu$ m in diameter), which are welded on the outer surface of the test tube, are used to measure the local wall temperature along the heated surface of the tube, and the other thermocouples are inserted into the flow at the inlet (Tin) and outlet (Tout) of the test section to measure the bulk temperature of a working fluid. Here, axial positions are 150 mm, 290 mm, 430 mm, 570 mm, 710 mm, 850mm, 990mm, 1130mm, 1410mm, 1690mm, 1730mm and 1870 mm from the inlet of the test section, whose locations are named as T1, T2, T3, T4, T5, T6, T7, T8, T9, T10 T11, and T12, respectively. The working fluid in the test loop is circulated by a magnet pump (IWAKI MD-100RM) and is measured by an electromagnetic flow meter (KYENCE FD-81SO). The inlet working fluid was maintained at Tin=293K and the corresponding value, Tout, of the outlet which depend on Reynolds number, volume fraction and heat flux, was less than 313K throughout all experiments. Notice that the test loop is cleaned up between runs even with the same nanofuid.

The thermal conductivities behavior of nanofuids with low particle concentrations

temperature, pressure drop and the water flow rate.

is studied experimentally. Test apparatus based on the transient hot-wire technique are designed and fabricated to measure the thermal conductivities of nanofuids. The transient hot-wire method is one of the important means for measuring thermal conductivity. It has been widely employed to measure thermal conductivity of nanofuids. Thus, the effective thermal conductivity of nanofuids is measured with the aid of a KD2 thermal property meter (Labcell Ltd, UK). Here the thermal conductivity of the nanofuids and base liquid (distilled water) are measured at 293 K. The KD2 meter is calibrated using distilled water before any set of measurements. The accuracy of the probe was carefully checked on pure water, and confirmed against literature values of the thermal conductivity.

The viscosity of nanofuids is measured with the use of a rotary viscometer (BROOKFIELD Co. DV-II+ProCP). The measurement is carried out at 293 K.

The volumetric fraction of 0.1 % is tested for graphene-oxide nanofuid in the present study, as shown in Fig. 6. Notice that nanofuid for higher volume fraction can not be developed due to the limitation of experimental facility. The Reynolds number is ranged from 3000 to 10000. An uncertainty analysis (Kline and McClintock [4]) yields the following results: the uncertainty in nanofuid flow rate is estimated to be  $\pm 1.5\%$ , the uncertainty in the physical properties is less than  $\pm 1\%$ , and the uncertainty in the temperature measurement is estimated to be  $\pm 1.5\%$ . The uncertainty of the measurements was within  $\pm 3\%$  under the conditions of this work. For reference, the nanofuid employed here is produced using grapheme-oxide nanosheets (1nm in thickness and 1 $\mu$ m in length, 1.02kg/m<sup>3</sup>, 3000W/mK).

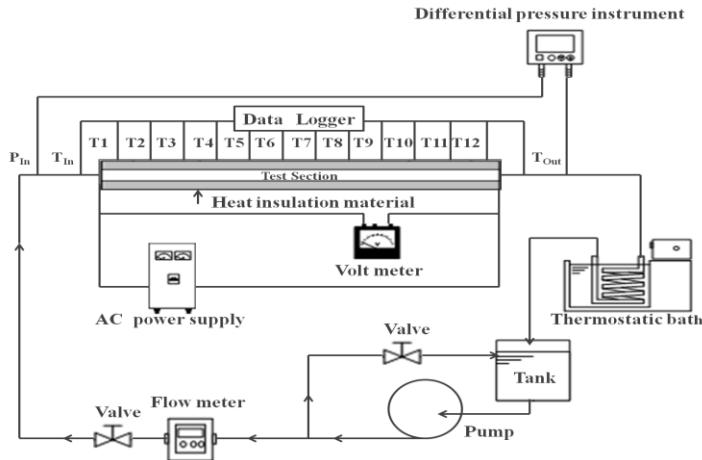
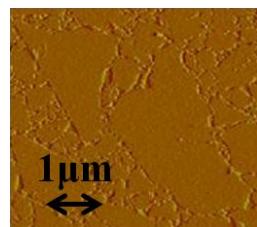


Figure 5. Experimental apparatus



(a) AFM image



(b) Graphene-oxide nanofluid

Figure 6. Photographs of graphene-oxide and its nanofluid.

## RESULTS AND DISCUSSION

### Thermal Production from Biomass

Combustion experiment was performed for the wide range of moisture content and air flow and fuel flow rates. And it was found that except the 40% moisture content case, the fuel was perfectly combusted and the combustion gas temperature was stable, while that of 40% was unstably combusted (not shown). One of the results is illustrated in the follows.

Figure 7, for 30% moisture content, depicts that the stable combustion is kept because the combustion gas temperature at each location in the combustor is maintained as the time progresses. Here, the locations of CH1-CH7 are depicted in the cross-section of the combustor. Note that the combustion gas temperature can be easily controlled by the airflow and fuel flow rates.

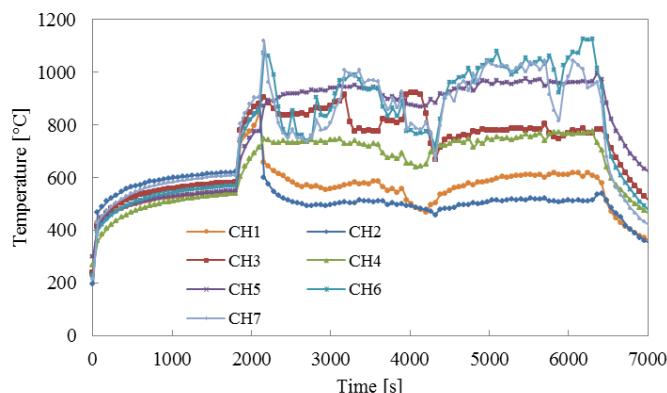


Figure 7. Time history of temperature in the combustor at 30% moisture content with a pulverized compost

The next task is to study the effect of the air-fuel flow ratio on the O<sub>2</sub> concentration and combustion gas temperature in the combustor. Figure 8 illustrates the relationship of the O<sub>2</sub> concentration and combustion gas temperature with the air-fuel ratio, as the parameter. It is found that the optimum condition of the air-fuel ratio is 3.6. This is

because the lower O<sub>2</sub> gas concentration yields by the perfect combustion in the combustor and the combustion gas temperature is kept in the vicinity of 800°C-1000°C whose temperature corresponds to the suppression of the ash-combined material production.

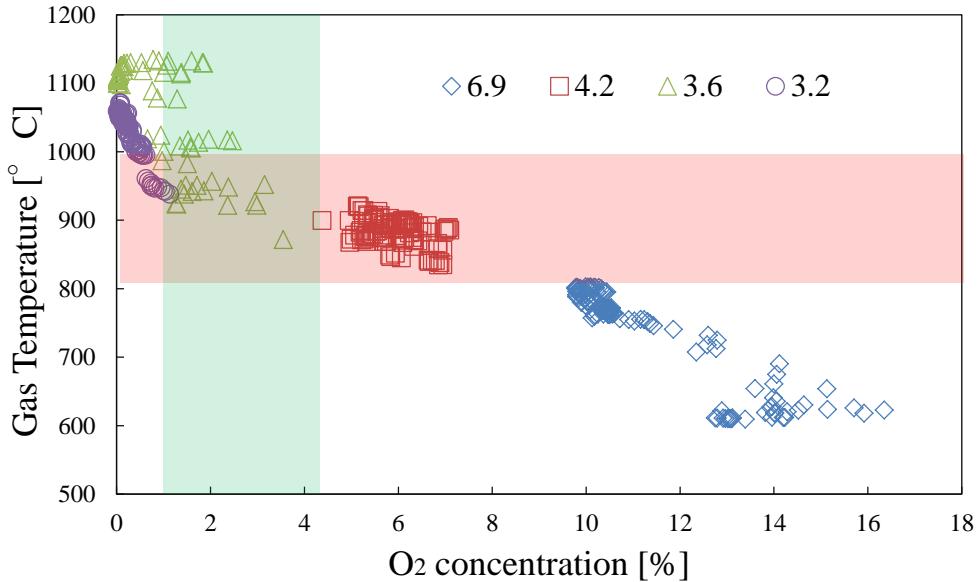


Figure 8. Effect of air-fuel ratio on O<sub>2</sub> concentration and combustion gas temperature in combustor

## OPTIMUM OF PLATE SHAPE IN PLATE EXCHANGER

Figure 9 depicts the overall heat transfer coefficient for different plate shapes. Here, “Separate herringbone (Block)” and “Plover Pattern (Block)” in figure imply that the angle of convex part is edge. The corresponding coefficients for the herringbone plate and separated herringbone plate are substantially higher than that for flat plate over the whole range of the volume flow rate considered here. This is because the flow is disturbed by the presence of the ribs constructed on the plate, resulting in enhancement of heat transfer performance. The corresponding frictional pressure drop is summarized in

Fig. 10. It is observed in Fig. 10 that substantial higher frictional pressure drop occurs on the herringbone plate in comparison with the other plates, particularly the separated herringbone plate. In other words, the friction pressure drop for the separated herringbone plate is lower and is almost the same as that for the flat plate. Note that the open space of middle line of the separated herringbone pattern causes the main fluid flow, resulting in an attenuation of the pressure drop, even if the hydrodynamic diameter is the same.

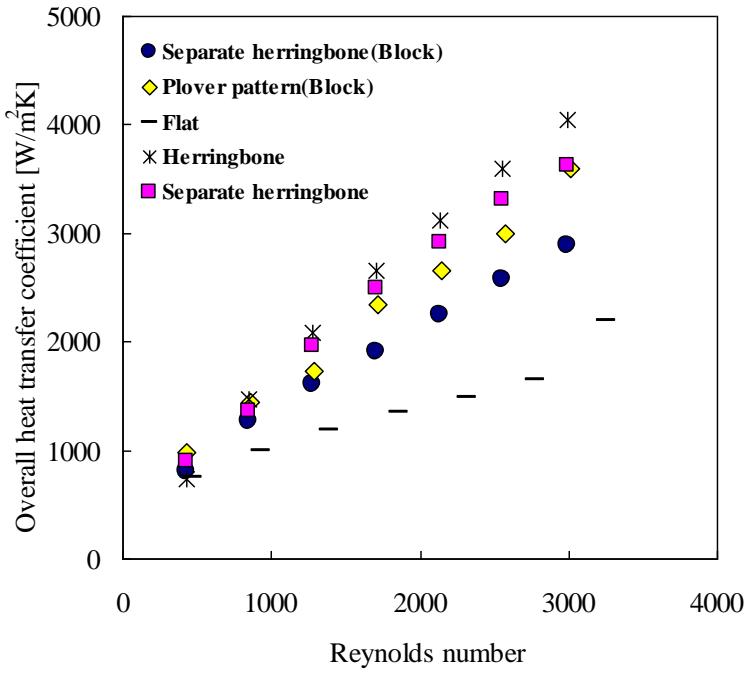


Figure 9. Overall heat transfer coefficient for different plates

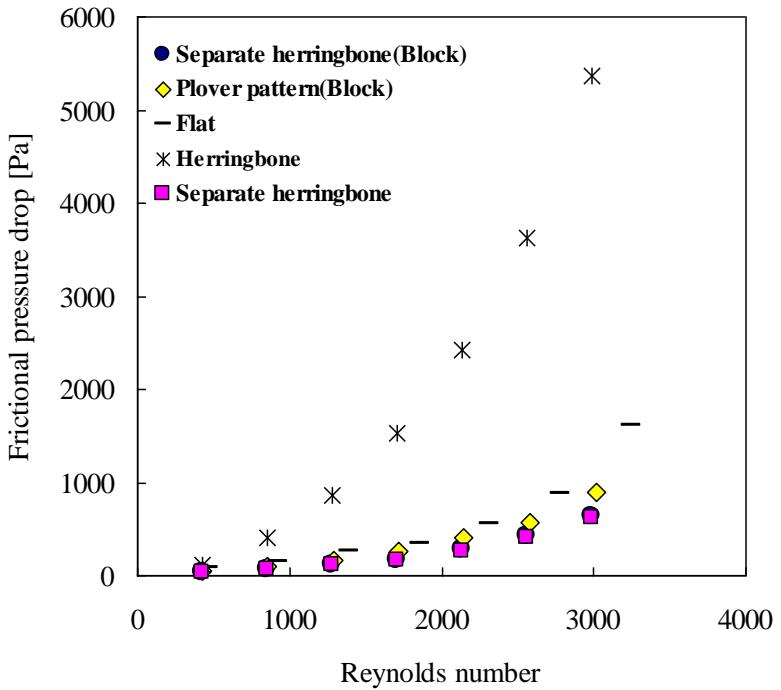


Figure 10. Friction pressure drop in narrow channel for different plates

## HEAT TRANSFER USING NANOFUID

The measured effective thermal conductivity  $k$  for grapheme-oxide nanofluid is illustrated in Fig. 11 in the form of volume fraction versus dimensionless thermal conductivity that  $k$  is divided by that of the base liquid (water),  $k_o$ . One observes that the thermal conductivity at the same volume

fraction is slightly low or high in comparison with that of CuO-nanofluid and  $\text{Al}_2\text{O}_3$ -nanofluid [5]. Although Yu et al. [6] reported that graphene oxide is a good additive to enhance the thermal conductivity of the base fluid, the corresponding value of the grapheme-

oxide nonofluid developed here is not

substantially high.

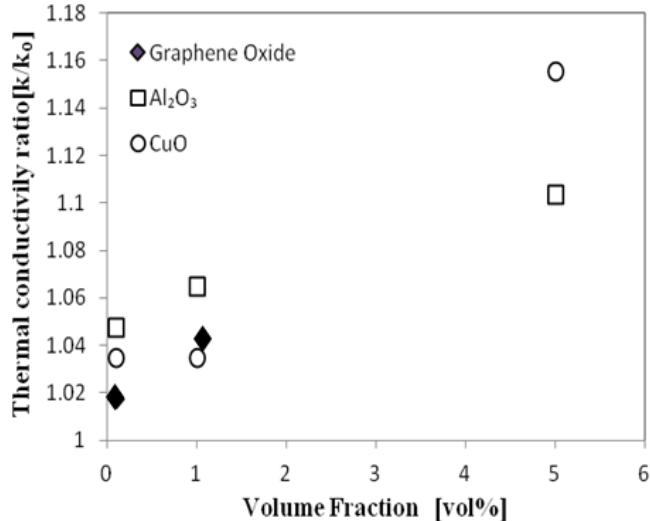


Figure 11. Measured thermal conductivity of nanofluid.

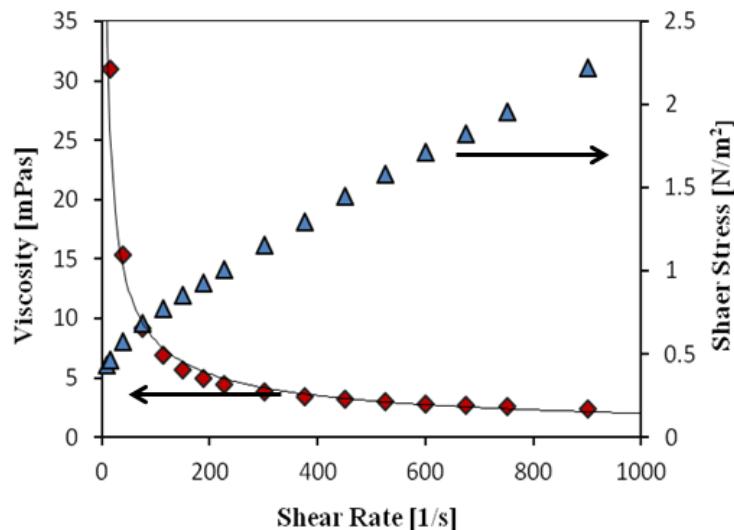


Figure 12. Viscosity of graphene-oxide nanofluid.

The viscosity for 0.1vol% is illustrated in Fig. 12 in the form of shear stress or viscosity versus shear rate. One observes that the measured viscosities of nanofluid are different for each shear rate, that is the viscosity of nanofluid decreases with an increase in the shear rate, particularly in the lower shear rate region. Thus, it is postulated that the nanofluid of graphene-oxide nanofluid is non-Newtonian fluid. For reference, the viscosity of nanofluids including CuO or Al<sub>2</sub>O<sub>3</sub> are Newtonian fluid and increases with an increase in the particle concentration, and this trend is different for different nanoparticles [5].

The pressure loss in the test section is illustrated in Fig. 13 in the form of pressure drop versus flow rate at 0.1% of volume fraction. For reference, the corresponding data of different nanofluids [5] are superimposed in Fig. 13. Each line in figure is predicted by  $\Delta p = \frac{1}{2} \rho U^2 / D$ . The pressure loss of the nanofluids is slightly suppressed compared with that of the pure water, because an increase in the friction loss is caused by suspension of nanoparticles in the pure fluid. Note that no substantial discrepancy for pressure loss appears in three different nanofluids.

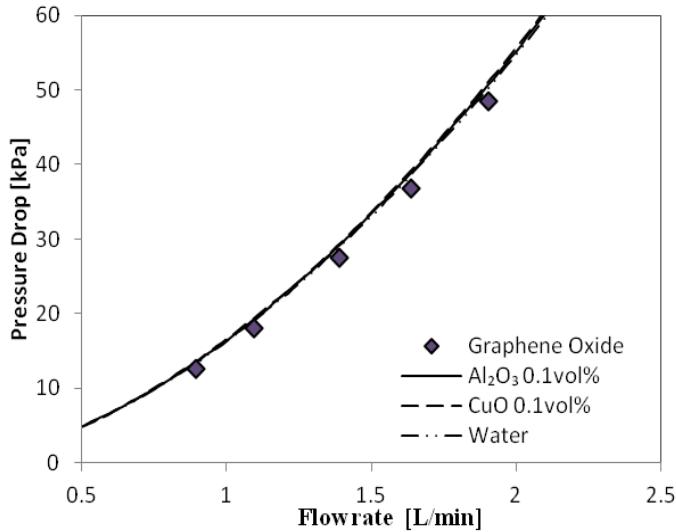


Figure 13. Pressure drop for different nanofluids at 0.1 vol%.

Figure 14 depicts the relationship between Nusselt number Nu and Reynolds number Re with volume fraction as the parameter. The corresponding data of CuO and Al<sub>2</sub>O<sub>3</sub> are superimposed for comparison [5]. Here the heat transfer coefficient at

x/D=200, which corresponds to the hydrodynamically and thermally fully-developed region based on the pre-experimental result, is employed to obtain the Nusselt number.

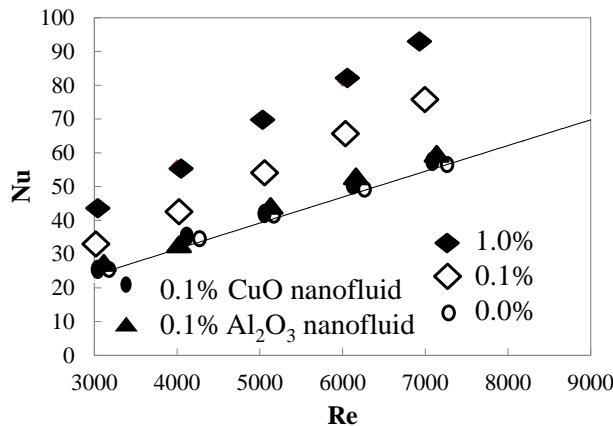


Figure 14. Heat transfer performance for different volume fractions of nanofluid

For reference, the following Gnielinski equation [7] in the turbulent flow is superimposed as a solid line:

$$Nu = \frac{(f/8)(Re - 1000)Pr}{1.07 + 12.7\sqrt{f/8}(Pr^{2/3} - 1)} , \quad (1)$$

where

$$f = [1.82\log_{10}(Re) - 1.64]^{-2} \quad (2)$$

One observes that the Nusselt numbers for each nanofluid are slightly higher than that for pure water. And heat transfer

performance becomes larger in the higher Reynolds number region, as expected. Thus since the volume fraction of nanoparticle is substantially low, heat transfer enhancement is slightly attributed due to the suspension of nanoparticles. In contrast, substantial heat transfer enhancement yields for graphene-oxide nanofluid. Throughout the experimental results, heat transfer enhancement is caused by the suspension of particles and its trend becomes larger for graphene-oxide nanofluid. In general, the particle volume fraction in the centerline of the pipe

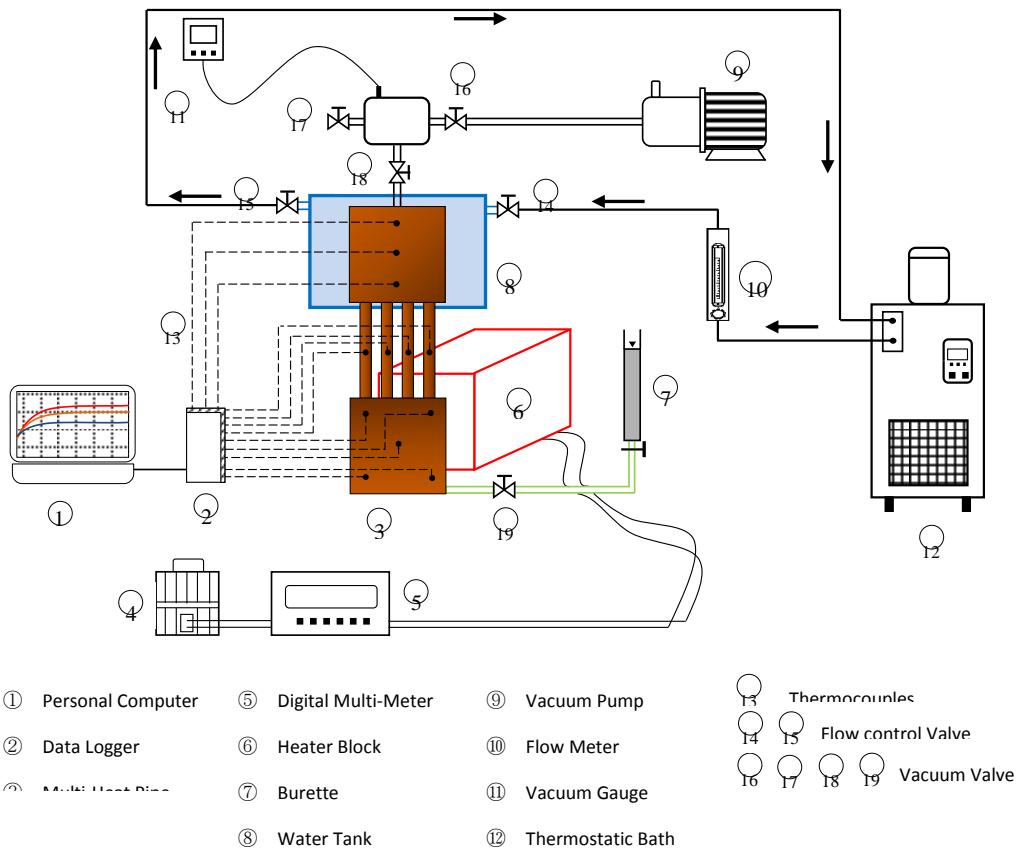
increases and leads to the increasing of the viscosity and as a consequence of the viscosity increase near the centerline, resulting in flat velocity profile. This trend becomes larger, because for the nanofluid including graphene oxide nanosheets (1nm in thickness and 10m in length) the corresponding central velocity in the pipe is suppressed due to its flat sheet in comparison with that nanofluids for CuO

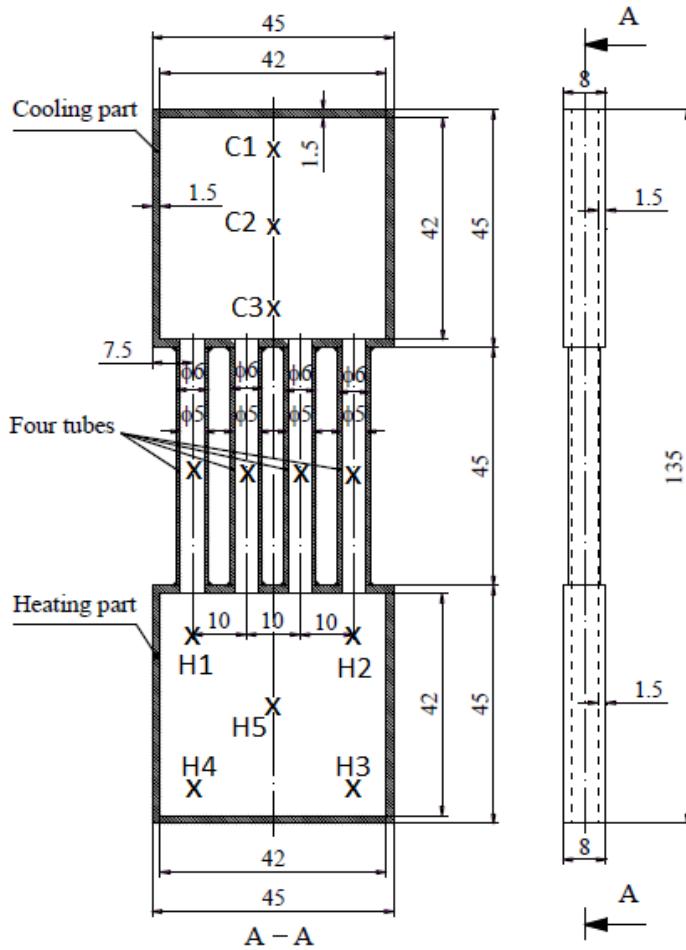
and Al<sub>2</sub>O<sub>3</sub>. At the same time, the substantial velocity gradient is induced in the vicinity of the heated wall. It is postulated that the particle, i.e., nanosheet suspension induces the velocity gradient near the heated wall, resulting in enhancement of heat transfer performance for lower volume fraction of grapheme-oxide nanofluid.

## APPLICATION USING NANOFUID

The experiments are carried out by using four various filling ratios (40%, 60%, 80% and 100%) with multi-heat pipe kept in vertical position (the evaporator section

at the bottom and condenser section at the top). The corresponding experimental apparatus and multi-heat pipe are illustrated in Fig. 15.





(b) Multi-heat pipe

Figure 15. Experimental setup

The experimental setup consists of a test section (multi-heat pipe) which connected with burette (NALJENE, USA) to calculate the amount of working fluid that filled the heat pipe. Vacuum pump (ULVAC KIKO, Japan) was connected with vacuum gauge to generate vacuum pressure inside the heat pipe. The evaporator section was electrically heated by heater block (HAKKO, Japan) made from cooper containing five heaters (five heaters are not shown in the figure) which connected with transformer (YAMABISHI, Japan) and its voltage and power were measured by digital multi-meter (HIOKI, Japan). The condenser section was cooled by immersing it into the plastic cooling chamber and water was used as the coolant fluid which pumped from the thermostatic bath (NCC-1100, Japan). The

cooling water flow rate was measured by flow meter ((KOFLOC, Japan)). Both evaporator and adiabatic sections were thermally insulated with glass fiber to prevent heat loss. The surface temperatures of the heat pipe were measured using twelve k-type thermocouples (Fig. 15(a)).

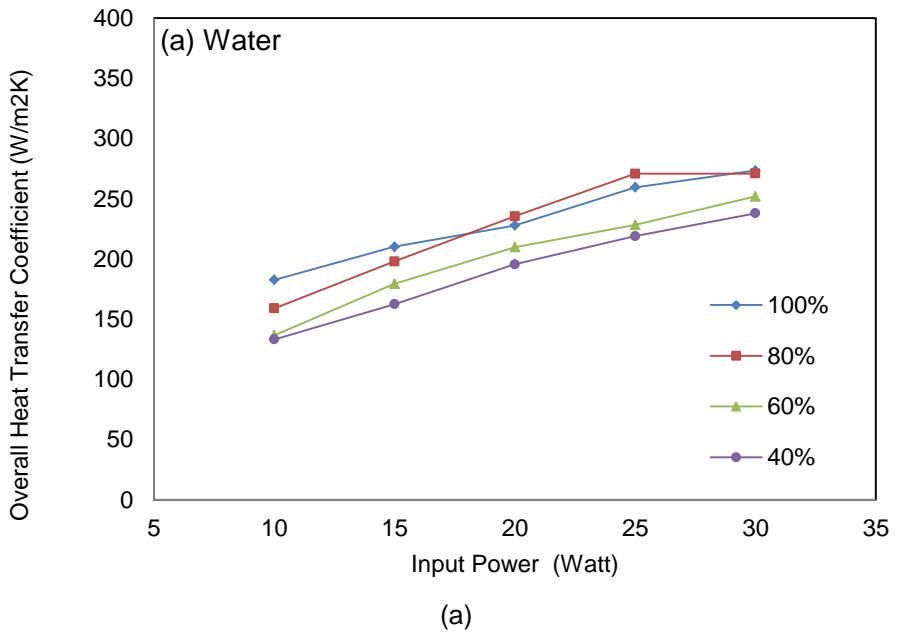
Heat pipe with pure water as working fluid used in the comparison of results to understand the effects of volume concentration of GO/water nanofluids on the heat pipe thermal performance with different filling charge ratios and input heat power

The overall heat transfer coefficient of the heat pipe calculated using the surface temperature of evaporator and condenser section using Eq. (3).

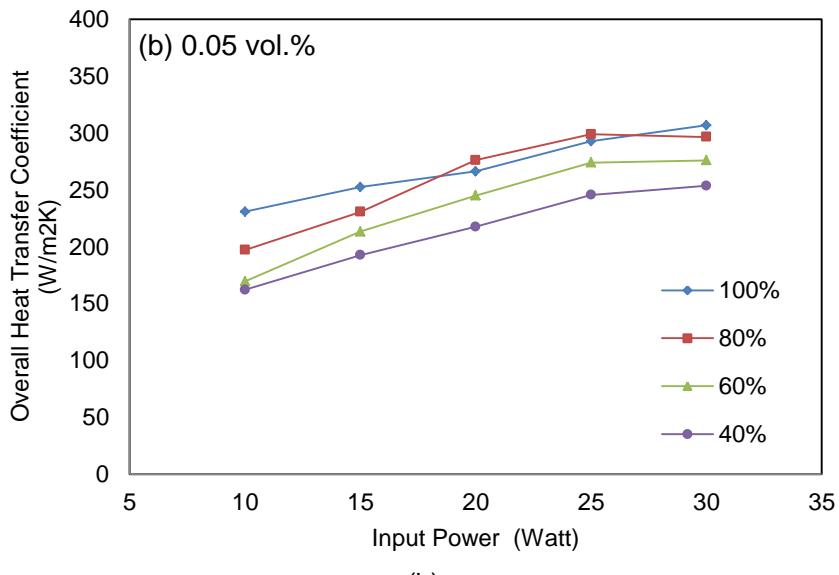
$$h = \frac{Q}{A_e (T_H - T_C)} \quad (3)$$

Figure 16 shows the overall heat transfer coefficient against the heat load for all the filling charge ratios and the volume concentrations. For GO/water nanofluid, a higher heat transfer coefficient is registered for all volumetric concentrations of nanoparticles in comparison with those reported for pure water at a similar condition. The GO nanoparticles in the heat pipe not only increased the fluid thermal conductivity but also enhanced the heat transfer coefficient due to the particles migration. It is clear from Fig.16 that the increase of the heat load intensifies the heat transfer coefficient of the heat pipe for each filling ratio. Results demonstrate that the heat transfer

coefficient of heat pipe drastically increases with increasing the filling charge ratio at the same input heat fluxes, because the temperature difference between the evaporator and condenser section decreases with increasing the filling charge ratio. The optimum heat transfer coefficient was obtained at 100% filling ratio for 0.15 vol.% and 0.2 vol.% and at 80% for 0.1% volume concentration. For pure water and 0.05 vol.%, the heat transfer coefficient increases with the rise of filling ratio till 15W input heat load. Beyond 15W, the maximum heat transfer coefficient was obtained at 80% filling ratio.



(a)



(b)

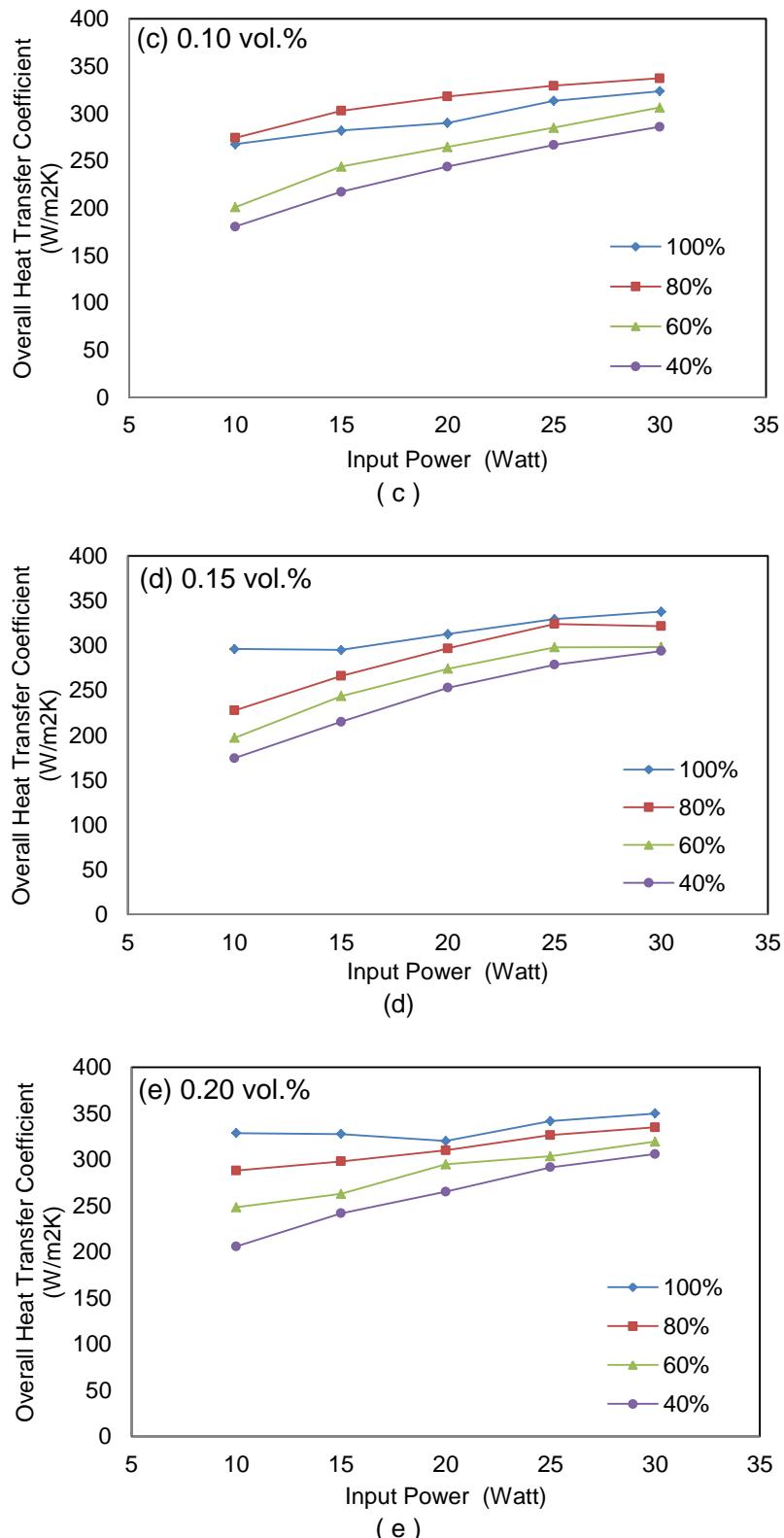


Figure 16. Overall heat transfer coefficient as a function of input heat load and filling ratio

## SUMMARY

The thermal production from the biomass, the heat exchange of its production to the working fluid, and higher efficiency thermal fluid transport have

been introduced. The results are summarized as follows:

- (a) Moisture content, compost can be combusted as a fuel and the

- combustion gas temperature is controlled by air-fuel ratio.
- (b) Overall heat transfer coefficient for herringbone plate is higher than the other of plate shapes employed here. The corresponding frictional pressure drop is substantially high. On the contrary, an amplification of frictional pressure drop is suppressed for the separate herringbone plate.
  - (c) Heat transfer performance in the circular tube flow is amplified by
  - (e) t.
- suspension of nanoparticles in comparison with that of the working fluid.
- (d) The heat transfer performance of a multi-heat pipe is apparently improved after the addition of GO nanoparticles in the working fluid. The overall heat transfer coefficient depends greatly on the filling ratio, and the lower filling ratio (40%) yields smaller heat transfer coefficient

## REFERENCES

- [1] Choi, S. U. S., 1995, "Enhancing thermal conductivity of fluids with nanoparticles," in Developments Applications of Non-Newtonian Flows, FED-vol. 231/MD-vol. 66, ASME: 99-105, edited by D. A. Siginer and H. P. Wang. New York.
- [2] Khanafer, K., Vafai, K., and Lightstone, M., 2003, "Buoyancy-driven heat transfer enhancement in a two-dimensional enclosure utilizing nanofluid," International Journal of Heat and Mass Transfer, **46**, pp. 3639-3653.
- [3] Lee, S., Choi, S. U. S., Li, S. and Eastman, J. A., 1999, "Measuring thermal conductivity of fluids containing oxide nanoparticles," Journal of Heat Transfer, **121**, pp. 280-289.
- [4] Kline, S. J., and McClintock, F.A., 1953, Mechanical Engineering, **3**.
- [5] Torii, S., 2010, "Turbulent heat transfer behavior of nanofluid in a circular tube heated under constant heat flux," Advances in Mechanical Engineering, ID 917612, pp.1-7.
- [6] Yu, W., Xie, H.Q., Bao, D., 2010, "Enhanced thermal conductivities of nanofluids containing graphene oxide nanosheets," Nanotechnology, **21**, 055705.
- [7] Gnielinski, V., 1976, "New equations for heat and mass transfer in turbulent pipe and channel flow," International Chemical Engineering, **16**, pp. 359-368.

## **ANALYSIS OF KEYWORD EXTRACTION METHODS FOR CYRILLIC SCRIPT TEXT DOCUMENT**

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### **ABSTRACT**

*To introduced our experimental approach to automatic keyword extraction based on NLP (word suffixes analysis) and Word Statistical Information. Keyword extraction are extracted in a new way derived from a combination of NLP methods, statistical method, WF-IWF and TF-IDF. NLP method are used with Cyrillic Mongolian word inflexion and stop words according to patterns. Statistical methods are keyword extraction methods from single and many documents are useful in WF-IWF, TF-IDF.*

*And we analyze the different methods for keyword extraction and the impact of each frequent term. We also define a framework for statistical keyword extraction. Evaluation of system performance is used in three datasets. Each article contains manually assigned keywords which are used for keyword evaluation.*

*The results of these experiments showed the ability of the NLP method to be applied on the Cyrillic Mongolian documents.*

**KEYWORDS:** Word Analysis Cyrillic Mongolian language; Keyword extraction; Natural language processing; Word structure

### **1 INTRODUCTION**

The amount of information is rapidly increasing in many different languages [1] and documents in Cyrillic Mongolian language are part of this growth Therefore there is an increasing need for the retrieval, filtering and data mining of Cyrillic Mongolian documents through the local network.

Current studies proposed different methods to extract keywords such as term cooccurrence, term frequency-inverse document frequency (TF-IDF), term weighted and vector space model, lexical chains, k-Nearest Neighbor (kNN) algorithm and others methods. But some

of these techniques are not applied to Cyrillic Mongolian texts.

This study we aims to build an Cyrillic Mongolian language keyword extractor based on word frequency, word statistical information and NLP (inflexion method) methods. To create new document using word stem transforming word terms based on method of Natural Language Processing. Then selecting the keywords which high value of word weight (TF-IDF, WF-IWF) and applying some rules that are appropriate for Cyrillic Mongolian language.

The remaining sections this study is structured as follows: section 2 presents feature of Cyrillic Mongolian language; section 3 presents the scope of the study and the adopted methodology; section 4

## 2 METHODOLOGY OF RESEARCH

The overall steps that make up the methodology of this study. Including: text preprocessing phase, keyword extraction

### 2.1 Text Preprocessing

In the text preprocessing phase the system prepare the document for the next three phases. In this phase: documents will be partitioned into sentences and word, frequent words that do not have any

### 2.2 Formating Document and to extracting one word Sentences

The first step in the text preprocessing phase is phrase extraction from Cyrillic Mongolian language documents which include one or more paragraph, each of which contains a set of sentences that have a particular meaning or benefits to the whole document.

Full stop, question and exclamation marks like “.”, “?”, “!” and whitespace “ ”

### 2.3 Stop Words Removal

This step deals with the elimination of non-meaningful words, which does not indicate the semantic content of the document such as: connectives, subordinate connectives, or appearing frequently in the document like pronouns such as: prowords, pre-positional particles, demonstrative rewords, interrogative rewords

These words may have a bad effect to the Study approach which depends on

### 2.4 Creating new document parsing word stem

Word of Cyrillic Mongolian Language can be connected with one stem and one or more suffixes.

(1) Lexicon: In the research working, we used word stem of noun, adjectives, verb and substantivized words. Currently, lexicon included 70159 word stem and noun word stem 30756, word stem 13799, uninflected words 2061, others words 2353.

presents the conducted experiments with evaluation methods, their results and interpretations. Conclusion and possible future work are presented in section 5.

phase, and keyword selection. Fig 5 shows the overall algoritm that make up the methodology of this study.

chance to be a candidate keyword are removed and we proposed create new text document parsing word term in sentence settlement using method of inflexion of NLP.

### 2.5 Statistical Information and Word Frequency

are used to understand the structure of the text document.. ie, sequence of words that ends with the dot (.), question (?), exclamation (!) are considered as a sentence. Whitespace “ ” are used to understand the words of the text document.

statistical information and word frequency of the words [7].

Also, foreign words, numbers and symbols like (“№”, \$, %, +, -, \*) and some words that indicates a sequence of the sentences like are also recognized as stop words.

A list of 2061 stop words is used to complete this step. After removing all these types of stop words we got pure sentences. Next, created new text document.

(2) Affix: Affix is called terms based on terms' feature or relationship. We are considering that Cyrillic Mongolian has total 84 terms such as plurals, case, possessive, negative, mood, connectors, related connectors so on.

We have collected total 1500 terms foundation parsing words terms of experimented text document in frame of the thesis.

## 2.5 Algorithm for parsing word formation

To show how to transform algorithm for parsing word formation into mood according to word structure in fig 1.

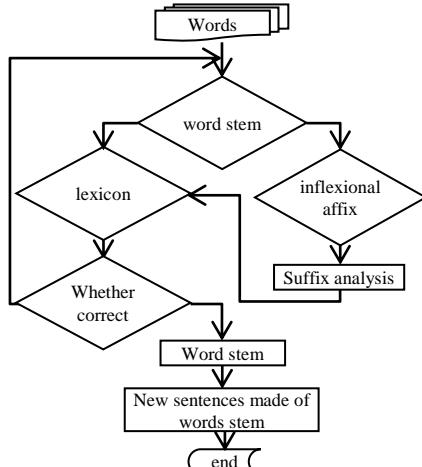


Figure 1. Word structure analysis algorithm

The process will be repeated cutting term formation from word endings until word stem. The algorithm will have four steps. Including:

**Input: word**

## 2.6 Keywords Extraction

In this phase the system extraction keywords from the preprocessed Cyrillic Mongolian language sentences. We extraction pure words with meaningful

### 2.6.1 Selection of Frequent Words

In this step the system obtain the frequent terms by counting term frequency of each unique word that forms the entire training document. Our system selects the top 10 frequent terms denoted as the set of the frequent terms  $T$ , and 30% of the number of the running terms  $N$  total. As an example, Table 1: Frequency and Probability Distribution of the top 10

**Step I.** Given word cannot be changed or word stem in the vocabulary.

**Step II.** Given word can be form of adding term on the stem. There is used vocabulary for adding terms on the stem.

**Step III.** If given word is connected with two or more terms, it will transfer into 2<sup>nd</sup> step parsing final term of the word. Form of term should be recovered during such parsing of the terms.

**Step IV.** Word stem will be parsing (as foundation of morph tactic).

**Output:** there will become sentences sourced from word stems.

words of sentences the system extract candidate keywords. This phase consist of the following steps.

Cyrillic Mongolian language Frequent Words in a first documents. Table 2: Frequency and Probability Distribution of the top 10 Cyrillic Mongolian language Frequent Words used in a new documents. After, frequency and probability calculated using WF-IWF and TF-IDF methods.

Table 1.

Frequency and probability distribution of the top 10 Cyrillic Mongolian language frequent words in a first documents

Frequent words	Education	Tour	Travel	Organizations	Person	Region	Method	Certain	Official	Body	Total
Frequency	470	349	237	223	153	147	140	134	132	121	2106
Probability	0.223	0.166	0.113	0.106	0.073	0.070	0.066	0.064	0.063	0.057	1

Table 2.

Frequency and probability distribution of the top 10 Cyrillic Mongolian language frequent words in new documents

Frequent words	Education	Tour	Travel	Organizations	Person	Region	Method	Body	Certain	Official	Total
Frequency	744	352	337	360	352	215	155	148	139	133	2935
Probability	0.254	0.120	0.115	0.123	0.120	0.072	0.053	0.047	0.047	0.045	1

After preprocessing of NLP in table 1-2, the word repeat and measure of the probability have been increased changing order of 10 words with the highest repeat. The document will be positive indication

for keywords extraction. Frequent differences of the stem and the terms for 10 words with the highest frequent was showed in table 3.

Table 3.

Difference of frequency and probability distribution of the top 10  
Cyrillic Mongolian language frequent words in a first documents and new documents

Frequent Words (word stem)	Zero form	Case suffix and suffix frequent																				
		+ын,	+ийн	+ыг, +ийг	+ынх	+аа, +оо, +зээ	+д	+аас,	+ы, +ий	+асаа	+тай,	+тэй,	+уудийг	+уудэд	+уудын,	+уудийн	+уудаар,	+еэр	+гүй	+уудаас	+дээ	+нээ
Education	200	470	54	2	3	7								8								
Tour	349		3																			
Travel	18	238	78											3								
Organizations	104	223												23	6	1						
Person	155		19											4	14							
Region	147	34	3											23								
Region	140													1								
Body	121	5	1	2	6									4								
Certain	135																					
Official	132													1								
Total words	1501	973	15	5	4	14	80	10	5	14	1	14	4	2	2	1	8	7	2	4	3	2935

## 2.6.2 Computing TF-IDF method the weight of specific word detected in a multiple documents

TF-IDF (term frequency-inverse document frequency) is a numerical statistic that is intended to reflect how important a word is to a document in a collection or corpus. TF-IDF is often used as a weighting factor in information retrieval and text mining [8]. In the case of the term frequency TF (Term Frequency) the simplest choice is to use the raw frequency of a term in a document. When word is detected from similar text document, it detects more detail in difference of other text documents [9]. Inverse Document Frequency detects few words no contains in text documents. Special words among text document can be expressed their main feature which was showed in following equation:

## 2.6.3 Computing WF-IWF method the weight of specific word detected in a one document

The other method that the system will use to extract the candidate keywords is the novel WF-IWF which depends on the WF (Word Frequency) and IWF (Inverse Word Frequency) [10]. This measure is derived from TF-IDF. The only difference is that TF-IDF is used in the corpus while WF-IWF is used in a single document.

$$TF_{ij} = \frac{n_{i,j}}{\sum_k n_{k,j}}$$

the number of term  $n_{ij}$  occurs in document  $d_j$ , the sum of all the word detected in document  $d_j$ .

Inverse document frequency is measure of universal quality of one word. It can be counted as following equation:

$$IDF_i = \log \frac{|D|}{|\{j : t_i \in d_j\}|}$$

Where:  $|D|$  is the total number of words in,  $|\{j : t_i \in d_j\}|$  is contains the text number of word  $t_i$  - in the document, (This is text number  $n_{i,j} \neq 0$ ).

Extraction of keywords will be extracted according to the following equation:

$$WF - IWF_{(t)} = F_t * \log(\frac{f_d}{f_t})$$

Where:  $f_t$  is the total frequency of word  $t$  in the document.  $f_d$  is the total number of words in the document. Words

with highest WF-IWF values are

#### 2.6.4 Keywords Selections

Most of the keywords are extraction noun and words of five or eight words. Also in exclusive cases of the keywords are not single word, where can be detected compound words of two or three words. In Cyrillic Mongolian language documents the sequence of words is helps

considered candidate words for extraction.

to understand the in sentences content. Cyrillic Mongolian language documents the sequence of words is ruled by the grammar which helps to understand the meaning of the words according to their position in different sentences.

### 3. EVALUATION AND EXPERIMENTS

In this section experiments have been conducted, and an overall evaluation of the proposed system is presented. The

#### 3.1 Evaluation Methods

Many different measures for evaluating the performance of keyword extraction systems have been proposed. The performance of the extractor system is measured by comparing the generated keywords by the system for each document with the extracted suggested keywords by an expert. The performance measure is based on the number of matches between the system generated keywords and the human generated keywords [11,12]. Measure the following parameters:

(1) Precision: Precision is the fraction of keywords extracted by the system that are made by the human, and given by the following equation:

$$Pre = \frac{|SU|}{|Sys|}$$

(2) Recall: Recall is the fraction of keywords made by the human that are extracted by the system, and given by the following equation [11]:

$$Re = \frac{|SU|}{|User|}$$

#### 3.2 Evaluation Datasets

Three datasets are used to evaluate the proposed system. This sets are consists of three types of documents. Such as: large documents, medium documents and small documents. Each group consists of 3 large, 38 medium, and 3 small Cyrillic Mongolian documents collected from Electron learning Materials of Mongolian universities. The collected

system's overall performance is evaluated in words of precision and recall.

(3) F-measure: The above two measures clearly trade off against each other; therefore  $F_\beta$ -measure can be used to measure the trade off of precision versus recall as follows:

$$F_\beta = \frac{2 * (Precision * Recall)}{(Precision + Recall)}$$

Calculated use the precision and recall to measure the system performance results. Let Sys be the set of keywords extracted by the system, User the set of keywords extracted by the human, SU the intersection set between these two sets (Sys & User) that shows the number of correct keywords extracted by the system.

The accuracy measure will be used to measure the accuracy of the system to extract keywords, which are concepts in specific domain. The accuracy is defined as the percentage of correctly extracted keywords, and given by the following equation [12,13].

$$Accuracy = \frac{CT}{N}$$

Where: CT is the total number of corrected terms extracted by the system that match concepts in the thesaurus, N is the total number of terms extracted by the system.

documents may be tourism regional planning, educational studies and management, where a number of keywords are assigned manually to each of the collected documents. These documents are used to test the effectiveness of the proposed system to extract proper and significant keywords. Table 4. shows the overall statistics

information of the test on the first documents of collected documents.

The statistics information of the test on the first documents of collected documents

Documents Type	Number s of Sentenc es	Numb ers of Words	Averag e of Words	Averag e of Senten ces.
Large documents	2380	40218	6.213	16.898
Medium documents	2717	48561	6.32	17.9
Small documents	706	4008	5.677	5.459
Totals	5803	92787	6.07	13419

In the text preprocessing step we proposed novel method are inflexion of NLP used created new documents. Such as this step deals with the elimination of non-meaningful words, which does not indicate the semantic content of the document such as: connectives, subordinate connectives, appearing frequently in the document like pronouns

is prowords, pre-positional particles, demonstrative prowords and interrogative prowords. Also, foreign words, numbers and symbols and some words that indicates a sequence of the sentences are also recognized as stop words. After removing all these types of stop words we got pure sentences. Next, created new documents.

The statistics information of the test on the preprocessing next new documents of collected documents

Documents Type	Number s of Sentenc es	Numb ers of Words	Averag e of Words	Averag e of Senten ces.
Large documents	2192	31293	6.96	14.276
Medium documents	2493	36230	7.09	14.5
Small documents	545	2636	6.951	4.836
Totals	5230	70159	7.000	11.204

Statistic information of first documents of databases in table 4 was compared with statistic information of new documents after preprocessing of NLP. The new system extracts total sentences numbers, words numbers, words average and sentences average comparison rate. This work we applied sentence reduction methods. As a result of the experiment, number of sentence decreased until 188, number of word decreased until 8925, and middle measure of sentence decreased by 2.622% or middle sentence was middle measure of 14.276%. In small documents, number of sentence decreased until 224,

count of word decreased until 12338, and middle measure of sentence decreased by 3.4% or sentence was middle measure of 14.5%. These indications will be positive influence for extraction accurately keywords. In middle measure of word in text document of all experiments, large document is 6.96% and small document is 6.95%. This indication is same with the result of the research working [2-Ts. Baatarkhuu 2006, p.55] that was confirmed on 5-6 letters for middle measure of word in Cyrillic Mongolian Language of previous research working. Also such "human or 'xyH'", "action or

‘үйл”, “more or ‘их” and “to be (am, is, are) or ‘болж” words are being used mainly

### 3.3 Evaluation Results

In the chapter, we made the experiment for keywords extraction from first text document of database according to traditional method. The first experiment

in types of the information.

was conducted on the first documents, where evaluated the results for the TF-IDF and WF-IWF methods are shown in table 6.

The Performance of the TF-IDF and WF-IWF method on the first documents of collected documents

Documents Type	Pre	Re	F
Large documents	0.500	0.667	0.571
Medium documents	0.458	0.611	0.524
Small documents	0.533	0.667	0.593
Average	0.497	0.648	0.563

Table 6 shows the performance of the TF-IDF and WF-IWF methods on the first documents. Results showed that the Small document set achieved the highest F-measure with a value of 0.593, followed by the Medium document set with an F-measure value of 0.524 and followed by the large document set with an F-measure value of 0.571.

Then we formulated document of first database using method for transforming words of preprocessing of NLP. Also we made the experiment for keywords extraction from new text document using previous two methods. Table 7 showed results.

The Performance of the TF-IDF and WF-IWF method on the new documents of collected documents

Documents Type	Pre	Re	F
Large documents	0.583	0.778	0.667
Medium documents	0.542	0.722	0.619
Small documents	0.733	0.917	0.815
Average	0.619	0.806	0.700

Table 9 shows the performance of the TF-IDF and WF-IWF methods on the new documents.. Results showed that the Small document set achieved the highest F-measure with a value of 0.815 changed at 0.22 percent, followed by the Medium document set with an F-measure value of 0.619 changed at 0.09 percent and followed by the large document set with an F-measure value of 0.667 changed at 0.15 percent.

Sometimes the length of the document plays an important role in the performance of the extractor method. Therefore, fig 2 show a comparison between the two variants sets in the large documents, in the medium documents and in the small documents. Also respectively to give us indication about how these methods deals with variant document lengths.

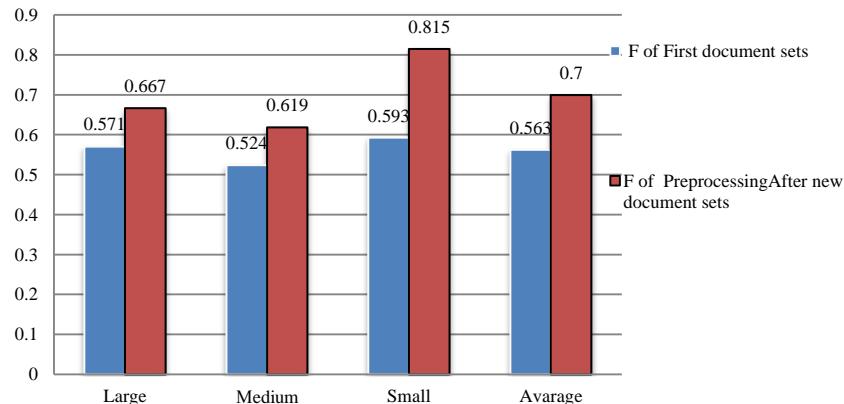


Figure 2. Results comparison of two variants in the first documents and in the new documents

The above figure show that the preprocessing after new document sets performed better than first document sets when dealing with large documents, the highest value was for Recall with a value of about 0.815. Also the value of preprocessing after new document sets was better than the value first document sets within medium documents yields 0.619 Recall and preprocessing after new document sets was better than the value first document sets within large documents yields 0.667 Recall. The results obtained from this experiment show the ability of the system using the TF-IDF and WF-IWF

methods to extract keywords that are concepts in three documents. Fig 3 shows the accuracy of the two variants to capture important concepts within local database. The new documents variant probability better results than first document variant. The new documens variant probability 78% accuracy while the first document variant probability 59% accuracy. This percentage gives us a good indication about the capability of the system to capture important concepts from a set of Cyrillic Mongolian language documents that belongs to local database.

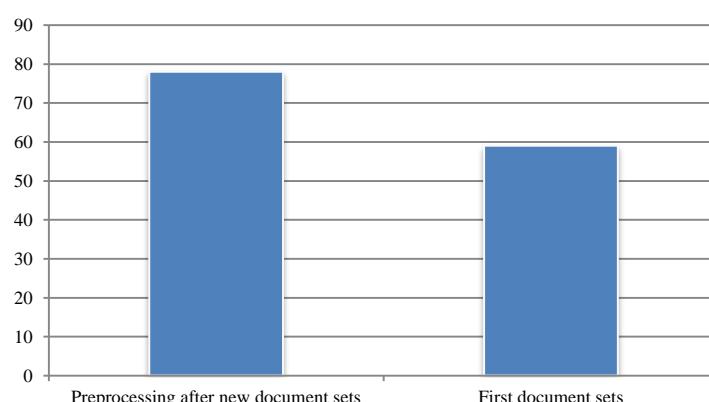


Figure 3. Test results of accuracy in the new documens variant and first documens variant  
The experiments results give a positive indication about the ability of the system to extract significant keywords from Cyrillic Mongolian language documents.

#### 4 CONCLUSIONS

This Study proposed an automated Cyrillic Mongolian language keyword extractor using the knowledge of the NLP and a novel WF-IWF measures.

The system can extract Cyrillic Mongolian language keywords simply from

a single document without the need for a corpus.

Also, the proposed system is very useful for extracting keywords that is related to a local database as demonstrated in table 9 as well as the system is also useful for extracting

keywords that are database independent. The TF-IDF болон WF-IWF methods is used to show the importance of the word by computing the degree of correlation between the word and the top frequent words, and the novel WF-IWF method is effective in showing how the word is more important than other words in the overall document.

Precision, recall and F-measure are used to judge both TF-IDF and WF-IWF methods, and the results show that the preprocessing after of NLP method is better than first documents when dealing with small, medium and large documents. The Precision, Recall and F-measure for the overall performance were 0.667, 0.619 and 0.815 respectively..

Also, the two documents (first documents and new documents) showed their ability to extract keywords that are concepts in the database that the

documents belong to. The new documents variant was better than first documents variant with 78% accuracy.

The experimental results show the ability of the system to extract significant keywords from the Cyrillic Mongolian language documents and the ability of the NLP method to extract important words that have high frequency. Both the NLP, TF-IDF and WF-IWF methods yield acceptable results for Arabic text keyword extraction..

As a future work, some techniques to implement to enhance the ability of the system to extract significant words. Also, an improvement to this technique can be done by taking the position of the words into accounts, as known the words that appear in the introduction and conclusion or appear in the titles and subtitles may have a higher value than other words.

## REFERENCES

- [1] Yang W. Chinese Keyword Extraction Based on Max-Duplicated strings of the documents [C]. Proceedings of the 25th annual international ACM SIGIR conference on Research and development in information retrieval, Tampere, Finland, 2002, ISBN1-58113-561-0, 439-440.
- [2] Nasan-Urt S. Some theory or practical issues for learning approach in Mongolian language [M]. Ulaanbaatar, 2004.
- [3] Byambadorj D. Form studies of Mongolian Language [M]. Ulaanbaatar, printing house of Pedagogy University, 2006.
- [4] Luvsanvandan Sh. Modern Mongolian Structure Words and terms of Mongolian language [M]. Ulaanbaatar, Sanaa and Tunaa LLC, 1999.
- [5] Altangerel K. Tsend G, Jalsan K E, N-gram Analysis of a Mongolian Text [J]. IFOST proceedings, Tomsk 2008.
- [6] Nyandag Bat-Erdene, Li Ru. Developing an Tree-levels, Two-tier Diagnostic Assessment Dynamic System for Improving Distance Learning Result [C]. International Conference on Global Science and Technology Convergence, The 6th Conference of MUSTAK-2015, 19-20 August, 2015, Ulaanbaatar, Mongolia, pp 185-189.
- [7] Khuder A, Ganbat Ts. Classify words in text of Mongolian language by unigram [J]. Research paper of Mongolian University of Science and Technology, 2011, 2/118, pp. 271-275,
- [8] Khuder A. Classify words of text by method of computer linguistics [C]. in the bulletin of conference for the 25th anniversary of Mongolian University of Science and Technology, Ulaanbaatar, 2009.
- [9] Alesh M. Using Arabic [J]. Cambridge University Press, UK, 2005, ISBN: 0521648327,
- [10] K Sparck Jones. A statistical interpretation of term specificity and its application in retrieval [J]. Journal of Documentation, 1972, 28 (1).
- [11] Berger A, et al. Bridging the Lexical Chasm: Statistical Approaches to Answer Finding [C]. In Proc. Int. Conf. Research and Development in Information Retrieval, 2000, 192-199.
- [12] Liu W, Li W. To Determine The Weight in a Weighted Sum Method for Domain-Specific Keyword Extraction [C]. International Conference on Computer Engineering and Technology, Singapore, 2009, ISBN 978-1-4244-3334-6, 11-15.

- [13] Mohammed Al-Kabi et al. Keyword Extraction Based on Word Co-Occurrence Statistical Information for Arabic Text [J]. ABHATH AL-YARMOUK: Basic Sci. & Eng. 2013, Vol. 22, No. 1, pp. 75- 95.
- [14] Turney P. Extraction of Keyphrases from Text: Evaluation of Four Algorithms [J]. Technical Report ERB-1051, National Research Council, Institute for Information Technology, Canada, 1997.
- [15] Manning C, Raghavan P, Schütze H. Introduction to Information Retrieval [M]. First Edition, ISBN 0521865719, Cambridge University Press, UK, 2008.
- [16] Nyandag Bat-Erdene. Research of distance learning based Cloud platform [J]. Mongolian Academy of Agricultural Sciences (MAAS), Mongolian Journal of Agricultural Sciences, Volume 14, Issue 01, UB, 2015, pp 192-202. ISSN: 2310-6212.

## **ANALYSING ISSUES TO IMPROVE EQUIPMENT SERVICE AND MAINTENANCE SYSTEM IN AGRICULTURAL SECTOR**

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### **ABSTRACT**

*Within the framework of this study, some issues, need to be determined, was discussed as studying the technical service system in Mongolian agricultural industry.*

*More than 60 percent of the enterprises involved in this study have no shelters and closed facilities to store their equipment and machineries and 30 percent of them have no mobile fuel charging equipment. However dealer companies such as Gatsuurt, Wagner Asia ASIA EQUIPMENT and MSM, which supply agricultural equipment and machineries, offer many types of services but there is no planning program or database. In order to establish a complex technical service system, it is necessary to develop relevant information databases and planning and control programs as cooperating with the dealer companies, further it is needed to extend a collaborative research to develop information networks.*

**KEYWORDS:** Service center for equipment users, dealer's branch, service shop of the manufacturers

### **INTRODUCTION**

Well-equipped, fully functional, high-accuracy and compound new equipment and machineries are more being developed in larger production sections of the agricultural industry. In this context, the mission of the engineers and technicians is to seek ways to improve the management of utilization of new equipment and its service and maintenance system, and try to find ways to use them effectively.

As for agricultural engineers and mechanics, technical service and maintenances are main concern. Because

some risks such as capacity loss of equipment, increase of operating cost and use of technically non-reliable equipment have been still existed due to lack of service and maintenance system, insufficient spare parts, and poor quality of service and repairs.

Having imperfect management and service and maintenance technology for equipment and poor quality of the service makes negative impacts on the economy of the enterprises. However it is possible to save on technical maintenance costs and

improve the quality. To do this, we need to study the current status of the activity and to make and analysis. As of 2016, we have used over 30 types of tractors with power of 60 hp to 510 hp which are manufactured by 10 major brands in the world such as John Deere, Case, New Holland, Belarus, as well as over 10 types of crop harvesting combine with 5m (155m.x, 3m cubic) to 9.1m (439m.x., 11 m cubic) cutter bars, which manufactured in 8 countries, including Russia , China Branch of John Deere, USA and Finland, and about 10 types and models of weeders

manufactured in 4-5 different countries such as Russia, Canada and 6-7 types of seeders (pneumatic seeders 10, 12, 15, 18 m) each respectively.

Also there are 8891 tractors and 1234 combines nationwide, among them Selenge province which is main agricultural region, owns 1052 tractors and 517 crop harvesting combines. In addition, there are 5833 tractors up to 25 horsepower nationwide and 375 of them are in Selenge province. The number and power of the tractors are shown in Figure 1.

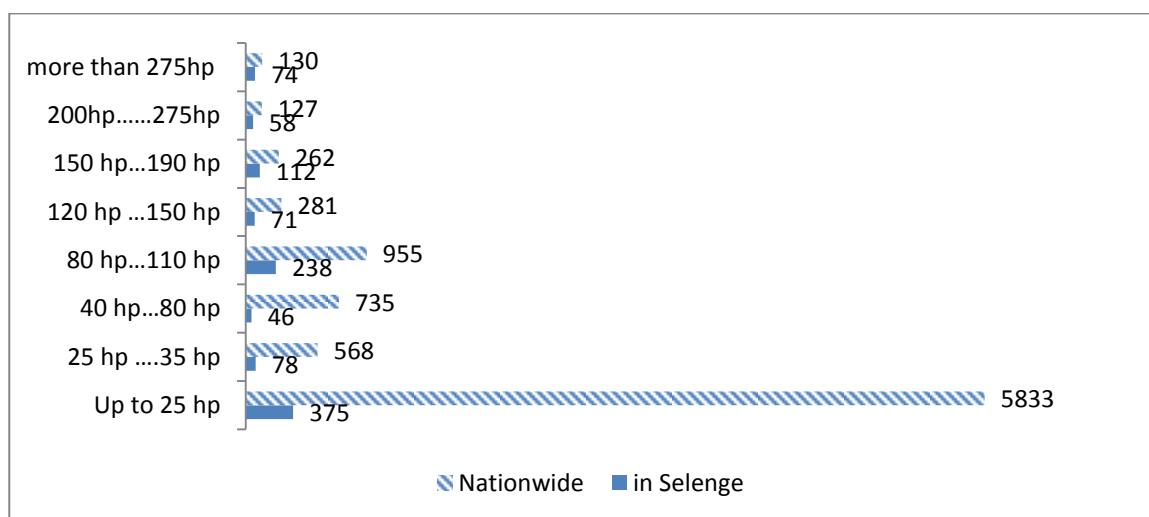


Figure 1. Number of the tractors (in power)

In addition, as of January 2015, Gatsuurt Company has supplied 5 types of 381 agricultural equipment to 5 different

enterprises. Quantities and capacities of the equipment are shown in Table 1.

Table 1.

Types, quantities and capacities of the equipment supplied by Gatsuurt

No	Equipment type	Capacity and quantity
1	Tractor	154 of 21 modifications with power of 65hp-510 hp (tractors with power more than 120 hp for 200000 hectares)
2	Crop harvesting combine	155 combines of 7 modifications (75000-80000 hectares) 13 Grimme combines (650-700 hectares)
3	Pneumatic seeder	22 seeders with capacity for 10m-18m area (35000-40000 hectares)
4	Ploughing machine or weeder	17 ploughing machines with capacity for 10-18 meters of area (70000-80000 hectares )
5	Spraying machine	20 machines with capacity for 24 meters of area (100000 hectares)

## RESEARCH TOOLS AND METHODS

Under the research, service and maintenance environment of the enterprises and material environment of the

dealer companies are studied comparatively with each other using experimental research methodology to

recognize the reality of the situation, to create theoretical assumptions and to distinguish the reality of the current situation in order to identify the service and maintenance system of the agricultural equipment.

As of 2016, we cultivated 505281.93 hectares of land, and the Selenge aimag has the largest cultivated area of 182482.26 hectares. The size of the planted area is shown in aimags by Figure 2.

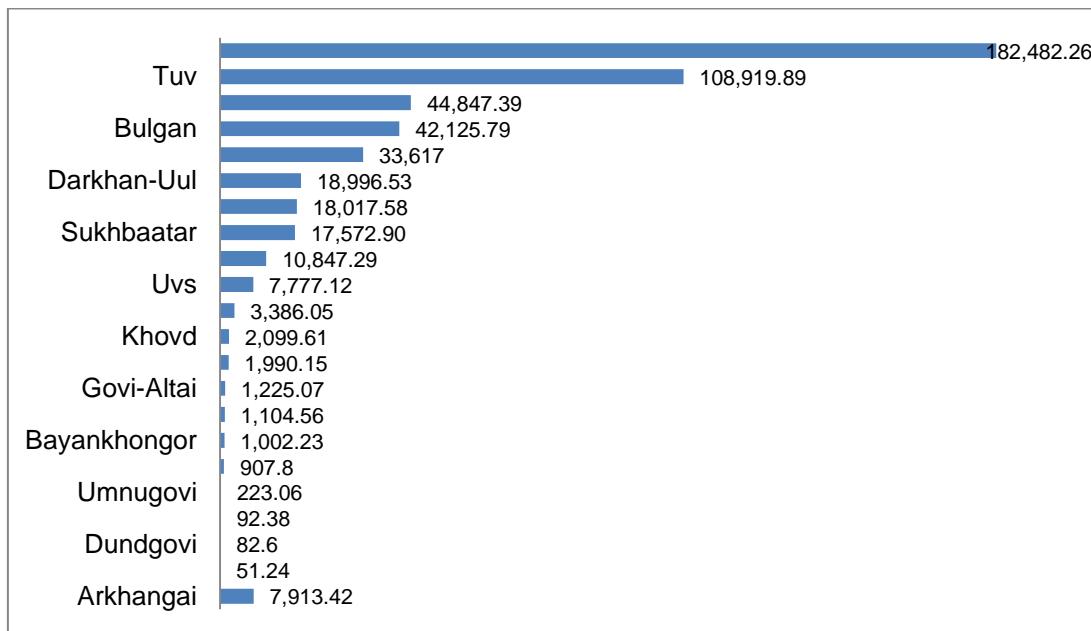


Figure 2. Planted area, hectares (in province)

Therefore, we have studied the service and maintenance system of the equipment for the largest agricultural companies in Selenge and Bulgan

provinces such as "Khutag Undur" (Photo 1), Gatsuurt "(Photo 2),"Urgatsiin khishig" (Photo 3), "InToSa" (Photo 4).



Outside of the facility

Photo 1. Facility used as a purpose for equipment storehouse, service and maintenance shop, "Khutag Undur" LLC in Altanbulag soum, Selenge province



Inside of the facility Crane capacity is 5 tons  
Photo 2. Facility used as a purpose for equipment storehouse, service and maintenance shop, "Khutag Undur" LLC in Altanbulag soum, Selenge province



Service and maintainence shop

Large size of weather haven to store equipment and machineries

Photo 2 . "Gatsuurt" LLC in Tsagaannuur soum, Selenge province



Weather haven with wooden structure supports for equipment and machinery storehouse



Service and maintenance shop made of container

Photo 3. "Urgatsiin khishig" in Tsagaannuur soum, Selenge province



Facility for storing equipment and machineries



Photo 4. "InToSa" LLC in Selenge soum, Bulgan province

## OUTCOMES OF THE RESEARCH

As seen as of the above, it is considered that there 3 types of environment of the current service and maintenance system for the agricultural equipment of the enterprises (see Figure 1.).

These include:

1. Service and maintenance shop of equipment users: This type of service center usually runs activities like small technical service, maintenance, storage, and fuel supply. This type of service is equipped with welding apparatus, lifting equipment, stands, pneumatic hammer, battery charger, and drilling and lathe base machines. Table 3 shows the type and quantities of equipment for enterprises' service and maintenance center.
2. Dealers branch (factory): This type of service center has not yet been established in Mongolia.

3. Factory repair shop: for example: "Service center" of Gatsuurt" LLC located in Ulaanbaatar. This service center has well equipped shops to make services like free maintenance during the after sale warranty period (2 years warranty), spare parts orders, sale of new equipment, washing and diagnostics, maintenance, welding, lathe etc. and there 3 mobile service equipment to make field services. There are 20 service and maintenance equipment and machineries in nationwide. For example, Mercedes Benz, "Unimog" service machinery of ANMAC MGL LLC, Toyota service machinery of "Agro motors" starter company which is responsible for the diagnostic and maintenance services of "InToSa" LLC, under subscription of Mongolian University of Life Sciences.

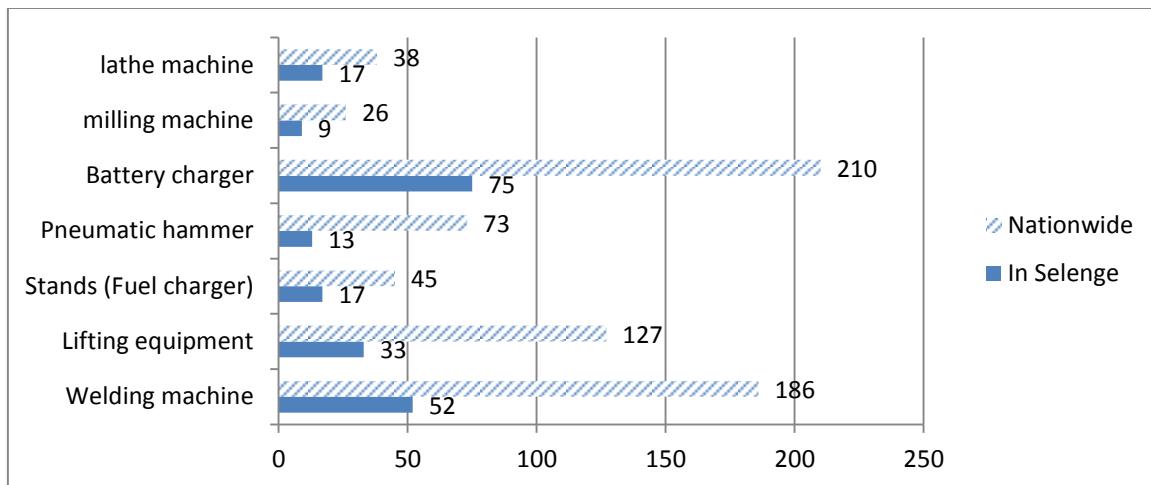
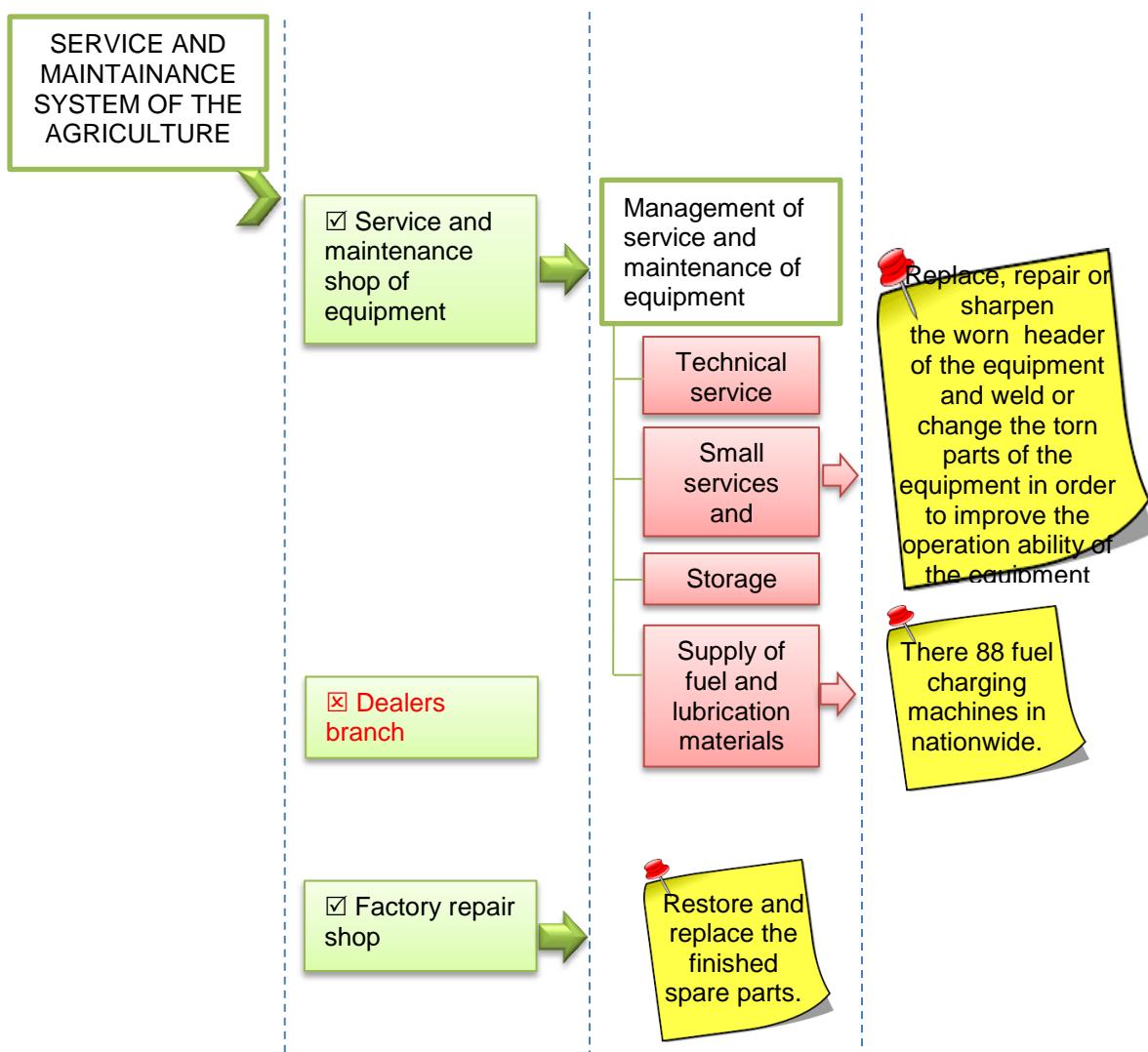


Figure 3. Types and quantities of the service and maintenance equipment of the enterprises (in pieces)



Graph 1. Service and maintenance system of the Agricultural industry

## **CONCLUSION**

1. Most of the equipment user companies have small and medium-sized repair and service shops, but more than 60 percent of the companies involved in the research have no closed facilities to store their high priced equipment and machineries, and over 30 percent of them don't equipped with fuel charging mobile devices.
2. Agricultural equipment supplying dealers such as Gatsuurt LLC, Wagner Asia-ASIA EQUIPMENT and MSM are providing more services such as repair and maintenance equipment, providing services such as warranty period service, supply of spare parts, aggregate repair and operator training etch through their well-equipped facilities and service centers.
3. There is no software or database in dealer companies supplying agricultural equipment and machineries for recording the equipment sale, supply of spare parts, service and maintenance plan.
4. In order to establish a comprehensive service and maintenance service system for agricultural equipment, it is necessary to expand collaborative research in developing the associated database and planning and monitoring software and further in creating information network with the cooperation of equipment dealer companies.

## **REFERENCES**

<http://mofa.gov.mn/exp/blog/12/25>

[http://www.1212.mn/Stat.aspx?LIST\\_ID=976\\_L10\\_2&type=tables](http://www.1212.mn/Stat.aspx?LIST_ID=976_L10_2&type=tables)