Ministry
of Foreign Affairs
Republic of Poland

Catalogue of technologies
developed by
Polish Research Institutes

MATERIAL AND CHEMICAL TECHNOLOGIES, MATERIAL SCIENCE, CHEMICAL AND PROCESS ENGINEERING

FERTILIZER RESEARCH INSTITUTE

(Instytut Nawzów Sztucznych)

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Instytut Nawozów Sztucznych (Fertilizer Research Institute) seated in Puławy, Poland is a state research institute with a long lasting tradition. Its beginnings as Research Laboratory at United Factories of Nitrogen Compounds date back to 1935. The name was changed into the present one in 1958.

INS is one of the best Polish research institutes. It enjoys a good reputation and INS trade mark is well known in Poland and abroad.

The principal aim of the Institute is work for chemical industry, mainly its fertilizer and inorganic branches, which leads to making innovations and higher competitiveness of companies operating in chemistry and chemical technology areas. INS carries out research and development work in close partnership with industry employing high qualified staff and maintaining latest standards applying to research methods and procedures. It cooperates with all nitrogen works in Poland and many ones abroad. It has the unique advantage of carrying research works in pilot plants and directly on industrial plants.

In the last 10 years INS signed over 100 local contracts and 65 export ones for sale of technologies, licences and products to 15 countries in Europe and Asia.

Work for administration and local authorities (tasks defined in the regulation concerning fertilizers and fertilization, REACH and CLP regulations, preparation of expert opinions etc.) are an important Institute activity field.

By constant development of the investigation potential, scientific and technical staff, infrastructure and research equipment the Institute is going to become a leader initiating innovatory actions competitive on the local, European and world markets in the area of chemical technology and connected branches such as chemical engineering, safety, and waste management.

THE SCOPE OF ACTIVITY:

Research and development works including:

- mineral fertilizers including liquid and suspended ones,
- feed additives,
- chemical inorganic products – ammonia, nitric acid, urea,
- catalysts, sorbents, catalyst supports,
- plant extracts (hop extracts and others),
- selected organic products – methanol, formaldehyde melamine,
- selected plastics processing – trioxane, dioxolane,
- chemical technology and chemical engineering,
- environmental protection including wasteless processes of technological streams, purification and influence of organic and mineral fertilizers on agricultural production, impact of mineral fertilizers on natural environment, analysis of potential sources of pollution and contamination caused by fertilizers, sewage and smoke.

Experimental production:

- mineral fertilizers (micro-element concentrates INSOL®; NP, PK, NPK suspension fertilizers),
- catalysts, sorbents, catalyst support, ceramic balls,
- hop extract,
- plant extracts,
- formalin (reagent grade),
- research apparatus – gradientless reactors.

COOPERATION OFFER

1. Technologies:

1) REVAMPING OF CO_2 REMOVAL SYSTEM (BENFIELD/CARSOL UNIT) FROM AMMONIA SYNTHESIS GAS

A unit for carbon dioxide removal from synthesis gas is one of the most energy-consuming parts of ammonia production plant and it is also "bottle-neck" limiting production capacity of the whole plant. That is why modernization of the unit is a key issue at modernization of the ammonia plant.

Revamping is carried-out by an in-built system of boiler-flash tank-ejector in CO_2 removal unit. Semi lean solution of potassium carbonate is directed from the regenerator to the flash tank where adiabatic steam evaporation takes place due to pressure reduction. Steam generated in the flash tank is pressurized by the ejector and is directed to the bottom part of the regenerator. Driving steam for the ejector is generated in an additional boiler which uses heat of process gas. Application of the new system allows to optimize heat utilization for solution regeneration and it increases production capacity and reduces energy consumption.

Process characteristics:

- Process for revamping of CO_2 purification units based on Benfield/Carsol technology;
- Heat recovery of hot solution after regeneration results in:
  - increased production capacity of ammonia plants by 15-20%;
  - reduction of heat consumption after regeneration from 1200 to 880 kcal/1000 Nm^3 CO_2;
  - reduced natural gas consumption by approx. 25 Nm^3/t NH_3.

INS offer includes a license, know-how, basic design and detailed engineering, supervision during erection and start-up as well as a delivery of key-equipment, piping, and control system.

2) IMPROVEMENT OF CARBON DIOXIDE PURITY IN BENFIELD/CARSOL UNIT

Purity of carbon dioxide from Benfield/Carsol unit does not exceed 98.5%. It also contains substantial amounts of such impurities as methanol and flammable gases which creates explosion hazard of hydrogen/oxygen mixture.

Saturated solution of potassium carbonate containing approx. 0.7-0.8 vol. % hydrogen and other syngas components, flows through a separator after leaving an absorber. A separator where flammable gases are released and separated before the solution enter regenerator, is placed after the expansion turbine. Due to prior inerts separation, CO_2 stream from the top of the regenerator contains 99.9% CO_2 and only trace impurities and can be used for urea production without further purification. The separator operating at pressure of 4-6 bar, enables a selective liberation of flammable gases from the solution, without any significant CO_2 losses – what allows to increase of CO_2 stream directed to the urea production process.

Process characteristics:

- CO_2 purity improvement to the level of 99.9 vol. % ;
- increased pure CO_2 stream for urea production by 20-25 %;
- elimination of explosion hazard in urea synthesis loop;
- reduction of CO_2 compression energy consumption in a urea plant by approx. 5-8 %;
- increased urea plant capacity by 5 %;
- reduction of ammonia consumption in urea production plants by approx. 2-3 kg/t NH_3.

INS offer includes a license, know-how, basic design and detailed engineering, supervision during erection and start-up as well as a delivery of key-equipment, piping, and control system.

3) HIGH PRESSURE PURIFICATION OF PROCESS CONDENSATES IN AMMONIA PRODUCTION PLANTS

A plant for high pressure condensate degassing serves for removal of ammonia and organic compounds, mainly methanol, from the process condensate. In high pressure process large heat losses are avoided what happens in case of low pressure processes.

Stripping technology utilizes overheated stream directed to natural gas steam reforming at pressure of approx. 4 MPa. Impurities are recycled to technological stream and then to the primary reformer where they are decomposed to H_2, CO and N_2. Pure condensate containing only traces of ammonia and methanol is fed to medium and low pressure steam boilers and its surplus is recycled to a demineralization unit as a raw material for demineralized water production which can be used for feed high pressure boilers.

Process characteristics:

- possibility of the process application in large capacity syngas systems operating with natural gas steam reforming and coal gasification processes;
- ammonia and methanol recovery;
- reduction of demineralized water consumption by approx. 1.25 t/t NH_3;
- reduction of exhaust gas temperature by approx. 60 °C;
- the process is not harmful to the environment.

INS offer includes a license, know-how, basic design and detailed engineering, supervision during erection and start-up as well as a delivery of key-equipment, piping, and control system.

4) SATURATION OF NATURAL GAS IN AMMONIA PRODUCTION PLANT

Technology consists in utilization of combustion gas heat and reduction of process steam consumption in reforming section of ammonia plant. A novel system for natural gas saturation with the process condensate is applied in the reforming section with the use of low-potential heat of combustible gases from the reforming furnace.

Natural gas, directed to steam reforming process, flows counter-currently to the hot condensate stream which sprays the saturation column. Process condensate is heated in heater located in flue gases utilization section. Natural gas is saturated with steam evaporated from the condensate stream. Reduction of technological steam consumption is a direct effect of the saturation. The generated steam replaces middle pressure process steam. All this results in reduction of natural gas consumption for fuel.

Process characteristics:

- novel technology which can be used in ammonia, methanol, hydrogen plants, etc.
- reduction of natural gas consumption by approx. 12 Nm^3/t NH_3 (0.42 GJ/t NH_3);
- reduction of demineralized water consumption in high pressure steam system by 0.4 t/t NH_3.

INS offer includes a license, know-how, basic design and detailed engineering, supervision during erection and start-up as well as a delivery of key-equipment, piping, and control system.

5) SYNTHESIS GAS DRYING IN AMMONIA PLANTS

Novel technology for syngas drying on molecular sives with TSA process application is proposed. After methanation process synthesis gas flows through one of 2 driers packed with molecular sieve operating in TSA (*Temperature Swing Adsorption*) cycle. Final gas drying to moisture content < 1 ppmv H_2O and removal of remaining CO_2 to the level of < 1 ppmv takes place in contact with the adsorbent. Fresh syngas stream (without any traces of residual moisture and CO_2 which are ammonia synthesis catalyst poisons) is mixed with circulation gas stream just before entering ammonia synthesis conventor. As the result NH_3 content in the inlet gas stream is reduced and conversion of synthesis gas during one pass through the catalyst bed is increased. This leads to reduction of gas circulation in the synthesis process and enables reduction of synthesis pressure. The final effect of process modifications are reductions of compression energy consumption and synthesis gas circulation as well as reduction of heat losses in the cooling system.

Process characteristics:

- reduced natural gas consumption by 20 $Nm^3/t\ NH_3$;
- improved product (liquid ammonia) quality.

INS offer includes a license, know-how, basic design and detailed engineering, supervision during erection and start-up as well as a delivery of key-equipment, piping, and control system.

6) METHOD FOR REDUCTION OF NITROUS OXIDE EMISSION FROM NITRIC ACID PLANTS

Nitrous oxide (N_2O) is a by-product of nitric acid production process and it is formed in catalytic ammonia oxidation. N_2O is a greenhouse gas which destroys the ozone layer protecting Earth against harmful UV radiation. Iron-alumina catalyst developed in Instytut Nawozów Sztucznych (Fertilizer Research Institute) is installed in ammonia oxidation reactor, just under the layer of platinum-rhodium and palladium gauzes (for ammonia oxidation and platinum recovery). The catalyst reduces N_2O emission from nitric acid plants even by 95%.

Process characteristics:

- high and stable activity providing N_2O decomposition rate in the ammonia oxidation reactor up to 95%;
- high selectivity – the catalysts does not decompose nitric oxide (NO) it rather increases NH_3 to NO conversion rate.
- catalyst of high mechanical strength;
- low and stable flow resistance values;
- low production and utilisation costs of the catalyst;
- the spent catalysts is not harmful to the environment.

INS offer includes a modernization and intensification of nitric acid plants as well as investigations and delivery of catalyst.

2. Products:

Catalysts and sorbents for the following processes:

Raw hydrocarbon desulfurization,
Hydrocarbon steam refoming,
CO shift reaction,
Methanation of carbon oxides,
Ammonia synthesis,
Reduction of N_2O emission in nitric acid plants,
Benzene hydrogenation,
Oil hardening.

Alumina balls – can be applied in many processes of various branches of chemical industry.

Plant extracts:

Hop extract for brewing, pharmaceutical and cosmetic industries;
Blackcurrant seed oil for cosmetic and food industries;
Raspberry seed oil for cosmetic and food industries;
Strawberry seed oil for cosmetic and food industries;
Sweet red paprika extract for food industry, dietary supplements.

Mineral fertilizers:

Micro-element concentrates INSOL®;
INSOMIX® for green-house crop fertigation;
NP, PK, NPK suspension fertilizers.

Reagent grade formalin

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FOUNDRY RESEARCH INSTITUTE

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Foundry Research Institute was established in 1946 as a leading scientific research centre of the foundry industry in Poland. Focusing on the problems of reconstruction, first, and modernisation, next, of the domestic foundry industry, in its over sixty five year-lasting period of operation, the Institute has managed to develop and implement many successful and original solutions in the field of new materials, foundry technologies, control and measuring apparatus, and foundry machinery and equipment.

In the late seventies, in cooperation with UNIDO, Foundry Research Institute became an important world training centre for the foundry personnel from developing countries. Many times, the Institute staff provided services in numerous countries in Africa and Asia, where our engineers were working as UNIDO experts and specialists in the start up of new foundries.
In its present embodiment, the Foundry Research Institute is a research and development centre operating according to the modern market rules, rendering services to the foundry industry, and also to other industries, institutions, offices and international partners.
The Institute's mission is to create new energy-efficient and environmentally friendly technologies and materials, and undertake various complex and interdisciplinary tasks in different sectors of the industry.

The scope of the services offered by the Institute covers all forms of research and application from planning and preliminary tests to implementation and project economic analysis.
The Institute activities covering all problems related with the art of making castings, including basic and applied research, the development of new cast materials and casting technologies, as well as expert studies, are performed by highly specialised staff of research workers.
The organisational structure of the Institute is closely related to the scope of its activities.

The scientific and technical achievements are particularly evident in the following areas:

- metallurgy and technology of making castings from a variety of cast materials (based on Fe, Al, Cu, Mg, Zn, Sn, Ti, Ni, Co, and metal matrix composites);

- the technology of moulding sands, gravity and pressure die casting, investment casting and lost foam process;
- reclamation and recycling of foundry waste;
- rapid prototyping, 3D scanning, simulation of the pouring process, solidification and stress distribution;
- studies of:
  - high temperature liquid state, and the reactivity and stability of liquid metals in contact with solid materials,
  - mechanical properties and structure of cast materials, and physico-chemical and technological parameters of basic and auxiliary materials;
  - defects in castings.

The significant scientific and cognitive achievements of the Institute during the last four-year period include:

- determination of relationship between the manufacturing parameters and performance characteristics of titanium implants made by precision casting and isostatic compaction,
- development of the mechanism of pressure infiltration of porous bodies and the distribution of reinforcing phase particles to manufacture heterogeneous products with local reinforcement,
- determination of the effect of alloying elements and heat treatment on the structure and properties of spheroidal and vermicular graphite cast irons, including ADI (Austempered Ductile Iron),
- development of physico-chemical backgrounds of the synthesis of a water-based binder of the next generation for precision casting,
- explanation of mechanisms governing the stability and reactivity of nitrides in contact with liquid metals and alloys,
- determining the mechanism of multi-stage heat treatment of selected alloys,
- simulation of the solidification and crystallisation processes of monolithic and composite materials (including *in vitro* and *in situ* composites – on the example of a regular structure as a concentration-related picture of temperature microfield) and modelling the crack-formation process in cast alloys in a spatial state of stress,
- studies of the mechanism responsible for the formation of ordered porosity in high-porosity media and development of a mathematical model explaining this phenomenon,
- determining the mechanism of isothermal transformation in ADI with nickel and copper additions austempered in salt bath,
- studies of the effect of the conditioning regime of sodium silicate glaze on the structure, the value of "zeta" potential and cohesive properties of hydrated sodium silicate serving as a complex binder for the chemically hardened moulding sands,

- shaping the structure and mechanical properties of a metal - aluminium oxide joint based on physico-chemical phenomena occurring at the phase boundary,
- synthesis and investigation of mechanism responsible for the formation of new monolithic materials (nickel-free piston silumins and magnesium alloys) and innovative composites (lead-free bronzes, graphite-containing aluminium alloys reinforced with aluminium oxide, silicon carbide, and selected fractions of fly ash),
- mastering the physico-chemical fundamental rules for the manufacture of cast *in situ* composites of the Al-Al_2O_3 type,
- development of a method for the rheocast-type structure formation in an application approach to the technique of making products in semi-solid state (thixocasting process),
- developing fundamentals of the chromium-nickel cast steel nitriding process,
- development of a comprehensive system for the evaluation of moulding sand reclamability and reusability,
- studies of the effect of evaporative patterns on changes in carbon content in the subsurface layer of iron castings and on the formation of structure and properties of cast aluminium alloys and composite materials,
- optimising the composition of protective gas mixture in the recycling process of magnesium alloys,
- computer simulation of the solidification process of castings made from copper and its alloys with further experimental verification.

Foundry Research Institute maintains extensive contacts with foreign institutes and companies in the exchange of scientific and technical information, and execution of joint research projects. For many years, the Institute has been very active in the development of international cooperation, carrying into effect a number of long-term international projects, among others, with Russia (All-Russia Institute of Light Alloys), Ukraine (National Academy of Sciences of Ukraine, National Metallurgical Academy of Sciences, Dnepropetrovsk), Germany (Giesserei Institut RWTH - Aachen, IFG - Institut fur Giessereitechnik, Düsseldorf, Institute of Casting Technology in Düsseldorf), China (Shenyang Research Institute of Foundry), bilateral agreements, among others, with Bulgaria (Bulgarian Academy of Sciences), Czech Republic (VSBTU - Ostrava), France (ENSGI - Grenoble and CTIF - Paris), Spain (TECNALIA-INASMET – San Sebastian), Lithuania (University of Technology - Kaunas), USA (University of Wisconsin - Milwaukee and Stout, Lawrence Berkeley National Laboratory, National Research Council - Washington, Energy Industries of Ohio, University of Central Florida, NASA Glenn Research Center), Japan (University of Osaka, NIRIN - National Industrial Research Institute of Nagoya). With the majority of these research institutes a long-term cooperation agreements or letters of intent have been signed, e.g. with CTIF (France) and TECNALIA-INASMET (Spain) on the research project proposals regarding the renewal and revitalisation of the national foundry industry through tighter linkage with the EU countries.

In 2002, at the Foundry Research Institute, a COCAFTEC Centre of Competence for Advanced Foundry Technologies was established. The programme of its activities addresses mainly the countries of Central and Eastern Europe (Baltic countries, Czech Republic, Slovakia, Hungary, Slovenia, Romania, Ukraine and others.). Its activities are supported by participation of the Institute in European projects (e.g. CRAFT - Advanced Process for the Pressure Rolling of Materials in the Foundry Industry, SARE - New Technology for Investment Casting, SUBLIB - Lead Free Copper Alloys, CASTEVENTS, COST - Materials Action 531 "Lead-Free Solder Materials", CORROSION – Detection and discrimination of corrosion attack on ships (oil tankers) with Acoustic Emission, ADI-SYNERGY – Manufacture of castings of ADI using the Lost Foam process, MAGNET – Magnetic moulding – innovative technology to improve the competitiveness and working conditions of the European foundries, ECO-IN-FOUNDRIES – Eco information in SME European Foundries, SURUZ – Scientific Network of Surfacants and Dispersed Systems in Theory and Practice, RECYSAND – Recycling of foundry sands, DIOFUR – Dioxins in Cupolas, rotary and electric furnaces, emission-free melting practises in foundries, FOUNDRYBENCH – Foundry Energy Efficiency Benchmarking, LEAN – Development of Light Weight Steel Castings for Efficient Aircraft Engines) and running the Branch Contact Point for Foundry. Designated by the State Committee of Scientific Research, an expert from the Institute has been appointed Poland's representative to the Management Committee of the COST Action 531 "Lead Free Solder Materials", which was started in 2003.

Foundry Research Institute is a member of many international organisations, such as, among others: CAEF - Committee of Associations of European Foundries, AFS - American Foundry Society, WFO - World Foundrymen Organisation.

The basic research programme of the Institute is supported by the standardisation, publishing, training, and scientific-technical activities, the main aim of which is to assist foundrymen working in the industry.

In the past four-year period, the Institute issued numerous books, monographs and brochures, conference and seminar proceedings, and training materials.

PROJECTS:

1) "Development of technology and launching the production of high-quality foundry bentonite based on dried starting material and waste fractions formed in the preparation of sorbents".

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2) "Development of technology and launching the production of high-quality materials called 'ekomix' and of bentonite – 'ekomix' mixtures for foundry industry".

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3) "Development of an innovative technology and launching the production of modified bentonite used in the manufacture of high surface quality steel castings".

The implementation of the above mentioned three projects helped to launch the production of high quality, eco-friendly, bentonite-based materials for foundry. Currently, we can offer ready-made implementation of industry-proven high-quality materials, the application of which allows improving the surface quality of castings and reduce casting defects, and has a positive impact on the environment by reducing the level of dust, the use of sorbent post-production fines in the preparation of foundry bentonite, and reducing harmful emissions evolved from moulding sands during casting, especially polycyclic aromatic hydrocarbons and volatile organic compounds.

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4) "Development of an innovative design and technology for the manufacture of cast components of agricultural machinery."

The aim of the project was to replace the forged and welded blades in bed ploughs with blades made by the casting technology. This conversion of both material and technology has provided longer life of these elements without increasing the cost of their production. The results of operational tests have shown that the manufactured cast blades are more durable than their high quality counterparts made by forging and welding. The project was awarded a number of medals in many national and international exhibitions (Brussels, Paris, Poznan, Kielce and others). As part of this subject, in cooperation with the Industrial Institute of Agricultural Engineering in Poznan, the design and casting technology have been developed to produce a number of tillage tools, like blades for reversible ploughs and single-sided ploughs, subsoiler coulters, cultivator duckfoot, etc.

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5) “The start up of production of ferrous castings, designed for operation under extra harsh conditions of abrasive and corrosive wear and tear to replace forged and welded structures".

Innovative elements of machines and equipment were designed and made by casting technology to replace elements forged, welded or rolled. The main objective of the project was to develop an innovative design of machines and equipment in terms of their shape geometry, making prototype castings from materials of a new generation intended for use under extra harsh operating conditions, and optimising the mechanical and tribological properties in terms of increased functionality and service life of the developed parts. Further aim of the project was to improve the competitiveness of machinery and equipment, mainly in areas such as agriculture, road building, environmental protection, and transportation. Under this topic,

among others, castings of rotor blades for shot blasting machines were developed and implemented in production. The castings won Gold Medal at an exhibition in Brussels.

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6) "Determining the impact of technological process on the quality of castings made from nickel superalloys for power, chemical and automotive industries".

The project aim is to improve energy security and economic use of the available fuel that is coal, getting less greenhouse gas per 1 MWh of produced energy, reducing the amount of coal mined and transported, reducing solid waste, reducing the consumption of cooling water, and obtaining greater efficiency than with the conventional materials used so far. The scope of the studies carried out by the Institute covers comprehensive research on the properties of some heat- and creep-resistant nickel superalloys, to determine their tendency to react with the furnace atmosphere and ceramic materials used in foundry processes and to develop, based on the results obtained, a technology for casting of these alloys and making pilot castings. As part of this subject, studies have been carried out to master the technology of casting nickel superalloys, such as INCONEL and HAYNES. So far, these alloys have been used only in wrought condition. Mastering the technology of casting the above mentioned elements should enable making the “ready for use" (cast) components often of large overall dimensions and intricate shapes, thus reducing the necessary metal working and welding.

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7) „Studies and development of modern technology of the cast materials resistant to thermal fatigue".

Based on physico-chemical interactions in a 'liquid metal - coating - metal mould' system, a new generation of protective and insulating coatings has been developed. The aim of the project is to develop an advanced technology for the manufature of innovative cast materials (ferrous alloys) of controlled structure, modified with alloying elements and offering increased resistance to thermal fatigue under the cyclic changes of temperature. The project also anticipates the development of a modern method for the determination of boundary parameters and dynamics of cyclic changes in temperature and state of stress in the large objects in motion; a prototype test stand to examine the destruction of iron-based alloys under the conditions of cyclic temperature changes; a database of static and dynamic operating parameters of the cast heavy equipment parts for the domestic copper metallurgy industry. The outcome of the project is expected to contribute to the reduced operating cost of numerous devices used by the steel industry, automotive and glass industries, and many other sectors of the domestic industry.

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8) „Improving the reliability of lead-free solder joints in electronic packages."

The aim of the project is meeting the EU directives prohibiting the use of hazardous substances in electronic products, obtained through improved reliability of lead-free solder joints in electronic packages, manufactured from the environmentally friendly new generation of lead-free solders, and conducting a systematic and comprehensive comparative study of the properties of various types of solder joints produced in laboratory scale and in industry, to identify the causes accounting for the loss of reliability of the connections, and to determine the influence of material characteristics, process parameters and other identified factors on the structure, and physical, mechanical and functional properties of various types of solder joints. Another aim of the project is development and improvement of the soldering process control procedures and quality evaluation of solder joints, as well as the development of solutions to improve the reliability of connections in electronic packages.

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9) „Retrofitting the research infrastructure of Malopolska Centre for Innovative Technologies and Materials".

The project concerns the priority of research in the field of materials technology. The immediate purpose of the project is to develop a common research infrastructure in the Malopolska Centre for Innovative Technologies and Materials through construction or purchase of new equipment, or retrofitting and/or replacement of the existing test stands with the excellent research and diagnostic apparatus and the experimental and technological equipment necessary for the joint implementation of research programme for processing of metals and materials engineering.

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The Institute is in charge of the execution of a number of subjects in the strategic project entitled: "**Advanced materials and technologies for their production**", coordinated by the Institute of Non-Ferrous Metals in Gliwice. The overall objective of the project is to use the latest achievements of modern materials engineering to create a database and to submit an offer for advanced solutions in the field of materials and technology for industries operating in the area of non-ferrous metals. Although this area is strictly related with the non-ferrous metals industry, a number of other modern economic sectors such as electronics, photonics, transport, energy and sources of energy are also involved in the project.

1) **Area III** New light alloy-based materials

Area Manager: Adam Kłyszewski, PhD, Eng. **(**Institute of Non-Ferrous Metals in Gliwice – Light Metals Division Skawina)

“Ultralight sections extruded from the new magnesium-lithium alloys”.

The aim of the project is to explore the possibility of using new super light Mg-Li alloys to shape products by casting and plastic forming, and to evaluate the possibility of obtaining a high strength/density ratio. Elements of machines and equipment are produced mostly by casting, forging and extrusion, and less often by rolling and drawing. An additional goal will be to examine structural changes occurring in the processed material during plastic forming and mechanical properties of the ready products. Efforts will also be taken to examine the corrosion behaviour of alloys of this type. The obtained information of cognitive, technological and technical character can be used in the development of a manufacturing technology of new products used in the ground and air transport, and in precision industry.

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„Elaboration of technology to manufacture special-purpose cast components from titanium alloys."

The project aim is to determine optimum parameters of a technological process of making ceramic moulds for precision casting of titanium alloys.

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2) Area V Functional metal matrix materials

Area Manager: Prof. Jerzy Józef Sobczak, DSc, PhD, Eng. (Foundry Research Institute, Cracow)

"The development of squeeze casting and thixocasting technology to produce functionally graded materials and castings from non-ferrous alloys with local reinforcement".

The execution of the project has enabled a comprehensive and interdisciplinary solution of the problem related with the manufacture of functionally graded materials based on non-ferrous metals, and with the fabrication of monolithic, laminated and locally reinforced products. The newest concepts of liquid-phase technology, based on the application of high external pressure exerted on the liquid or semi-solid metal during solidification (squeeze casting), combined with thixocasting, or squeeze/pressure liquid metal infiltration of porous shaped elements reinforcing the casting locally were used.

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„Advanced, fly ash-reinforced, light metals-based, composite materials such as MAGFA and ALFA".

The aim of the project is to develop backgrounds for the manufacture of new metal matrix composite materials in which the reinforcing ceramic phase is waste material - fly ash (both materials are referred to as MAGFA® and ALFA® composites, i.e. Magnesium / Aluminium + Fly Ash), where the fly ash is formed during the combustion of coal in power plants. Due to the low value of density and thermal expansion, increased resistance to abrasion, high resistance to thermal shocks and sufficiently good mechanical properties, aluminium- or magnesium-based composites with the fly ash reinforcement are considered to be a potential solution for materials of industrial application, particularly in car transport as materials for brake discs and pistons for IC engines. Institute of Nuclear Chemistry and Technology.

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3) Area VII Disposal and recycling of materials

Area Manager: Prof. IMN A. Chmielarz, PhD, Eng. (Institute of Non-Ferrous Metals in Gliwice)

"Ecological foundry mould and core technologies for casting of non-ferrous metals, including the recycling and disposal".

Task VII.3. in the project "**Ecological foundry mould and core technologies for casting of non-ferrous metals, including the recycling and disposal**" has as a main objective introducing new ecological binders to the process of making moulds and cores for casting of non-ferrous alloys to replace the most commonly used sands with bentonite and resin binders. The use of the new technology based on ecological inorganic binders characterised by favourable technological parameters and better knocking out properties and reclamability shall reduce the adverse effect of waste moulding materials on the environment. The methodology and studies carried out within the framework of the project will make a basis for the development of complex mould- and core-making technology with recycling and disposal of waste materials.

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„Recycling of process scrap of cast magnesium alloys using an innovative method of endomodification".

The aim of the project is to explore and explain the mechanism of magnesium alloys endomodification by introducing to the primary alloy a specified, in terms of both quality and quantity, addition of different grades of process scrap. The use of own process scrap additionally allows its recycling in the foundry. The end result of the project is clarifying the mechanism by which compounds contained in the scrap can affect the process of the endomodification of liquid alloys of magnesium, and developing instructions and technical documentation concerning introduction of process scrap to the metal charge (recycling) and its impact on the quality of magnesium alloy castings.

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“Studies of casting properties and determination of quality requirements for products cast from magnesium alloys designated for further decorative and protective surface treatment”.

The research work was carried out within the target project: UDA-POIG.01.04.00-16-001/08-00/UDA-POIG.04.01.00-16-001/08-00 "Innovative technology for application of coatings on magnesium castings at Polmag " and it covered complex development of technology enabling application of decorative and protective coatings on die castings made from selected magnesium alloys, allowing for the specific character of the hot chamber die casting process. The scope of work included:

- identifying requirements regarding the surface condition of castings, including the casting surface defects such as folds, streaks, flower outlines, etc
- assessment of surface quality for the presence of elements from the technological process, including the phase analysis of chemical compounds present on the surface of castings,
- selection of technological parameters of the casting process for better surface quality.

The composition of the decorative and protective coatings and the process of their deposition on the test magnesium alloy die castings have been developed within the framework of cooperation with the IMN OML - Skawina. The end result of the work was the development of guidelines for pressure die casting parameters to achieve the required surface quality of magnesium alloy castings necessary for the application of protective and decorative coatings.

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„Aluminium matrix composites with the textile 3-D (3D-CF/Al-MMC) type reinforcement for parts operating under complex loads in the automotive industry and machine building sector."

The aim of this German-Polish bilateral project is to combine the possibilities offered by materials science, mechanical engineering and technology to develop an effective, optimised in terms of mechanical properties, and sustainable approach to the fabrication of carbon fibre / aluminium matrix composites reinforced with 3D type fabric. Within the framework of the project, theoretical and technological backgrounds will be developed to use a considerable potential of the low density metal matrix composites, and also wide opportunities to design their properties. Particular emphasis will be placed on selection of appropriate fibres and aluminium alloys, and best techniques of their modification, as well as optimising the strength of 3D shaped elements based on the available fabrics and allowing for the thermomechanical service loads under different operating conditions.

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„Studies of the effect of various factors on the properties of liquid and semi-solid lead-free solders for high temperature applications (COST MP0602)".

The project concerns the participation of Polish research units in the European Union programme implemented within the framework of COST Action MP0602 entitled: "Advanced Solder Materials for High-Temperature Application - HISOLD" executed in the period of 2007-2011. The scope of work is aimed at high-temperature liquid state studies and liquid-phase technologies to manufacture alloys and soldered joints, including a comprehensive study of properties of selected alloys in the liquid state (melting point and temperature of phase transformations in the liquid state, density, surface tension of liquid alloys, the kinetics of wetting and spreading in contact with different materials) and determination of the effect of major technological factors (temperature, atmosphere, alloying additions, the technique of preparing a solid substrate, e.g. by metal coating).

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„Passive protection of mobile objects (air and ground) from the impact of AP projectiles".

The project covers research and development of sandwich panels for armour components made of lightweight materials designed to be technologically innovative on a global scale, and above all competitive in many respects to the ones manufactured and used previously. The developed solution offers highly effective protection against the impact of AP type small-calibre projectiles and can be incorporated into the outer layers of a security system of the mobile transport means (ground and flying vehicles). The design of armour in terms of the materials applied (light alloys, ceramics) is characterised by a low surface weight, which significantly reduces the total weight of the vehicle, affecting the economics of use - lower fuel consumption, possible increase in the vehicle capacity. The unique solution of the armour design and the method of manufacture based on the available techniques of casting (squeeze casting) make this type of armour cheap, durable, and requiring no costly and time-consuming finishing work.

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„The process of structure formation in the ternary Gd-Co-Ti alloys".

The project aim is to determine the physical and thermodynamic properties of a new class of advanced materials, which are ternary Co-Gd-Ti alloys characterised in the liquid state by an area of limited miscibility. The scope of the planned research is directed at understanding the process of shaping a unique structure of the alloy during rapid cooling, and in particular at the clarification of the existence of an area of the limited miscibility, investigating further the composition of the coexisting phases, as well as the physical properties of homogeneous liquid phases or their mixture. The selection of alloy chemical composition is expected to enable fabrication of new metal composite materials with a metallic glass matrix.

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„Technology for processing of titanium alloys by casting route for production of implants and surface treatment."

The project aim is to develop the basic parameters of a technological process for precision casting of titanium alloys.

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„Complex technologies for the manufacture of cast spare parts of the military equipment and individual medical implants using rapid prototyping techniques".

For special applications, such as military vehicles used by special services - fire, medical and the like ones, numerous items are made individually and are tailored to the specific needs of a given vehicle. In this case, making models of special parts by the methods of rapid prototyping allows quick verification and finding an optimum design solution. For the needs of the project, numerous parts used in the automotive industry made so far by the traditional methods of casting (e.g. gears, rocker arms, crosses, brake calipers) were identified. At the same time, attention focused on the selection of parts that would be representative of both the precision casting process and casting in sand moulds. Precision casting technology has been used for castings with different characteristics in terms of the alloy cast, and casting geometry, shape and weight. This is a different approach to the practical application of investment casting process, which is currently used to make small but complex castings. Making models by rapid prototyping (RPS) allows for multiple and rapid, compared to traditional pattern-making techniques, changes in part configuration without having to incur the high costs of foundry pattern and mould production. In development of the operating parameters of the component and in elaboration of the casting technology, the following numerical programmes were used: Ansys, Abaqus, MAGMASOFT, Flow3D. Studies of the casting process to make the test parts included: control of metallurgical processes (metal preparation), all tests and examinations related with the lost foam patterns in ceramic layered moulds (the investment process), preparation of these moulds for pouring (e.g. determination of an optimum mould temperature). In the case of sand mould castings, the studies aimed at the selection of the most appropriate sand mixture to make these castings. Studies included monitoring and examining the accuracy of reprodution, casting surface quality, the time necessary to make a mould, and the knocking out properties.

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„Development of surface and materials technology for the manufacture of parts and components operating in a high reliability drive system for the long-term and permanent prosthetic heart."

The project aim is to develop a surface engineering technology and a materials technology for the manufacture of parts and components of a high reliability drive system for the long-term and permanent prosthetic heart.

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„The new generation of liquid ceramic slurries for precision casting based on multifunctional binders of improved biocompatibility."

The utilitarian purpose is to develop technologies for the manufacture of precision castings from reactive alloys such as titanium, using water-based binders with selected colloidal solutions (SiO_2, Y_2O_3, ZrO_2 and CeO_2).

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„Development of an innovative casting technology using directional solidification."

The outcome of project execution will be implementation of new technological solutions and application of advanced techniques in the preparation of production (CAD/CAM), verification of casting technology (computer simulation of pouring, solidification and cooling of castings), organisation and planning of production (FEM), and enterprise management (ERP).

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“Innovative ceramic-carbon filters for metal alloys”.

The project aim is to develop a technology for making filters of a new type for the filtration of liquid metal alloys and a method for the use of these filters in casting practice. The use of the ceramic-carbon filters provides the required mechanical strength and thermal stability on pouring of moulds with liquid metal, as well as a good corrosion resistance to the effect of liquid alloy. The structure of the filter wall surface forces a laminar alloy flow through the pores of the filter. An additional advantage is the high thermal conductivity of the filters. Ceramic-carbon filters are designed for the filtration of cast steel, and nickel and cobalt alloys, and can replace the zirconia filters used so far. Also important is the economic effect resulting from a lower temperature at which the filters are being fired.

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„Development of design and technology to make a hydroactive suspension system used in mobile unmanned vehicles resistant to IED type threat”.

The aim of the project was to develop a new design of the suspension system made from new materials. The use in the suspension design of castings instead of parts forged or welded gives more flexibility in the choice of material and in shaping the geometry of the structure. The world trends are aiming at a significant reduction in labour consumption necessary to make a given part. The developed methods for computer modelling and data exchange, and the advanced modelling algorithms allow completing and limiting the physical experiments. Integrated Computational Materials Engineering ICME is a new direction in the rapid development of materials and implementation of new technologies. It provides numerous benefits, including considerable reduction in the design and lead time, mainly due to a

comprehensive analysis of many variants of the solution without the need for a costly and energy-intensive research carried out on true models. In the study, various programmes have been used, among others, for material analysis (Pandat), operation (Ansys, Abaqus), and the technology of manufacture (MAGMASOFT, Flow3D). The conversion of design or of both the design and material requires the use of modern materials and modern manufacturing technologies, all in close cooperation carried out between the researcher, designer and technologist.

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“Development of technology for casting responsible titanium alloy elements improving in a significant way the technical parameters of the equipment manufactured for the automotive industry, chemical industry, and medical applications”.

A utilitarian objective is to develop a technology for the production of precision castings in reactive metal alloys, using water-based binders prepared from the colloidal solutions in SiO_2, Y_2O_3, ZrO_2 and CeO_2, thus significantly reducing the thickness of the surface layer of casting. This should enable undertaking the commercial production of small responsible castings requiring in practice nearly no expensive machining.

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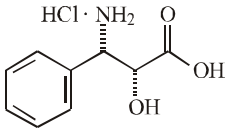
TECHNOLOGIES

1) Synthesis of (2R,3S)-3-phenylisoserine

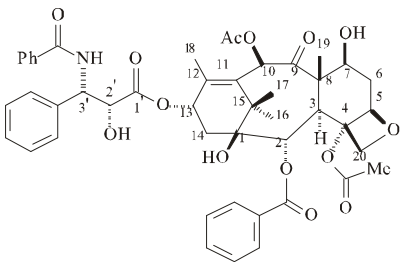
(2R,3S)-3-phenylisoserine-a-amino-b-hydroxyacid hydrochloride of structural formula:



obtained according to the offered technology is characterized by high enantiomeric purity > 99 % and the following physicochemical properties:

- molar mass: 217.50 g/mol
- chemical formula: $C_9H_{11}NO_3 \cdot HCl$
- chemical purity: 98.0 % (HPLC, λ_{obs} = 210 mm)
- optical rotation of sodium light: α = -14.6 (c = 0.55, 6 M HCl aq., temp. 20 °C)
- melting point: 242–244 °C
- solubility: soluble in water, poorly soluble in alcohols
- CAS No: 132201-32-2

(2R,3S)-3-phenylisoserine hydrochloride constitutes a side chain in a particle called *paclitaxel* with a formula:



Paclitaxel is a bioactive substance isolated from the bark of yew *Taxus brevifolia,* vegetating at the Pacific coast of the USA. The second component in the *paclitaxel* particle is 10-deacetylbaccatin III, available in Poland (Agropharm Company, Tuszyn near Łódź).

Paclitaxel reveals activity in curing such kinds of neoplasm like ovary, breast and lung cancer. World demand for *paclitaxel* is 250 kg/year.

A brief description of the technology

In the first stage of the synthesis methyl *trans*-cinnamate is stereoselectively oxidized into methyl *(2R,3S)*-2,3-dihydroxy-3-phenylpropionate in the presence of a chiral catalyst. As a result, the synthesis produces methyl *(2R,3S)*-2,3-dihydroxy-3-phenylpropionate with 72 % yield and enantiomeric purity after crystallization 99 % ee.

It is the key stage of the synthesis, which decides on the stereochemistry of the product. Then, after a number of reactions of type esterification, addition and reduction with hydrogen, there is obtained a product in the form of ester, which at the last stage of the synthesis is hydrolyzed, yielding white crystals of *(2R,3S)*-3-phenylisoserine hydrochloride with purity over 98 % and 99 % ee $\left(\alpha_{\mathrm{D}}^{20} = -13{,}5^{\circ}\right)$. The yield of this method related to methyl cinnamate is 23 %.

Advantages of the technology offered

The technology offered allows to obtain *(2R,3S)*-3-phenylisoserine hydrochloride with purity > 98 % and 99 % ee.

Equipment

The installation to produce *(2R,3S)*-3-phenylisoserine hydrochloride should be equipped with glass apparatus placed in specially adapted rooms, according to GLP requirements.

The installation is based on two apparatus sets:

- an universal glass set with a glass or enameled reactor 120 l in capacity to conduct syntheses and distillations,
- a Simax glass set for extraction, with an extractor 200 l in capacity and 2 tanks for phase separation, 100 l in capacity each.

The reactor instrumentation should include a Teflon stirrer of propeller type with speed adjustment, a sounder to measure temperature and pH of the reaction mixture, two substrate feeders, a distillation column, a condenser, a cooling bath and a distillate receptacle.

The reactor blanket should be adjusted to heating the reactor up to 150 °C and cooling it contents down to -30 °C.

Patents

Patent application P-385 118 (2008) *„(2R,3S)*-3-phenylisoserine hydrochloride purification

method”.

Market competitiveness

Implementation of the technology enables to obtain the product of domestic origin and thus lowering the medication price on the Polish market.

References

Confirmation of high chemical and enantiomeric purity of the product by customers.

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2) Obtaining heparin

Heparin – a sulfonated mucopolysaccharide, derived mainly from animal organs in the form of crystalline sodium salt.

Sodium, calcium and ammonium salts of heparin are used in the health service. Lithium heparin is used for test tube coating in biochemical research and in gasometric analysis.

A brief description of the technology

The process involves two stages. The first stage consists of obtaining heparic acid from a sodium salt of unfractionated heparin. A concentrated sulfuric acid is added to a 10 % aqueous solution of sodium heparin with pH ≈ 8.3 until pH ≈ 0.5 is reached.
At the second stage, porophores from sulfonyl groups are substituted with metal or ammonium cations. Then the appropriate hydroxide is introduced into the heparic acid solution, resulting in full substitution of sulfonyl groups with hydroxide cations. The hydroxide is added until pH ≈ 9.2–10.2 is reached.

If heparin ammonium salt is to be obtained, concentrated aqueous ammonia solution is added to crystalline heparic acid until pH ≈ 9.5–10 is reached and then full dissolution of the acid crystals is effected through stirring. Instead of hydroxides may be applied oxides or carbonates of cations to be introduced.

At the third stage appropriate heparin salt is precipitated with alcohol (methanol or ethanol). The solution shall be stirred while adding alcohol. After drain-off the heparin salt crystals are rinsed a few times with alcohol and then dried.

Advantages of the technology offered

The technology does not require any complicated apparatus, is cheap and the product obtained with 98 % efficiency is very pure (pharmacopeial purity). Currently employed methods to obtain salts, other than sodium ones, comprise mainly running an aqueous solution of heparin sodium salts through columns filled with a cation exchange resin filled with appropriate cations, which substitute sodium cations. The electrodialysis method can also be applied, using appropriate membranes permeable to cations and anions. Both methods produce good results but the electrophoresis method requires specialist apparatus, whereas the ion exchange method causes expansion of the puncture front and hence dilution of solutions, complicating the precipitation process and lowering its efficiency.

Equipment

- open agitators,
- vacuum nutsche filters,
- drying chambers,
- pH meter.

Patents

Patent application P-386 867 (2008) „Method to obtain other heparin salts from sodium heparin”.

Market competitiveness

No information.

References

The technology has been developed on a laboratory scale. It has not been implemented.

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3) Obtaining morphine

Morphine is known throughout the world as a pain relieving medication.

A brief description of the technology

The method comprises morphine separation from the aqueous extract with appropriately matched absorbents and then desorption. The product obtained is of high purity.

Advantages of the technology offered

In comparison to traditional methods, the method is simple as far as technology and apparatus are concerned and less power-consuming. Other methods involve multiple extraction / re-extraction and then evaporation.

Equipment

Extractors, columns, agitators, a drying chamber.

Market competitiveness

No production in Poland.

References

The technology was implemented in the Kutno Pharmaceutical Plant.

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4) Separation and purification of salicylic acid

Salicylic acid is an *ortho*-hydroxybenzoic acid. It is produced in big quantities and constitutes an important precursor to produce numerous pharmaceutical preparations.

A brief description of the technology

Salicylic acid is produced mainly from phenol. The post-reaction mixture contains: sodium salicylate, excess sodium hydroxide or sodium carbonate, small amounts of phenol and a number of unidentified by-products of tarry character. Salicylic acid is isolated from this solution by thinning with water and separation with hydrochloric or sulfuric acid. This way obtained raw acid has brown color and is much polluted. The developed technology to purify raw salicylic acid comprises selective absorption and desorption.

Advantages of the technology offered

The method of selective absorption and desorption employed to remove pollution and by-products from the salicylic acid is less power-consuming and cheaper than the traditionally used sublimation method.

Equipment

- three column sets (three columns each) filled with the same absorbent (in the production process two columns in each set operate connected in series and the third one is then regenerated),
- agitators,
- filtration press.

Patents

Patent No P-192 178 „Method to purify raw salicylic acid”.

Market competitiveness

The method is much cheaper and more efficient than the sublimation method.

References

The technology was developed on the half-technical scale and has not been implemented so far. Half-technical trials have been performed on the installation mounted in a production hall at the PSA branch of the „Polpharma” Pharmaceutical Plant in Starogard Gdański.

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5) Extract from root and leafy parsley fruits

Dietary supplements constitute a concentrated source of nutrients or other substances with feeding or physiological effect. Their receiving is favorable in complementing the daily diet with some lacking mineral nutrients and vitamins and in correcting nutrient deficiencies caused by dietary recommendations or social, cultural and aesthetic ramifications.

There are grown two species of parsley (*Petroselinum sativum* Hoffm., syn. *Apium petroselinum* L.):

- **leafy** (subsp. *macrocarpum*), with hard, inedible roots, whose leaves are used for food,
- **root** (subsp. *microcarpum*), with edible both roots and leaves.

Both species contain ethereal oils, giving them specific taste and flavor.

Ethereal parsley oil contains mainly allyl-4-methoxybenzene, apiol (0.06–0.08 %), myristicin and α-pyrene.

According to the developed technology, two products are obtained:

- Loose – ground and dried parsley root with the extract deposited on it;
- Liquid – oily extract obtained by extraction from parsley fruits using soya oil or extract obtained by extraction from parsley fruits using liquid and supercritical carbon dioxide, thinned with soya oil.

Obtained preparations constitute a feedstock into hard or soft capsules.

A brief description of the technology

Leafy and root parsley fruits are subjected to extraction using soya oil or liquid and supercritical carbon dioxide and then the extract is stabilized with tocopherol used in the quantity of 0.1 wt. %.

As extracts from fruits of both parsley species (root and leafy) contain comparable apiol quantities, both kinds of fruits can be used interchangeably.

The best extrahent of apiol from parsley fruits is supercritical carbon dioxide (apiol contents – 0.681 %). The process proceeds with efficiency about 3.4 %.

In the extraction can be applied edible soya oil, which is a good apiol solvent. This simplifies the technological process and allows to skip a complicated analysis of vestigial amounts of organic solvents in the food product.

- Extraction with liquid and supercritical carbon dioxide

A carbon dioxide stream under appropriate pressure is fed into the extractor using

a pump and then the stream is decompressed using a throttling valve, down to the atmospheric

pressure. Then it is directed to a receptacle placed in a bath at temperature about -30 °C, goes through a rotameter and a gas meter and finally returns to the installation.

- Oil extraction

Ground seeds of root or leafy parsley are placed in an agitator, a specified amount of soya oil is added and then the extraction proceeds for 24 or 72 h. Then the reactor contents is filtered and the extract is analyzed for apiol contents.

Advantages of the technology offered

The technological process of oil extraction is simple and does not require any complicated apparatus. The only labor-consuming stage is the filtration process.

An advantage is also the usage of edible soya oil, allowing to avoid specific analytic check of the product, necessary if other solvents are used.

Equipment

Extraction with liquid and supercritical carbon dioxide requires special pressure apparatus:

- extractor,
- pump,
- receptacle placed in a cooling bath at temperature about -30 °C.

Oil extraction:

- agitator,
- filtration press.

Patents

Patent application No P-381 198 (2006) „Dietary supplement, especially for diabetics".

Market competitiveness

There has been obtained a liquid preparation with twice more apiol contents than in commercially available products.

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6) Extract from celery fruits

Celery, both root and leafy, is a precious source of mineral nutrients (contains *i.a.* potassium, zinc, calcium, iron, phosphorus, magnesium) and vitamins (C, of group B, PP, E and provitamin A). Curative properties has first of all uncooked celery. It purifies blood, slows down ageing process, produces soothing, anti-depressive and painkilling effect.

Characteristic, typical and lasting flavor and taste of celery give it mainly two lactones: 3-*n*-butyl phthalide and 3-*n*-butyl 2-hydrophthalide. Contents of these ingredients in oils and extracts does not exceed 1 %. Total contents of these lactones is a measure of the extract concentration in preparations to be encapsulated.

Carbon dioxide in supercritical state extracts from celery fruit 0,9 % of sedanolide (3-*n*-butyl 2-hydrophthalide) and 0,5 % of *n*-butyl phthalide.

A brief description of the technology

Fruits of leafy or root celery undergo extraction with soya oil or carbon dioxide in liquid and supercritical state. The process proceeds with efficiency of about 3.4--3.96 %. As extracts from fruits of both root and leafy celery contain comparable lactone quantities, both kinds of fruits can be used interchangeably. In the case of root celery fruits the extraction time should be longer, compared to the leafy species.

Extraction with liquid and supercritical carbon dioxide

A carbon dioxide stream under appropriate pressure is fed using a pump into an extractor placed in a water bath at temperature about -30 °C. The carbon dioxide stream with the extract solved is then decompressed using a throttling valve, down to the atmospheric pressure and is directed to a receptacle placed in a bath. The carbon dioxide stream goes from the receptacle to a gas meter and finally to the installation.

Extraction with oil

Ground seeds of root or leafy celery are placed in an agitator, a specified amount of soya oil is added and then the extraction at room temperature proceeds for 24 or 72 h. Then the reactor contents is filtered and the extract is analyzed for lactones contents.

Advantages of the technology offered

The extract obtained using liquid and supercritical carbon dioxide combines magnificent flavor of celery oil with intensive taste of oleoresins and also is free of macromolecular compounds *i.e.* waxes, fats and proteins.

It can be applied as an ingredient of food flavors, soup concentrates and spices and also as an aromatizing ingredient for other food products.

The extract in the form of yellow liquid and with intensive celery flavor has the following physicochemical properties:

- density, d_4^{20} 890 kg/m^3
- refractive index, n_D^{20}1,4800

- acid value, (AV) 27 mg KOH/g
- saponification value, (SV)236 mg KOH/g

Application of edible soya oil in the extraction simplifies the technological process and allows to skip a complicated issue to analyze vestigial amounts of organic solvents in the food product.

Equipment

Extraction with liquid and supercritical carbon dioxide requires to use special pressure apparatus *e.g.*: an extractor and a receptacle placed in a water bath and a rotameter.

Market competitiveness

On the Polish market there are no preparations containing celery extract.

References

The celery extract received an approval issued by National Hygiene Institute and can be applied in production of food flavors.

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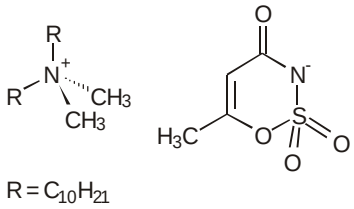
7) Didecyldimethylammonium acesulfamate

Didecyldimethylammonium acesulfamate – an ionic liquid with fungicidal and bactericidal properties. The compound may be used as an active agent in cosmetic preparations, such as:

- toothpastes,
- antiseptic mouth rinses.

It has no toxic effect on warm-blooded organisms (toxicity class IV).

Structural formula:



chemical formula: $C_{26}H_{52}N_2O_4S$

molar mass: 488.8 g/mol

Didecyldimethylammonium acesulfamate is a thick liquid, with color from light-yellow to willow-green-lemon, specific, pleasant smell and sweet taste.

Well soluble in chloroform, chloromethane and ethanol but poorly soluble in warm and cold water. Total decomposition temperature is 483 °C.

A brief description of the technology

Didecyldimethylammonium acesulfamate is obtained in a reaction between didecyldimethylammonium chloride and potassium acesulfamate, conducted in aqueous environment. The product is separated by extraction with methylene chloride. The ionic liquid, solved in an organic solvent, is concentrated by distillation under reduced pressure.

Purification of the product is conducted with extraction methods.

In order to remove water, additional drying of the product is needed, at increased temperature and under reduced pressure.

Advantages of the technology offered

The technology is simple, energy-saving and low-waste.

The environment of the reaction is aqueous and methylene chloride used can be turned back and used in the next synthesis. A waste product is potassium chloride.

The reaction proceeds with big efficiency.

The technology has been implemented on the scale about 5 kg per batch.

Equipment

A glass reactor with bottom drain valve, fitted with a high-performance, high speed mechanical stirrer, a thermometer and a dephlegmator, which can be exchanged for a distillation set. Additionally it should be equipped with a heating / cooling jacket, enabling to heat up or cool down the contents.

Auxiliary equipment consists of:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (for final drying of the product).

A precise description of analytic methods is included in a factory standard, worked out for the product.

Market competitiveness

Product interchangeable with commonly used biocidal constituents with similar or better bactericidal and fungicidal properties, but of better, more acceptable taste. It is non-toxic for warm-blooded organisms and price-attractive.

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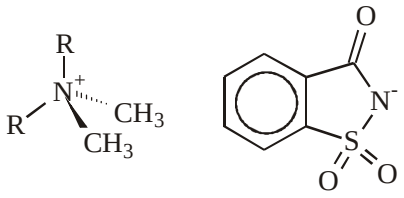
8) Didecyldimethylammonium saccharinate

Didecyldimethylammonium saccharinate an ionic liquid of sweet taste, with fungicidal and bactericidal properties. May be used as an active agent in cosmetic preparations, such as:

- toothpastes,
- antiseptic mouth rinses.

It has no toxic effect on warm-blooded organisms (toxicity class IV).

Structural formula:



R = $C_{10}H_{21}$

chemical formula: $C_{29}H_{52}N_2O_3S$

molar mass: 508.8 g/mol

Didecyldimethylammonium saccharinate is a thick, non-volatile liquid, crystallizing at room temperature, of color from light-yellow to willow-green-lemon, specific, pleasant smell and sweet taste.

Well soluble in chloroform, chloromethane and ethanol but poorly soluble in warm and cold water. Total decomposition temperature is 291 °C.

A brief description of the technology

The compound is obtained in a reaction between didecyldimethylammonium chloride and sodium saccharinate, conducted in aqueous environment. The product is separated by extraction with methylene chloride. Resulting ionic liquid, solved in an organic solvent, is concentrated by distillation under reduced pressure.

The product needs additional drying at increased temperature and under reduced pressure, in order to remove water.

Advantages of the technology offered

The reaction proceeds with big efficiency.

The technology is simple, energy-saving and low-waste.

The reaction proceeds in water and methylene chloride used can be turned back to the next synthesis. The only by-product is sodium chloride.

The technology has been implemented on the scale about 5 kg per batch.

Equipment

The apparatus set to synthesize ionic liquids consists of a glass reactor with bottom drain valve, fitted with a high-performance, high speed mechanical stirrer,

a thermometer and a dephlegmator, which can be exchanged for a distillation set with a heating / cooling jacket, enabling to heat up or cool down the contents of the reactor.

Auxiliary equipment consists of:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (necessary for final drying of the product).

A factory standard worked out for the product includes description of analytic methods.

Market competitiveness

Product in some cases interchangeable with commonly used didecyldimethylammonium chloride. It has similar or even better fungicidal and bactericidal properties and better, more acceptable taste.

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9) Syndiotactic polystyrene (sPS)

Structural thermo-resistant polymer, with melting point 250–275 °C (depending on the catalyst used in the production process) and perfect processing properties, not requiring drying before processing, easily able to be painted and metalized.

Main applications:

- photographic films, magnetic films of „high density" type;
- insulation films for electric and electronic products;
- heat-resistant dishes, especially for microwave ovens;
- car parts exposed to chemicals and high temperature: *e.g.* radiators, reflectors, battery covers, car body elements;
- machine parts working at high temperature and in contact with steam;
- food packaging films;
- machine construction materials, machine housings;
- pipes to transport fluids and gases (except for aromatic compounds) at temperature > 100 °C (for overheated steam – standard: 140 °C);
- office furniture;
- appliances and equipment used in medicine and dentistry, resistant to sterilization with overheated steam, ethylene oxide and UV.

A brief description of the technology

The process of syndiotactic styrene polymerization in the presence of catalysts [P-318774 and P-318775 (1997)], proceeds under waterless and oxygen-free conditions, in an organic solvent – hexane. The raw product is purified by extraction with organic solvents and distillation with steam, and then dried at temperature up to 90 °C in inert gas atmosphere. The process proceeds under normal pressure and at temperature up to 70 °C. Properties of the resulting product and the process yield do not diverge from those described in literature and patents.

Advantages of the technology offered

The process is similar to suspension propylene polymerization, what enables to use its redundant installations to produce sPS.

The process, proceeding in a solvent, directly provides granulation favorable to modification with improvers increasing mechanical strength of the product.

High melting point of the product (about 260 °C) enables a wide range of high--temperature

processing.

Easy control of the process, proceeding in solvents.

It is possible to use both installations and catalytic system to conduct reactions of styrene and ethylene copolymerization (INSITE DOW CHEMICAL process) and butadiene polymerization (90 % of 1,4-*cis*-polybutadiene), which can be used to obtain high impact strength polystyrene (HIPS).

Equipment

- Typical reactor equipped with a stirrer, dephlegmator, drain valve, heating / cooling jacket. The reactor is coupled with a column to purify technical styrene and a filter separating the polymer from the solvent and possibly the unreacted monomer;
- metering pumps dosing hexane, styrene and MAO;
- continuous distillation columns to purify hexane and styrene;
- catalyst dosing device;
- pressure filter or centrifuge;
- apparatus for distillation with steam;
- centrifuge for aqueous suspensions;
- shelf dryer;
- nitrogen heater;
- sensors and elements metering temperature, flow and power consumption by the stirrer.

Patents

Patent No P-186 001 (2003) „Method to produce catalysts for syndiotactic styrene polymerization".

Patent No P-186 002 (2003) „Method to obtain syndiotactic polystyrene".

Market competitiveness

At present only IDEMITSU company (Japan) is a producer of syndiotactic polystyrene.

References

Process verified in an experimental installation with a 250 l reactor (acid resistant steel and enamel), capable of obtaining about 20 kg of polymer.

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10) Chemosetting polymeric composites

The subject of the offer is a chemosetting self-leveling polymeric composition containing unsaturated polyester or epoxy resins and (when needed) plasticizers, flame retardants, greases, stabilizers and modifiers in the total amount of 30–70 wt. %. The composition includes also a mineral filler, especially thermally conditioned phosphogypsum left from production of phosphoric acid or its mixture with other mineral fillers *e.g.* talc. The composition is destined for production of floor screeds, tiles, inner and outer wall facing involving the pouring method.

A brief description of the technology

The process includes ingredients mixing for about 1 h at temperature about 20 °C, deaeration for about 1 h and addition of the last ingredient, which is a stiffener. This way prepared mixture is suitable for pouring onto an in advance prepared ground.

Advantages of the technology offered

The compositions offered, due to application of waste raw materials are characterized by very low cost.

Equipment

Concrete mixer or other stirrer.

Patents

Patent application No P-194 809 (2001) „Chemosetting polymeric compositions".

Market competitiveness

No similar solutions on the domestic market.

References

The chemosetting polymeric compositions for floor screeds has an attest issued by National Institute of Public Health - National Institute of Hygiene and Technical Approval issued by Building Research Institute.

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11) Polymeric composites with silica nanoparticles

Polyamide (PA) and poly(ethylene terephthalate) (PET) composites with silica nanofiller content of several percent (0.5–6 wt. %), having various functional groups, show unique and enhanced properties in comparison to unfilled PA and PET polymers, such as: better barrier, mechanical and thermal properties, and in case of polyamide also increased chemical resistance. A significant influence on properties of the nanocomposites has the content and size of spherical silica particles, the number of introduced functional groups, the presence of a compatibilizer, and also processing conditions.

A brief description of the technology

The nanocomposite production technology comprises dispersion of spherical nanosilica with particle size between 40 and 180 nm in a polymeric matrix. The process is based on the reactive extrusion method which is carried out in a co-rotating twin-screw extruder, with screw revolution speed providing uniform dispersion.

Advantages of the technology offered

Composites produced according to the technology are competitive to composites containing layered nanofillers (*e.g.*: montmorillonite) due to ability to permanently connect the functionalized silica with the polymeric matrix and obtain at the same time system of homogeneous and high dispersion degree. Furthermore, application of compatibilizers with a defined physicochemical characteristics prevents agglomeration of nanoparticles and influences their permanent bounding into the polymeric matrix, what results in favorable properties of the nanocomposite.

Equipment

A intermeshing co-rotating twin-screw extruder.

Patents

Patent application No P-385 297 (2008) „Polyamide composite with a powdery nanofiller”.

Patent application No P-389 434 (2009) „Poly(ethylene terephthalate) composite with a powdery nanofiller”.

Market competitiveness

There are no producers of polymeric nanocomposites on the domestic market.

References

Awards gained on prestigious international invention and innovation exhibitions: 2 bronze medals (Geneva 2009, Nuremberg 2009).

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12) Poly(vinyl chloride) nanocomposites prepared *in-situ* in suspension polymerization process

PVC nanocomposites are prepared in suspension polymerization process in a typical equipment used for PVC production. The polymerization is carried out in the presence of spherical nanofillers *e.g.* nanosilica prepared in sol-gel process or hybrid silicone-acrylic core/shell filler. The nanofillers are added to the polymerization mixture in the amounts up to 1 wt. % per vinyl chloride monomer (VCM). These fillers do not disturb the polymerization process, do not prolong it and do not interact with initiators or other additives used in the process. The nanofillers used are dispersed in aqueous phase. Such dispersion can be stabilized with protective colloids. This form of a fillers prevents its agglomeration.

Advantages of the technology offered

Mechanical properties (impact strength, tensile strength) of the nanocomposites prepared by the method described are better than those of standard PVC prepared by standard suspension method. The nanofiller addition improves impact strength about 20–50 % dependently on the blend composition and does not influence the final product hardness.

Preparation of nanocomposites in the polymerization step is advantageous in comparison with applying of nanofillers in PVC processing as it gives excellent dispersions of the nanofillers in PVC grains and let use smaller amounts of them to reach the same properties improvements.

The process can be applied for the preparation of PVC nanocomposites of any molecular weight (full range of K value). Silica nanofiller allows controlling the polymer molecular weight in some range.

Equipment

The process can be used in every plant of VCM suspension polymerization. Any tank in the lines of media dosage to the polymerization reactor can be used as a nanofiller tank.

Patents

Polish patent application P-384 835 (2008) „Method of the suspension polymerization of vinyl chloride in the presence of a nanofiller".

Polish patent application P-388 960 (2009) „Method of the suspension polymerization of vinyl chloride in the presence of a nanofiller".

European patent application PCT/PL2009/000087 (2009) „Method for the suspension polymerization of vinyl chloride in the presence of a nanofiller".

Market competitiveness

There is no PVC nanocomposites in the world market in spite of intensive works of many research centers, known from the published papers and patents. The only known to us trial of the production of such nanocomposite is introduction of the pilot plant for physical mixing of emulsion PVC latex and bentonite aqueous dispersion. The dried product is a blend called NanoVin®. Production in the industrial scale has not started yet.

References

PVC nanocomposites production (at reactor 1 m^3 of capacity) in Spolana a.s. in Czech Republic (ANWIL SA Group) showed that suspension polymerization of VCM in the presence of spherical nanofillers is possible.

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13) Thermoplastic starch (TPS)

Biodegradable and compostable thermoplastic starch produced from renewable natural raw materials is characteristic of high homogeneity degree, a favorable set of mechanical properties, and products made of it have good dimensional stability in application conditions.

TPS in granulated form is a ready material to manufacture products with methods used on conventional thermoplastic polymers or it can be used as raw material to produce starch-polymeric composites, useful in organic recycling. Thermoplastic starch can be used for manufacture of any kinds of packaging, such as: films, bags (for shopping or waste) and one-off products (*e.g.* catering equipment pieces) and in this area it can be an equivalent substitute of conventional materials like polyolefins or PVC.

A brief description of the technology

The technology to produce thermoplastic potato and corn starch involves the destructurization of the native starch in specific dynamic-thermal conditions. The process is carried out in a co-rotating twin-screw extruder in the presence of a plasticizer, where due to pressure and high shear rates crystalline starch structure is disrupted and the starch is converted into homogeneous, amorphous material, suitable for thermoplastic processing.

Advantages of the technology offered

The technology to produce the new polymeric material, which is thermoplastic starch, relies upon renewable raw materials of vegetable origin. It provides for becoming independent of traditional raw material sources, and simultaneously allows for organic recycling and biodegradation of waste products *i.e.* decay in composting conditions.

Equipment

A intermeshing co-rotating twin-screw extruder.

Patents

Patent application No P-376 985 (2005) „Method to produce biodegradable polymeric material".

Patent application No P-386 832 (2008) „Biodegradable composition containing thermoplastic starch".

Patent application No P-392 109 (2010) „Method to produce thermoplastic starch".

Market competitiveness

At present, thermoplastic starch is not produced in Poland.

References

Awards received on prestigious international invention and innovation exhibitions: 2 gold medals (Geneva 2008, Brussels 2009), 2 silver medals (Seoul 2008, Shanghai 2008), 1 bronze medal (Warsaw 2008), Cup of the Minister of Economy of Poland, deputy Prime Minister Waldemar Pawlak (Brussels 2009).

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14) Polyurethane sealants and coatings – Elastofix PU Polyurethane-bitumen sealants and coatings – Elastofix PU-B

Those products have been developed for application in construction, specifically for water-proofing insulations as moisture-curable, single-component materials. They can however be applied also in two-component systems, what significantly accelerates curing process. Elastofix can be used also in mining and in production of window panels. Elastofix grades of enhanced chemical resistance and enhanced glass adhesion properties are also available.

They are supplied in a form of a paste with thixotropic and self-leveling properties, with light-creamy color in case of Elastofix PU, and black in case of Elastofix PU-B. Elastofix PU does not contain organic solvents, whereas Elastofix PU-B contains only a small amount of aromatic hydrocarbons mixture (from just few to over a dozen percent).

A brief description of the technology

The process to obtain Elastofix PU products comprises two steps. The first step is to disperse fillers in a starting polyol, then the mixture is dehydrated under reduced pressure and subsequently the polyaddition process of polyol and diisocyanate is carried out, at increased temperature, in inert gas atmosphere and in the presence of a plasticizer.

In case of the thixotropic grade, the product obtained is additionally mixed with colloidal silica.

The process to obtain Elastofix PU-B products includes mixing of Elastofix PU mass containing as a filler coal flour (and possibly carbon black) with asphalt-isocyanate adduct (produced in a reaction between molten asphalt and diisocyanate).

Advantages of the technology offered

The technology allows to obtain products forming elastic joints or coatings, well adhering to construction materials and resistant to outdoor environmental factors. The special grades are also resistant even to chemical agents, especially acid and base solutions.

Equipment

- typical reactor with an anchor stirrer and a heating / cooling jacket, able to keep inert gas atmosphere and conduct the process under reduced pressure,
- high speed mixer,
- tanks to store reactants,
- planetary mixer (in case of the thixotropic grade),
- a device for pneumatic discharge of the planetary mixer bowl (optional).

Laboratory equipment:

- equipment to determine the hydroxyl value and NCO groups contents,
- viscometer or rheometer,
- equipment for testing the properties of sealants and coatings.

Patents

The technologies were patented, but the patents have already expired.

Market competitiveness

At present there are market-available polyurethane sealants and coatings, including polyurethane-bituminous ones, but those are no moisture-curable products.

References

Elastofix PU and Elastofix PU-B (containing coal pitch adduct instead of asphalt adduct) were produced on the industrial scale (up to 300 TPY) in the eighties of the last century by Pilchem Company on site of the former Paints and Coatings Company in Pilawa. Production of Elastofix PU masses was then moved to „Silikony Polskie" Chemical Plant in Nowa Sarzyna, but after a few years was abandoned due to a reduction in the production profile of the plant to solely silicone products.

All grades of Elastofix PU and Elastofix PU-B products designated for construction applications received certificates of Building Technology Research Institute (ITB).

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15) Polyurethane, silicone-urethane, polyurethane-acrylic and silicone-urethane-acrylic aqueous dispersions – DPU-PJ

DPU-PJ aqueous dispersions were developed for application as paint and lacquer binders, applied on wood, metals or plastics and also to be directly applied as coating materials (of wide hardness range) or as additives to coating materials based on other aqueous dispersions, *e.g.* acrylic dispersions.

DPU-PJ dispersions can form coatings cured by UV irradiation or oxygen from air (with a siccative). Choosing suitable composition enables to produce DPU-PJ dispersions with various raw material cost, forming coatings with wide range of hardness, elasticity and adhesion. Based on the developed dispersions, two-component compositions (dispersion + hardener) can be obtained.

DPU-PJ dispersions have the form of opalescent liquids of low viscosity, pH about 8 and solids content about 33 %.

A brief description of the technology

At the first stage the starting polyol (or polyol mixture) is dehydrated under reduced pressure, and then, at increased temperature and in inert gas atmosphere, a polyaddition of polyol, dihydroxy carboxylic acid and cycloaliphatic diisocyanate is carried out in the presence of small (several percent) amounts of a diluent – *N*-methylpyrrolidone (NMP). Resulting NCO-terminated prepolymer containing carboxyl groups is neutralized with a tertiary amine, obtaining a concentrated prepolymer-ionomer solution in NMP. At the second stage the concentrated prepolymer-ionomer solution is dispersed in water and then the polymer chain is extended with polyamine.

Advantages of the technology offered

The technology allows to obtain dispersions forming coatings of wide range of properties.

Equipment

- typical reactor with an anchor stirrer and a heating / cooling jacket, capable to keep inert gas atmosphere and perform the process under reduced pressure,
- high speed mixer with a heating / cooling jacket,
- tanks to store reactants.

Laboratory equipment:

- equipment to determine the hydroxyl value and NCO groups contents,
- viscometer or rheometer,

- pHmeter,
- equipment for testing coating properties.

Patents

The technology was not patented.

Market competitiveness

There are polyurethane and polyurethane-acrylic dispersions available on the market, special grades forming coatings cured by UV irradiation or by oxygen from air (with a siccative). However, neither silicone-urethane nor silicone-urethane-acrylic dispersions are commercially available.

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16) General purpose silicone greases

A grease to seal up and/or secure ground glass joints in laboratory apparatus and metal surfaces, decreasing glass joints clotting due to grease leaching by solvents, especially in glass apparatus operating at increased temperature (-50 °C–250 °C) and/or under reduced pressure (3–5 mm Hg). The greases are also handy in lubrication and securing water fittings.

A brief description of the technology

The process to obtain the greases offered includes very fine grinding of silicone oil with fillers, until uniform consistency is not reached.

Advantages of the technology offered

Greases produced according to the technology are marked by very good resistance to solvents, especially at temperature range between 100 and 180 °C and under reduced pressure, thus guaranteeing very good effectiveness in securing ground glass connections in laboratory apparatus.

Equipment

- kneader or Z mixer,
- tube, box or glass jar packing device.

Patents

We offer our *know-how,* the technology is not protected with any patent.

Market competitiveness

The main advantage of the technology offered is a big added value to be earned from this production. It results from a big difference between the price of materials and labor costs, and the sale price.

Potential customers are chemical, medical and biological laboratories supplied by distribution companies, *e.g.* POCH S.A.

References

According to the technology developed, since 2004 is produced a grease for pipette plungers for HTL S.A. Company. Over 90 % of pipettes produced by the company is sold to world markets (USA, Europe).

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17) Associative non-ionic polyurethane thickeners (Pseudo-plastic and Newtonian Grades)

The thickeners can be applied to control the rheological profile of a number of products containing aqueous polymer dispersions as binders, such as paints, coatings (for both indoor and outdoor use) and adhesives. They are applied especially in products cured by UV irradiation or by oxygen from air (with a siccative).

The thickeners are 40 % solutions of active agents in a mixture of water and organic solvents of low viscosity (facilitating their dosing) and have density of about 1.03 g/cm^3. They are well soluble in water, forming viscous, opaque and opalescent liquids. The pseudo-plastic grade thickeners may be applied *e.g.* to increase viscosity in the range of low shear rates, enabling this way to reduce an unfavorable phenomenon of binder and filler particles sedimentation, and their amount in the product depends on required rheological effect. Usually 0.1–2 wt. % of the thickener is used relative to the final product mass. The Newtonian grade does not cause such big increase in viscosity in the range of low shear rates as the pseudo-plastic version does. The thickeners can be added at any manufacturing stage of the coating production.

A brief description of the technology

The process comprises a two-stage reaction of addition of poly(oxyethylene glycol), alcohol and isocyanate, and then dissolving the obtained thickener in a mixture of solvents.

Advantages of the technology offered

The thickener synthesis process is performed in the bulk, without any organic solvents, what is favorable from both the ecological and economical point of view. It allows to avoid a costly process of solvents recovery or utilization. Advantageous is also big simplicity of apparatus washing at each production stage.

Equipment

- two reactors with an anchor stirrer and a heating / cooling jacket, capable to keep inert gas atmosphere and conduct the process under reduced pressure,
- high-speed mixer,
- tanks to store reactants.

Laboratory equipment:

- equipment to determine the hydroxyl value and NCO groups contents,

- viscometer or rheometer.

Patents

Patent application No P-390 104 (2009) „Method to produce modifiers of rheological properties of aqueous polymeric dispersions".

Market competitiveness

At present, there are numerous market-available technologies to obtain associative non-ionic polyurethane thickeners, to be applied in paints and coatings based on aqueous polymeric dispersions. They have, however, no ability to permanently build themselves into the product structure. On the contrary to thickeners presently available on the market, the thickeners developed are able to build themselves into the structure of the coating and participate in formation of the coating under UV irradiation or with a siccative, together with the binder contained in the coating material. It allows to improve water-resistance of the coating in comparison to coatings obtained with using traditional thickeners.

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18) Modified nanofillers based on mine halloysite

This new group of fillers has a hybrid structure of type: inorganic core / organic envelope. Such construction of the filler improves its dispersibility and miscibility in polymeric matrices, especially in polymeric mixtures. Polymers filled with them, both thermo- and duroplasts, are characterized with very significant improvement in mechanical properties (first of all in impact strength and flexural strength).

A brief description of the technology

The modification of halloysite proceeds with the cladding method, using optimal recipes and process parameters.

Advantages of the technology offered

A new technology, no comparison.

Equipment

An ultrasonic bath, a reactor with the ability to take out the solvent of the modified compound, a dryer.

Patents

Patent application No P-386 380 (2008) „Method to produce modifiers of epoxy resin and method of modification of epoxy resins".

Patent application No P-386 833 (2008) „Method to produce modifiers of polypropylene and method of obtain modified polypropylene".

Patent application No P-386 455 (2008) „Method to produce polyolefines composites".

Patent application No P-390 410 (2010) „Method to produce modifiers of polymers and polymeric nanocomposites".

Patent application No P-390 578 (2010) „Method to produce modifiers and polymeric nanocomposites".

Patent application No P-390 868 (2010) „Method to produce modifier of polystyrene and polystyrene nanocomposites".

Market competitiveness

So far, no similar products on the Polish market.

References

Awards received on abroad invention and innovation exhibitions.

Gold medal for „Modifiers of epoxy resin based on halloysite”, Brussels-Innova 2009 (Brussels-Eureka), Brussel.

Bronze medal for „Modifiers of epoxy resin based on halloysite”, Geneva PALEXPO, Switzerland, 2009.

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19) New generation engineering polymers from PET waste

This innovative, ecologic technology, counted among „top 10 export hits" – most interesting Polish technical achievements in recent years, considerably reduces an overflow of non-degradable environmentally waste. It allows to produce engineering polymers used as material for practically all technical products.

Application of the new polymer in the electric and electronic appliance sector includes high precision bearings, levers, cog wheels and device housings with specified mechanical and electrical functions, *e.g.* office devices, computers, monitors, printers, cooking equipment, light bowls, photographic accessories and also electric sockets, plugs and capacitor cores (resistant to creeping current). Automotive industry can make use of the new polymer to manufacture such products as fuel system parts (fuel pumps and filters) or parts of braking system and air conditioners. This polymer can also be used to produce sports equipment, *e.g.* ski bindings and sailing gear.

A brief description of the technology

The technology utilizes the method of reactive extrusion using a modifier, facilitating creation of compatible heterogenic structures with enhanced adhesion at phase boundaries. Processing in a co-rotating twin-screw extruder results in chemical reactions between functional groups of processed polymers and functional groups of the modifier, creating permanent covalent or ionic bonds. Hence, the resulting polymer presents properties of engineering polymers.

Advantages of the technology offered

New generation engineering polymers made of secondary PET materials are equivalent and simultaneously cheap replacements of conventional polymers like poly(butylene terephthalate), high impact polystyrenes or reinforced with glass fiber species of polyamide 6, polyamide 66 or polycarbonates. They are also competitive to products of world leading companies.

Equipment

A co-rotating twin-screw extruder.

Patents

Patent application No P-183 370 (1996) „Thermoplastics recycling method".

Market competitiveness

At present no engineering polymers from PET bottles are produced in Poland.

References

Awards received on prestigious international invention and innovation exhibitions: 3 gold medals (Geneva 2000, Brussels 2002), including a WIPO gold medal for a woman inventor (Brussels 2002), 2 silver medals (Nuremberg 1999, Gdañsk 2001), a distinction in the VIth edition of the competition „Polish Product of the Future" in the technology category, Vth International Competition „EKO-2003" on solutions in the area of environment protection and Grand Prix of the VIth International Plastic Fair PTS 2003 (Warsaw 2003).

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20) Polymeric composites made from polycarbonate waste

The technology is based on most recent achievements in the area of chemical modification of thermoplastics, guaranteeing obtaining polymeric composites with excellent properties and a wide spectrum of technical application capabilities. A filler additive allows to obtain materials with diversified properties, *e.g.*: graphite additive allows to obtain sliding properties and increases wear resistance. Such a material is hence excellent to produce belt and chain conveyors used *i.a*. in food and packaging industry, for lining dock walls with special battens to protect ship boards from bouncing against quays and for runners in bowling alleys. Another example is addition of glass fiber, providing heat resistance and suitable stiffness and hence good damping of mechanical vibrations, dimensional and shape stability. Such composites can find their application in the automotive industry (motor housing, carburetor, filters, cable holders), in household appliances (housings of vacuum cleaners or fryers), they can be material for cog wheels, self-sealing rings, parts of rotary and metering pumps, valves, faucets, filtration plates and frames *etc.* Nanosilica added in very small quantities radically changes properties of a nanocomposite, improving among others its stiffness, mechanical strength and reducing flammability.

A brief description of the technology

The essence of the process is employment of the reactive extrusion process with simultaneous filling (with *e.g.* glass fiber, graphite or nanosilica). In a relatively small processing device, which is a co-rotating twin-screw extruder, occurs a process of chemical modification of compact disk waste (the process runs rapidly – within only several dozen seconds, whereas „traditional" polymerization used to obtain new kinds of polymeric materials takes usually over a dozen hours).

Advantages of the technology offered

The developed solution, based entirely on Polish technical thought, is at the highest technological level of a new, intensively developing area of reactive extrusion. Polymeric composites made of polycarbonate waste, including compact disks, depending on modifiers and fillers used, are equivalent and simultaneously cheap replacements of conventional engineering polymers. They belong to the group of products, which for many years will be used in leading industries, like: machine-building, automotive, electronic and electrical.

Equipment

A co-rotating twin-screw extruder.

Patents

Patent application No P-378 227 (2006) „Method to produce polymeric composites from polycarbonate waste".

Market competitiveness

No composites with engineering polymers properties involving usage of waste compact disk are produced at present in Poland.

References

Awards received on prestigious international invention and innovation exhibitions: 2 gold medals (Budapest 2006, Brussels 2008), 3 silver medals (Moscow 2006, Nuremberg 2006, Warsaw 2007), 1 bronze medal (Geneva 2006), a distinction in the XIth edition of the competition „Polish Product of the Future" in the future technology category, a special prize funded by *Gorodissky & Partners* Company from Russia (Brussels 2008).

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21) Polyester plasticizers

Synthesis of polyester plasticizers using waste poly(ethylene terephthalate) (PET) proceeds in four stages:

Ist stage – glycolysis of waste poly(ethylene terephthalate) with diethylene glycol, at temperature 220–230 °C in the presence of a catalyst,

IInd stage – condensation of mixtures of glycols, PET oligomers and adipic acid, performed at temperature 200–210 °C, until acid value > 50 mg KOH/g is reached, in order to obtain dicarboxylic polyester,

IIIrd stage – esterification of dicarboxylic polyester with 2-ethylhexyl alcohol, at temperature 150–180 °C, until acid value < 10 mg KOH/g is reached,

IVth stage – flash distillation and distillation under reduced pressure, allowing to obtain plasticizers of proper volatility. Distillation under reduced pressure is performed up to the moment when volatility of di(2-hydroxyl)polyester drops below 0.7 % at temperature 180 °C for 30 min (check using a thermo-balance).

Advantages of the technology offered

Because of big molecular mass, polyester plasticizers using poly(etylene terephthalate) are characterized by low volatility and low migration tendency, and hence will not be washed out from final products. Big thermal stability of PVC products obtained using polyester plasticizers guarantees much longer usage of these products, and to much extent this will bring about lower amount of worn-out products. Good miscibility and good efficiency of developed plasticizers produced from PET (comparable to polymeric plasticizers produced from petrochemical constituents on the industrial scale in Organika-Sarzyna Chemical Plant) will broaden the offer. Lower price of polyester softeners produced from PET compared to plasticizers available on the domestic market (produced by Organika-Sarzyna Chemical Plant and imported) will increase interest among purchasers.

Equipment

The synthesis is performed in a typical installation to synthesize polyesters in a reactor equipped with a stirrer, a distillation column and a thermometer.

Patents

In preparation.

Market competitiveness

Attractive price, compared to prices of polyester plasticizers.

References

Implemented production of polyester plasticizers from petrochemical constituents in Z.Ch. „Organika-Sarzyna" S.A. in 2002.

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22) Porous hoses made of polyolefin composites and vulcanized rubber scrap

Porous hoses are produced from polymeric composites, obtained entirely or partly from waste polyolefins and vulcanized rubber scrap. Typical outer diameters of these hoses are 15 and 19 mm. Porous hoses 19 mm in diameter are prepared for Gardene connectors, enabling them to be attached to an irrigating system.

A brief description of the technology

Porous hoses are produced by extruding polymeric composites obtained from polyolefin waste and vulcanized rubber scrap.

The mixture consists of:

Polyethylene or polypropylene (primary or waste) 10–60 wt. %, vulcanized rubber scrap 40–90 wt. % and porophor, playing an important role as a porosity regulator. The composition can also contain greases, mechanical properties modifiers, anti-frictional additives, fillers and stabilizers.

Advantages of the technology offered

An advantage of the technology is obtaining cheap hoses of good quality, which thanks to their porosity (open micropores, uniformly spaced throughout its whole mass) enables homogeneous pouring of water throughout the irrigation zone either on the surface or underground. They can be also applied in fertigation (irrigation joined with fertilization). Application of porous hoses provides a new, ecological and economical soil fertilization and irrigation system.

Another advantages of pipes produced according to the technology developed by Industrial Chemistry Research Institute are:

- water savings by 40–60 % relative to the amount used in traditional systems (installed underground, delivering water directly to roots of vegetation);
- ability to feed plants with fertilizers soluble in water;
- easy installation and dismounting;
- low working pressure of the system $< 1 \cdot 10^5$ bar (optimal $0{,}2 \cdot 10^5$ bar);
- water throughput 140 l/h · m.

Equipment

Single-screw extruder, screw diameter ≥ 45 mm, head of special construction (patented).

Patents

Patent application No P-175 637 (1995) „Device to produce porous pipes from polymeric compositions containing comminuted vulcanized rubber scrap".

Patent application No P-177 682 (1995) „Thermoplastic polymeric composition containing comminuted vulcanized rubber scrap".

Market competitiveness

No similar home-made porous hoses on the Polish market.

References

Silver medal IENA 95 (Nuremberg, Germany, 1995).

Diploma GENIUS '96 (Budapest, Hungary, 1996).

Gold medal Casablanca'97 (Morocco, 1997).

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23) Ground stabilizing nets (geonets)

The subject of the offer are ground stabilizing nets called geonets (globnets) produced from waste materials. They are produced from a mixture of comminuted vulcanized rubber scrap (particle size < 1,6 mm) from car tires (20–50 wt. %), mineral fillers (up to 30 wt. %) and polyolefin recyclate, *e.g.* PE-LD film agglomerate (50–80 wt. %).

A brief description of the technology

A mixture of comminuted vulcanized rubber scrap, polyolefin agglomerate and mineral filler (0–30 %) is extruded in the form of bands 15 mm thick and of free to choose width. The bands are connected in such a way, that they create a structure of „honey-comb" type when unfolded, with uniform mesh size, and when folded they are superimposed one layer upon another. The extruded and cooled band displays the effect of double-sided knurling without any additional tools. Due to knurling, meshes between bands can be filled with soil with vegetation, ground from excavations, sand, aggregate, *etc.,* providing increased ground stabilization and restricting migration of ground crumbs or sand. This facilitates vegetation rooting and constitutes additional effective and attractive protection form for escarpments and slopes.

Advantages of the technology offered

Offered by the Industrial Chemistry Research Institute technology to produce geonets, due to utilization of thermoplastic recyclates, is marked by very low cost of constituents, by 1/3 less than the cost of other widely applied geonets produced from primary high density polyethylene.

Equipment

- extruding line with a long tape receptacle to cool down the band for geonet, terminated with a calender and a cutter to cut the band into straps of suitable width;
- a device to weld or glue the band in the form of honey-comb.

Patents

Patent P-205 736 (2004) „Cellular ground stabilizing nets made of bands from waste materials and the method to produce them".

Market competitiveness

The domestic market offers only geonets made of primary high density polyethylene.

References

A piece of geonet, produced on the industrial scale, was mounted on the Polish coast near Jastrzębia Góra. It has been perfectly fulfilling its strengthening role. During 5 years of usage its properties have practically not deteriorated.

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24) Large-size road traffic security devices

The subject of the offer is a technology to obtain big-size road traffic security devices like: stands for emergency traffic signs, speed bumps, parking bollards, *etc.*, made of waste from polyolefins or poly(vinyl chloride) and vulcanized gum (particle size < 5 mm).

A brief description of the technology

Polyolefin composites containing vulcanized gum waste are obtained by their mixing in an appropriate mixer or by extrusion in granulated form. These composites can be processed with standard methods of extrusion, compression molding or injection molding.

Advantages of the technology offered

The composites offered, due to the usage of thermoplastic recyclates in production, are characterized by very low cost.

Equipment

- screw or drum mixer,
- extruder with screw diameter over 60 mm,
- press or injection molding machine.

Patents

Patent PL-177 682 (1995) „Thermoplastic polymeric composition containing comminuted vulcanized rubber scrap".

Patent PL-188 466 (1997) „Thermoplastic polymeric composition".

Market competitiveness

No similar solutions on the domestic market.

References

A speed bump produced with the form extrusion method is since 10 years mounted at the site of Industrial Chemistry Research Institute and works without any problems.

Silver medal at Moscow International Salon of Industrial Property Archimedes 2006, Moscow, Russia.

Bronze medal at International Exhibition "International Warsaw Invention Show" (IWIS) 2007.

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25) Complex processing of the pyrolysis tar to naphthalene and high-boiling aromatic hydrocarbon fractions

The technology relates to comprehensive processing of pyrolysis tar (liquid residues from gasoline pyrolysis), produced in PKN „Orlen" S.A. in Płock, till now fully disposed of as a component of heavy heating oil C-3.

Using the pyrolysis tar produced in PKN „Orlen" S.A., there is a possibility to produce petrochemical naphthalene, used to manufacture phthalic anhydride and b-naphthol in quantity about 10 thousand TPY. Processing of pyrolysis tar, would also enable to produce scrubbing oil, in short supply on the domestic market, used in coke oven plants (about 20 thousand TPY) and highly aromatic oil to produce carbon black (about 35 thousand TPY). Total market value of the products mentioned is about € 1520 mil.

A brief description of the technology

The technology comprises separation of pyrolysis tar by distillation under reduced pressure, using flash distillation and rectification. It allows to obtain suitable hydrocarbon fractions with boiling point in defined temperature ranges, which (except for naphthalene fraction) can be ready market products.

Obtaining pure naphthalene from pyrolysis tar involves distilling separation of the hydrocarbon fraction enriched in naphthalene, with boiling point usually between about 210 and 225 °C and containing > 70 wt. % naphthalene. This fraction is then subjected to the crystallization process and centrifugation or directly to fractional crystallization from the melt. This process allows to obtain naphthalene of 98–99.5 wt. % with high efficiency.

Advantages of the technology offered

Application of the technology of complex processing of pyrolysis tar would contribute to increase in the degree of crude oil processing and consequently to improvement in technical and economical indicators of the Olefin Plant in Polish Petroleum Concern „Orlen" S.A. in Płock.

Patents

Patent application No P-390 411 (2010) „Method to separate naphthalene from oil residues from olefin pyrolysis of gasoline".

Equipment

The technology to process pyrolysis tar can be used in petrochemical refineries possessing a

distillation installation equipped with columns for vacuum rectification and flash distillation. In order to produce pure naphthalene, there is necessary an equipment for crystallization with centrifugation or fractional crystallization.

References

The technology of complex processing of pyrolysis tar with this method has been investigated on the 1/4-technical scale. Obtained products: naphthalene, aromatic oil for manufacturing of active carbon black and methyl naphthalene fraction (scrubbing oil for coke oven plants) have been successfully tested, respectively, in: ZAK S.A., carbon black plant in Jas³o Refinery and Institute for Chemical Processing of Coal in Zabrze.

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26) Modified petroleum asphalt

The technology relates to modification of utility properties of asphalts using fractions of pyrolysis tar, boiling at temperature > 300 °C (liquid residues from gasoline pyrolysis). Commercialization of the petroleum asphalt technology will be possible after PKN „Orlen" S.A., or another company, implementation of the comprehensive processing technology of pyrolysis tar (a by-product from the process of olefin pyrolysis of gasoline in PKN „Orlen" S.A.).

A brief description of the technology

The technology to modify petroleum asphalts comprises mixing petroleum asphalt with a fraction of post-pyrolysis oil (bp > 300 °C) at temperature 110–125 °C, and then holding at temperature of 120–125 °C. Optimal quantity of the added post-pyrolysis oil fraction is 5–20 %.

Production of asphalt compositions with this method is technologically easy. The compositions obtained do not contain any substances harmful to the natural or operating environment.

Advantages of the technology offered

Petroleum asphalt compositions produced from the modified asphalt are characterized by increased resistance to deformations at high temperatures and also very good adhesion to mineral aggregate, ensuring good resistance to high shearing forces on road pavement, caused by heavy vehicle loads.

Patents

Patent No P-205 644 (2005) „Modified petroleum asphalt".

Equipment

The technology does not require any special apparatus and may be applied in all domestic petroleum processing plants, producing asphalts for highway engineering.

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27) Silica and titania-silica nanomaterials for high-tech applications

Functionalized and non-functionalized nanomaterials are new group of nanomaterials with unique properties resulting from exactly defined structure of these materials. Silica and titania-silica nanomaterials are characterised by desired uniform spherical particle size within the range of 30–600 nm, specific surface area within 300–1500 m^2/g as well as the defined kind and content of functional groups. These nanomaterials assigned for *high-tech* applications, especially as nanofillers for polymer nanocomposites and as nanocatalysts.

A brief description of the technology

The process of silica and titania-silica nanomaterials manufacturing according to sol-gel process is realised in precisely defined conditions (mixing speed, temperature, pH) in water-alcohol medium by using silane and titania precursors.

This technology gives the possibility of various modification of nanosilica according to application needs. The process is waste less.

Advantages of the technology offered

The most important advantage of this technology is the possibility of steering the synthesis process enabling acquisition of unique products characterised by the properties focused on given application. The main direction of production based on volume of production is manufacturing of nanofillers for polymer nanocomposites.

Equipment

The production line should contain enamel autoclave of the proper volume equipped with dosing system, heating-cooling jacket for synthesis in the temperature range 20–25 °C, solvents regeneration unit and drying unit (*e.g.* spray drier).

Patents

Patent application No PL 198 188 (2008): „The method of manufacturing of silica nanopowders, also functionalized".

Patent application No PL 204 519 (2010) „The method of manufacturing of titania-silica nanopowders".

Market competitiveness

On the Polish market there are not manufacturers of silica and titania-silica nanomaterials.

References

- Pilot scale production in Chemical Plant POLISH SILICONES Ltd. The manufactured sols and nanopowders were applied for the production of PVC nanocomposite in SPOLANA Works Anwil Group and for the production of nanocomposite in GEO GLOBE POLSKA Ltd.
- Awards on prestigious inventions fairs (gold medal Brussels 2005, Moscow 2007, Warsaw 2007, silver medal Genève 2006).

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28) Copper powders and nanopowders

The method for obtaining copper powders and nanopowders from industrial electrolytes, including waste waters through electrodeposition of metallic copper on the cathode was developed. The technology solves the problem of the necessity of using an electrolyte of appropriate purity and concentration, and of using additional electrolytes and other substances. Potential sources of metal nanopowders produced according to the technology are three types of (waste) electrolytes:

- electrorefining electrolyte,
- decopperised electrolyte,
- flotation waste waters destined for dumping.

Products which can be manufactured according to the technology include *i.a.* additives to polymers, lubricants, dye, antibacterial agents and microprocessor connections.

Nanopowders of copper or its alloys can find their application in microelectronics, as sorbents in radioactive waste purification, as an additive to cooling fluids and also as catalysts in fuel cells. The most recent application of copper nanopowder is connected with obtaining electronic circuits printed with the Ink jet method, superseding the traditional electrochemical method. Copper nanopowder additive has also positive influence on tribological properties of machining oils.

A brief description of the technology

The method consists in application of the pulse potentiostatic electrolysis with or without change in the electric current direction using the cathode potential value close to the *plateau* or on the *plateau* of the current voltage curve corresponding to the potential range between -0.2 and -1.0 V. A moveable or static ultramicroelectrode or an array of ultramicroelectrodes made of gold, platinum or stainless steel wire or foil is used as a cathode, whereas metallic copper is used as an anode. The process is carried out at temperature from 18–60 °C, and the electrolysis lasts from 0.005 s to 60 s. Copper nanopowders of 99–99.99 % purity can be obtained using that method. Depending on the size of the electrode, metal the electrode is made of, conditions in which the electrolysis is carried out and particularly the kind of electrolysis, temperature and copper concentration in the electrolyte, powders or nanopowders of different shapes, structure and dimensions can be obtained.

Advantages of the technology offered

Electrochemical methods used so far to obtain copper nanopowders are complicated and expensive. They require costly preparation of substrates (solutions, reagents of suitable purity, reductive agents, auxiliary substances etc.), which results in very high market prices of

nanopowders. The main benefit for purchasers of our technology is to increase competitiveness of their enterprises due to innovative solutions included in the method and significantly lower production costs, compared to traditional methods.

Equipment

- To produce nanopowders in the industrial scale, programmable pulse rectifiers enabling change of electric current direction in less than 10 μs will be necessary. Such rectifiers are available at a price of about $ 25.000. The applied current from 500 to 10 000 A, will depend on the electrolyzer size and the cathode used (pilot and industrial process).
- To study the structure and composition of obtained powders and nanopowders, scanning electron microscope (SEM) equipped with energy dispersive spectrometer (EDS) as well as instruments to determine particle size will be needed.

Patents

Patent application No P-387 565 „Method for obtaining copper powders and nanopowders from industrial electrolytes including waste idustrial electrolytes" and international patent application No PCT/PL2010/000022.

Market competitiveness

It is estimated that 15 % of total world industrial production will be based on nanotechnology in 2014 and market share of nanopowders will be over 80 %. The product based on the offered technology has surely a very dynamically developing market and will not require much marketing expenditures.

The technology should be of interest for entrepreneurs ready to introduce innovative production methods, *i.a.* in the area of nanotechnology, electronics, polymer plastics industry, paints and lacquers.

References

The technology for obtaining copper nanopowders from industrial waste waters has already resulted in signing a license agreement with NanoTech Ltd. from Wroc³aw. The technology has been qualified to *Global Partnership Programme,* in which a free assessment of the project, including preliminary market value assessment was performed.

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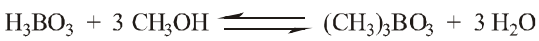
29) Volatile brazing flux

The object of the offer is a technology for producing volatile flux for brazing steel, copper, brass and zinc bronze with a gas torch (burner). The active substance of the flux is trimethyl borate, obtained in the form of its azeotrope with methanol. The flux in liquid form is fed into the brazing zone with a flammable gas supplying the torch. The gas flame saturated with the flux vapours exhibits a reductive effect on the most metal oxides and provides an effective screening of the brazing zone from atmospheric oxygen, thus safeguarding metallic purity of the joint, required anti-corrosiveness and aesthetics of the product. Such a way of brazing eliminates the burdensome necessity to clean joints from slag, what is characteristic of using classical fluxes in the form of powder or paste. The preparation is a uniform, colorless, clear liquid with a characteristic, acrid smell. It contains about 70 % azeotrope of trimethyl borate with methanol. Remaining ingredients are potassium fluoride with its stabilizing and activating influence and ethylene glycol.

A brief description of the technology

Synthesis of trimethyl borate proceeds according to the simple equilibrium reaction scheme:



$$H_3BO_3 + 3\,CH_3OH \rightleftharpoons (CH_3)_3BO_3 + 3\,H_2O$$

In order to ensure reaction progress in the expected direction to create the product it is necessary to separate the product from the reaction mixture. The synthesis is performed at the boiling temperature of the reaction mixture (72–78 °C). The distillate of azeotrope of trimethyl borate with methanol (about 70 wt. %) is separated from the reaction environment by the rectification method in the range of temperature 53–57 °C.

In order to separate the azeotrope enriched with trimethyl borate, there is a necessary to apply a rectification column. Depending on the technical parameters of the applied apparatus set (including the resolution capacity of the fractioning column) there can be different: speed of the process to separate from the reaction environment the azeotrope of trimethyl borate with methanol of required composition, the time to bring the system to the equilibrium state and the yield of the synthesis. Water created in the synthesis slows down the trimethyl borate creation process, until the equilibrium of the reaction is shifted to the substrates. Then the synthesis should be treated as completed, despite the fact that the reactor still contains unreacted boric acid and methanol.

Advantages of the technology offered

The offered technology allows to obtain, in a simple and a safe way, a home-made preparation of a quality comparable to foreign ones.

Equipment

The base of the installation is a periodic rectification apparatus set. The rectification tub acts at the same time as a reactor and it should be fitted with a stirrer and a drain valve. The rectification system consists *i.a.* of a column with filling, a condenser, a cooler and a receptacle.

The installation should be equipped with a control-measuring apparatus, allowing to keep technological parameters *i.a.*: temperature of the reactor, temperature of the rectification column and temperature of the column's top.

Installations of all electric devices, mechanical ventilation and lighting should be explosion-protected and non-sparking.

Patents

Patent application No P-376 168 (2005) „Method to obtain volatile brazing flux".

Market competitiveness

The technology allows to obtain the product from cheap constituents (boric acid and methanol) and it enables to separate the product from the reaction environment by the rectification of azeotrope of trimethyl borate with methanol. The price of the product is competitive to offers of foreign companies, *e.g.* German Company Chemet and characteristics of trimethyl borate in the brazing process is comparable with other foreign products.

References

Based on brazing tests, the preparation received a positive opinion by the Welding Institute in Gliwice – ruling No ZT/227/06.

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OFFERS FOR COOPERATION

1) Izowin-S – a bioactive preparation

Izowin-S is used as a dietary supplement in prophylactics of obesity, cellulite and in anticancerogenic therapy.

A brief description of the technology

The technology comprises isomerization of linoleic acid, a constituent of vegetable oils rich in this acid. The process is performed at temperature 130–190 °C, under normal pressure, using as a substrate edible vegetable oils. The product contains 55–70 % bioactive isomers 9c, 11t + 10t and 12cC18:2.

Advantages of the technology offered

Preliminary studies proved retarding influence of Izowin-S on hyperplasia of neoplastic cells. Carrying out of the planned researches will allow to introduce it on the market as a bioactive preparation supporting anti-neoplastic therapy.

Equipment

The production process can be carried out using typical apparatus and devices *i.e.* a reactor, a sedimentation tank and an evaporator.

Advancement of proceedings

The technology has been developed on the laboratory scale. Preliminary application studies have been already carried out and there has been received an attest issued by National Institute of Hygiene (PZH). It is necessary to carry out wider-ranging application studies.

Patentability

Patent PL No P-195 040 (2007) „Method to separate a fraction rich in isomers of linoleic acid with conjugated double bonds from natural fatty acids".

Patent PL No P-199 216 (2008) „Preparation with anticancerogenic activity".

Subsequent patent application in progress.

Market competitiveness

At present no similar preparation on the market.

Type of expected cooperation

Cooperation in financing of application studies, production organization and commercialization of the undertaking.

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2) Spinalpep – a nutraceutical combining peptides and yeast

This nutraceutical can be applied as a dietary supplement and support therapy of sclerosis multiplex.

A brief description of the process

Production can proceed in pressure-less conditions, at temperature ≤ 80 °C, raw material – pork spinal cord.

Advantages of the technology offered

Due to the combination of yeast and a mixture of short peptides, Spinalpep can be applied as a nutrient or in support of the sclerosis multiplex therapy. Short peptides are able to pass the intestinal barrier, get into the blood circulation and perform there a specific biological role. Therefore obtaining and administering of short peptides as nutraceutical components has huge potential application in both feeding healthy organisms and in therapeutic support.

Equipment

The production process can be performed in typical apparatus and devices used in enzymatic and fermentation processes.

Advancement of proceedings

There has been developed a technology to produce protein hydrolyzates (pilot scale) to be used as a nutraceutical. Talks concerning industrial implementation of the technology are under way.

Patentability

Patent application No P-386 296 (2008) „Method to obtain peptide preparations for oral administering".

Market competitiveness

The preparation has properties supporting therapy of sclerosis multiplex. The technology allows to obtain peptide mixtures from any sort of protein fractions. Selection of proteins and of created from them peptides can be made depending on the desired final effect. No similar preparation on the market.

Type of expected cooperation

Cooperation in production organization.

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3) Hydrogenated block (SBS / SIS) copolymers

The presence of double bonds in block copolymers styrene-butadiene-styrene (SBS) and styrene-isoprene-styrene (SIS) renders them vulnerable to weather conditions. Hydrogenation of these bonds allows to obtain new plastics with participation of polyethylene (SBES) or polypropylene (SBPS) blocks, more resistant to chemical and weather factors and to low temperature.

A brief description of the process

The SBS / SIS copolymers hydrogenation reaction is performed in waterless and (favorably) oxygen-free conditions in cyclohexane, at temperature ≤100 °C under pressure of $10 \cdot 10^5$ Pa of hydrogen, in the presence of a catalytic system. After the reaction is completed, the polymer is precipitated from the solution with methanol and then it is filtered and dried to a constant mass.

Advantages of the technology offered

Due to very good properties, *i.a.* good resistance to weather factors and low temperature, hydrogenated block (SBS / SIS) copolymers find wide usage *i.a.* in glues, freezeproof shoe soles, as freezeproof modifiers for bituminous mixtures (including *i.a.* road and roof asphalts) and as cosmetics ingredients.

Equipment

- pressure reactor fitted with a stirrer,
- agitators,
- dryer.

Advancement of proceedings

There have been defined optimal conditions to hydrogenate commercial SBS / SIS copolymers (KRATON® - Schell) on the laboratory scale (a 500 ml reactor).

Patentability

Patent application No P-382 997 (2007) „Method to hydrogenate block copolymers of styrene with butadiene and styrene with isoprene”.

Market competitiveness

Neither SBS / SIS nor hydrogenated forms of these copolymers are produced in Poland. SBS / SIS copolymers are however accessible on the international market and hydrogenated forms of SBS and SIS are produced by Shell and Repsol Companies.

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4) Modification of thermoplastic materials with waste from annual plants

The subject of this research are composites, with a matrix in the form of polyolefin waste or poly(vinyl chloride), left from the process to recover copper from cables, filled with comminuted waste from annual plants (straw from: rape, oats, barley, rye, wheat and triticale), processed by extruding, compression molding or injection molding.

A brief description of the process

Components of the composite are mixed in an extruder and then processed with the injection molding method. If the composites are used to obtain extruded cross-sections, the granulation step can be omitted in the extrusion process.

Advantages of the technology offered

Straw from annual plants is a kind of waste of virtually no use (they are used as bedding for domestic cattle or incinerated). The proposed solution will allow to use them as fillers (in the amount up to 50 wt. %) in composites made of waste thermoplastic materials.

Equipment

- extrusion granulating line,
- injection molding machine,
- press.

Advancement of proceedings

Laboratory scale.

Patentability

Patent application No P-383 568 (2007) „Poly(vinyl chloride) composition with a natural filler".

Patent application No P-383 567 (2007) „Polyolefin composition with a natural filler".

Patent application No P-385 117 (2008) „Biodegradable polymeric composite".

Market competitiveness

No similar solutions on the domestic and foreign market.

Silver medal at Brussels Eureka „The Belgian and International Trade Fair for Technological Innovation" 2009.

Type of expected cooperation

Assistance in carrying out of extrusion and injection molding tests on the industrial scale.

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5) Polystyrene with reduced flammability obtained by suspension polymerization method

A brief description of the process

The process pertains to a method to produce polystyrene with reduced flammability by polymerization of styrene in aqueous suspension. As flame retarding additives are used halogen-free compounds. Suspension polymerization of polystyrene is performed in the presence of initiator, by adding a solution or styrene dispersion of phosphorous burning reducing additives to water mixed with a suspension stabilizer. There can also be added a modified or unmodified mineral with nanometric layered structure, especially modified montmorillonite and in justified cases also porophor. The product obtained is characterized favorable parameters of horizontal and vertical flammability (according to PN-EN-60695-11-10:2002 standard) and favorable parameters of oxygen index (according to ASTM D 2863-97 standard).

Advantages of the technology offered

In the industrial practice, flammability of polystyrene obtained with the suspension polymerization method is reduced mainly with halogen additives, *e.g.* bromine compounds.

The technology offered reduces flammability of polystyrene in a pro-ecological way, without using noxious, halogen flame retardants.

Equipment

The process can be performed using industrially available apparatus to produce polystyrene.

Advancement of proceedings

Laboratory works have been completed.

Patentability

Patent application No P-386 868 (2008) „Method to obtain polystyrene with reduced flammability using suspension polymerization".

Market competitiveness

The proposed solution is competitive in relation to currently used methods to reduce polystyrene flammability with halogen additives, whose application is now being restricted by the European Union legislation.

Type of expected cooperation

Cooperation in industrial implementation of the proposed solution.

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6) Obtaining of polystyrene with reduced flammability

A brief description of the process

The method to produce the polystyrene composition with reduced flammability comprises polystyrene modification by creation of a premix with a flame retardant and possibly an auxiliary substance, in order to better homogenize the constituents. As flame retardants are used organophosphorus compounds. In the industrial practice it is favorable to incorporate the process to perform the flame retarding modification into the polystyrene production node.

Advantages of the technology offered

The technology offered reduces flammability of polystyrene in a pro-ecological way, without using noxious, halogen flame retardants.

Equipment

The process can be performed using industrially available apparatus to produce polystyrene.

Advancement of proceedings

Laboratory works have been completed.

Patentability

Patent application No P-379 453 (2006) „Polystyrene composition with reduced flammability and the method to produce the polystyrene composition with reduced flammability".

Market competitiveness

The solution is competitive in relation to methods to reduce polystyrene flammability with halogen additives, whose application is being restricted by the European Union legislation.

Type of expected cooperation

Cooperation in industrial implementation of the proposed solution.

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7) Application of graphite and graphite nanofillers to reduce flammability of plastics

The offer pertains to obtaining plastics with reduced flammability with graphite or its derivatives including: polystyrene with reduced flammability produced in the suspension polymerization process, polyester or epoxy compositions.

A brief description of the process

Graphite additives are introduced into ready polyester or epoxy resins as a composition constituent and into polystyrene during its obtaining by the suspension polymerization method.

Advantages of the technology offered

Graphite and its varieties raise mounting interest as additives able to effectively reduce flammability of plastics. Graphite is practically neutral to the environment, and its action comprises *i.a.* restriction of oxygen access to the flame zone and creation of non-flammable decomposition products. Unfortunately, application of graphite alone in many cases (*e.g.* polystyrene) does not warrant sufficient reduction in the plastic flammability and hence there is a need to modify graphite or use additional supporting flame retardants. Proposed solutions are of pro-ecological character.

Equipment

The process can be performed using industrially available apparatus to produce polystyrene.

Advancement of proceedings

At present laboratory works are under way.

Patentability

Patent application in preparation.

Market competitiveness

The solution is competitive in relation to currently used methods to reduce plastics flammability with halogen additives, whose application is now being restricted by the European Union legislation.

Type of expected cooperation

Co-financing of research works. Cooperation in industrial implementation of the proposed solution.

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8) Polyesterols for polyurethanes

A brief description of the process

Polycondensation of the reaction mixture is carried out at temperature 200–230 °C in a inert gas, with continuous stirring and condensate collecting. In the technology waste poly(ethylene terephthalate), vegetable oils (rape, soya and sunflower), by-products and waste products emerging in technologies dealing with processing of various chemical products (glycerin, mixtures of dicarboxylic aliphatic acids, aromatic acids, hydroxyacids and their derivatives) are used.

Advantages of the technology offered

Usage of up to 80 % waste materials. They are characterized by a wide range of physicochemical properties (acid number, hydroxyl number, viscosity, functionality, reactivity, molecular weight *etc.*), what enables their widespread application and allows to obtain products of various utility properties.

Economical advantages – consumption of cheaper and available waste materials, by-products and bio-renewable materials in the amount up to 80 wt. % of input raw materials (depending on the polyesterol type) substantially reduces production cost, compared to the input cost if technical petrochemical raw materials were used.

Ecological advantages – usage of waste materials (PET), by-products (alcohols, multi-carboxyl acids) and bio-renewable materials (oils of agricultural origin), contributes to protection of the environment.

Equipment

Typical apparatus to produce polyesters (unsaturated polyester resins, alkyd resins and polyesterols).

Advancement of proceedings

Works of the laboratory scale have been completed. In case of some types of polyesters there have been completed studies on the experimental (half-technical) scale.

Patentability

There have been received patents for the method to obtain polyesterols. If in further researches were obtained original solutions, new patent applications are anticipated.

Market competitiveness

Wide-ranging assortment for various applications. There has been stated full usability of the new polyesterol group to produce polyurethane foamy materials, glues, lacquers, solid screed masses and as modifiers (plasticizers) for epoxy and phenolic resins.

Significantly reduced input material cost.

Type of expected cooperation

Production launching. Research concerning application of polyesters to manufacture new polyurethane products. The Institute has compiled Material Security Data Sheets for products worked out within the development project and depending on the interest by receivers and destination of particular type of polyesterol we are able to hand over these materials to potential clients, with guidelines concerning their application.

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9) Halogen-free flame retardant epoxy compositions

The offer pertains to halogen-free epoxy compositions with reduced flammability. The composition is destined to obtain the flame retardant halogen-free plates for manufacturing of printed circuit boards. Flame retardancy of the composition is achieved through the use of a polymeric compound containing phosphorus. An organophosphorus compound is build into the resin structure by means of a chemical reaction. The obtained composition gives a product of required non-flammability degree, good mechanical properties, high glass transition temperature and low water absorption.

A brief description of the process

The halogen-free flame-retardant epoxy composition is obtained in a multistage process. The first stage is a modification of a commercial epoxy resin with a polymeric organophosphorus compound. At this stage functional groups of the organophosphorus compound react with epoxy groups of the epoxy resin. The synthesis proceeds with an excess of epoxy groups in relation to functional groups of the organophosphorus compound in the presence of an appropriate catalyst, at temperature 100–130 °C in a inert gas atmosphere. After the assumed parameters of the synthesized resin are obtained, the resin is dissolved in an organic solvent. At the next stage to a solution of resin containing organically bound phosphorus is added a curing agent, dissolved in an organic solvent and a curing catalyst. In the next step prepregs are prepared by impregnating a glass fabric with the epoxy composition and precuring at temperature 150–170 °C. The obtained prepregs are pressed under pressure of 50 kG/cm^2 at temperature 170–180 °C. The plates obtained using the offered composition meet a UL 94 rating of VO. Their glass transition temperature is about 170 °C (DMA) and water absorption 0.033 % (the acceptable value is 0.150 %).

Advantages of the technology offered

The technology offered allows to reduce the flammability of epoxy compositions in a pro-ecological way, without using harmful, halogen flame retardants. The organophosphorus compound applied is build into the structure of the epoxy system, thus allowing to avoid disadvantages related to the usage of additive flame retardants (worse mechanical and chemical properties, plasticization effect and lower glass transition temperature).

Equipment

Epoxy resins modification process:

- reactor equipped with a stirrer with the possibility of heating up to 130 °C and the possibility of dissolving the resulting product in an organic solvent.

The process to obtain plates for production of printed circuits

- industrial-available apparatus to produce epoxy laminates.

Advancement of proceedings

There have been carried out preliminary industrial tests to obtain halogen-free flame-retardant plates coated with copper film to produce printed circuit boards.

Patentability

Patent application No P-392 982 (2010) „Method to obtain epoxy resin with reduced flammability".

Market competitiveness

The proposed solution is competitive in relation to currently used technologies to reduce epoxy materials flammability with halogen additives (mainly bromic ones), whose application is being restricted by the European Union legislation.

Type of expected cooperation

Finding a partner for industrial implementation of the proposed solution.

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10) Polymer miscibility modifiers

A brief description of the process

The method to produce the modifiers comprises joining selected small-molecular compounds or oligomers (hydrocarbon resins) to macromolecules of polypropylene, polyethylene or block (SIS / SBS) co-polymers. The reaction is performed in alloy. The process is waste-free.

Advantages of the technology offered

Obtained modifiers, due to the presence of reactive groups in macromolecules, more favorably interact with constituents of polymeric compositions, influence morphology of the compositions and stabilize their phase structure. Therefore it is possible to obtain „tailor-made" materials.

Equipment

Heated agitators with sigma type stirrers or extruders (most favorably twin-screw).

Advancement of proceedings

Laboratory works have been completed.

Patentability

Patent application No P-388 949 (2009) „Method to produce polymer miscibility modifiers".

Patent application No P-387 336 (2009) „Method to produce polystyrene impact modifiers and modified low-impact polystyrene".

Market competitiveness

The modifiers are new products of diversified chemical construction, and hence they have a wide spectrum of applications in mixtures of various polymers. Moreover they can be based on both primary and secondary waste polymers.

References

Bronze medal for „A novel modifier for the enhancement of miscibility and mechanical properties of thermodynamically immiscible polymers", IENA 2009, Nuremberg, Germany.

Silver medal for „A method of strengthening the low-impact polystyrene", Concours Lépine, Paris, France, 2010.

Type of expected cooperation

Cooperation in order to carry out application studies and then implementation undertakings.

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11) Polymeric composites with metal nanopowders for applications in electromagnetic interference (EMI) shielding

The offered product is innovative in relation to traditionally used metal shields due to its properties characteristic of electromagnetic metamaterials.

A brief description of the process

The fillers of the composites are powders, nano-powders and/or nano-flakes of copper and other metals obtained from industrial waste waters and electrolytes according to the ICRI patent pending technology. The extrusion method is used to produce polymeric composites based on the polymer (*e.g.* EVA/HFFR) matrix with added copper nanopowder filler.

Advantages of the technology offered

The technology is based on the most recent achievements in the production of a qualitatively new group of metal nano-fillers in the form of copper and other metals powders and flakes. Since the nanopowders fillers are obtained from industrial waste waters the technology promotes pro-ecological manufacturing practices. Another key advantage of the patent pending technology is low production cost of both the nanofillers and composites. In comparison to metal shields traditionally used to reduce electromagnetic interferences (EMI), polymeric composite materials are characterized by low specific weight, good corrosion resistance, elasticity and easy processability.

Equipment

Nanopowders are produced on the laboratory scale using a two-electrode system with a potentiostat of type AUTOLAB GSTST30 made by EcoChemie.

The following procedure is used in order to obtain polymeric composites with nanopowders fillers:

- single- or twin-screw extruder,
- electrically heated metering mixer for PLASTI-CORDER device produced by BRABENDER Company,
- hydraulic press.

The mechanical and dielectric properties of the obtained composites are studied. In order to observe the structure and to perform qualitative chemical analysis of the composites a SEM with EDS is used.

Advancement of proceedings

The technology has been developed to obtain a group of polymeric composites, displaying low electric conductance and simultaneously characterized by very good ability to EMI shielding. For preliminary laboratory scale tests on the laboratory scale a material with the desired properties was selected and subsequently, after scale-up of the manufacturing process (to pilot scale) the obtained composite was tested in a company dealing with cable production (in Poland and Israel).

Patentability

Patent applications: PCT/PL2010/000022 and UP RP P 392 282.

Market competitiveness

The technology employs modern, pro-ecological, innovative nanotechnology (which is in-line with EU policy see *e.g.* FP7 projects calls). The technology is cost effective and based on recycling of copper recovered from industrial waste waters, hence its potential patent rights purchasers might have opportunity to get *e.g.* EU and public financial support for its implementation.

Type of expected cooperation

Cooperation with *flash*-investors and cooperative scientific-research works.

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12) Modification of thermoplastic materials with natural polymers

The subject of the offer are composites with polyolefin or poly(vinyl chloride) matrix filled with cellulose fiber of various origin *(e.g.*: waste from newspapers or chipboards grinding and waste cellulose from paper industry or wood flour), destined for processing with extrusion, compression molding or injection molding.

A brief description of the process

The composite granulate is obtained by extrusion and then various products are made from it with the injection molding method. If the composites are used to obtain extruded cross-sections, the granulation step can be omitted in the extrusion process.

Advantages of the technology offered

Thermoplastic materials used in the composites can be primary or they can be partly or entirely substituted with appropriate waste material. It can be an agglomerate from packaging foil or PVC waste left from copper recovery from cables.

Equipment

- extruding line for production of granulates or extruded cross-sections,
- injection molding machine of size depending on the obtained product.

Advancement of proceedings

The composite granulate have been obtained by extrusion in semi-technical tests. The tensile properties, flexular properties and impact strength have been carried out. Investigations of degradability by aging in different conditions of use have been carried out too. The various products about different largeness are made from the composites by the injection molding and compression molding (*e.g.* flowerpots). Composites have been used to obtain extruded cross-sections without the granulation step.

Patentability

PL 194 586 (2006) „The method of manufacture of cellulose fibre from waste paper".

Market competitiveness

Silver medal at Brussels Eureka „The Belgian and International Trade Fair for Technological Innovation" 2009.

Type of expected cooperation

Assistance in carrying out of extrusion and injection molding tests on the industrial scale.

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13) Melamine salts

The subject of the offer are salts of melamine and organic acids (cyanuric acid – melamine cyanurate) or inorganic acids (phosphoric – melamine phosphate, melamine pyrophosphate, polyphosphoric – melamine polyphosphate, boric – melamine borate).

The above-mentioned salts are solids with decomposition temperature > 260 °C. They are applied as flame retardants to thermoplastic materials, especially polyamides.

A brief description of the process

Melamine salts are obtained in a direct reaction between melamine and appropriate organic or inorganic acid in aqueous suspension. These reactions do not require any catalyst.

Advantages of the technology offered

Flame retardants used so far were based on chlorine or bromine compounds. An advantage of the offered technology is synthesis of ecological halogen-free flame retardants. The process of preparation of salts of melamine proceeds in aqueous suspension with 100 % efficiency, without by-products.

Equipment

A reactor equipped with a reflux condenser, a temperature recorded and a heating medium.

Advancement of proceedings

The melamine salts synthesis has been developed on the laboratory scale.

It is necessary to reach appropriate degree of fineness of obtained salts. There is also necessary to refine the method to introduce the obtained composites into polymeric materials.

Patentability

Patent application in preparation.

Market competitiveness

Halogen-free flame retardants constitute a competitive solution compared to flame retardants containing chlorine or bromine compounds.

Type of expected cooperation

Cooperation to increase the scale of synthesis of melamine salts and further research concerning application aspects of the obtained compounds.

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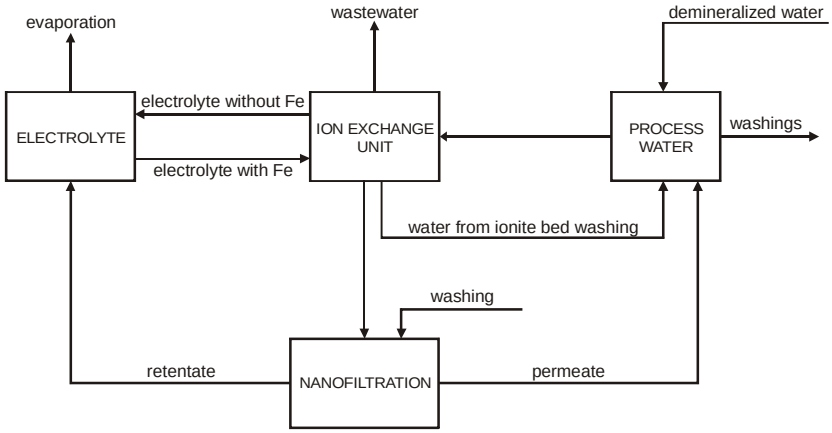
14) Utilization and recycling of the wastewater and technological streams in the galvanizing plant

The innovation of this technology is the application of filtration and membrane processes for separating of selected streams into clean water and concentrated solution of metals. Both resulting streams are fully subjected to recycling. The technology has been developed for the hot-dip galvanizing plant in which zinc sulfate solution is used as an electrolyte.

A brief description of the process



Selected technological streams and wastewater from different processes realized in the galvanizing plant are collected together and sent to the membrane unit (in this case, nanofiltration unit), where the separation into recovered water and concentrated solution of metals goes on. The products of the separation are turned back to the electrolyte.

Advantages of the technology offered

- reduction of the amount of wastewater only to the streams from the regeneration of the ionite column
- high degree (> 99 %) of the zinc recovery from technological streams and wastewater which underwent membrane process
- reduction of the water consumption by the galvanizing plant by over 70 %

Equipment

In this technology different membrane modules are used, all of them are commercially available.

Customization of the technology to the conditions in the particular plant, *e.g.* the hot-dip galvanizing plant, must be preceded by the semi-technical and pilot researches. The Institute has the appropriate apparata and installations for performing such studies.

Advancement of proceedings

Implementation of this technology requires the performance of studies which are necessary to adjust it to the conditions in particular industrial plant.

Patentability

Depending on the range of the customization work, the technology can be offered as *„know-how"* of the Industrial Chemistry Research Institute or it can be the subject of a patent application.

Market competitiveness

The technologies of recycling of technological streams, including recovery of water and other natural raw materials, offered by other companies, can be competitive to this technology.

Type of expected cooperation

Co-operation with industrial plants concerning elaboration of technological concept to the conditions of the particular company. Customization works and researches will be performed primarily at the location of the interested company.

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15) Usage of waste materials to produce acoustic screens

The subject of the offer are acoustic screen panels of a new type for highway engineering applications.

A brief description of the process

Polyolefin composites containing comminuted rubber scrap are obtained by mixing of components in a suitable mixer or they can be extruded in the form of a granulate. These composites can be processed with standard methods, like extrusion, compression molding and injection molding.

Advantages of the technology offered

Disposing of waste polymeric plastics and comminuted rubber scrap from tire.

Equipment

- granulation line with a single-screw extruder,
- single-screw extruder, screw diameter > 60 mm, used in the extrusion molding method,
- hydraulic press,
- injection molding machine.

Advancement of proceedings

Laboratory scale.

Patentability

W 60273 (1998) „Sound-absorbing panel".

Patent No P-201 467 (2004) „Thermoplastic composition".

Patent No P-201 466 (2004) „Polyolefins-based thermoplastic composition".

Patent No P-206 725 (2004) „Method to produce sound-absorbing screen panels".

Market competitiveness

No similar solutions on the domestic market. Market competition in the area of acoustic screens is high. Plastic screens used nowadays are transparent panels made from poly(methyl methacrylate) or polycarbonate. Keeping these screens clean is very difficult and after a few years they are useless.

Type of expected cooperation

Trial fabrication of screens on the production scale.

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16) Revulcanization of comminuted tire rubber scrap

The subject of the offer are utility goods fabricated from comminuted rubber scrap made of waste tires or other comminuted rubber scrap revulcanized using sulfur.

A brief description of the process

Rubber panels made of comminuted rubber scrap are obtained with the developed method to revulcanize this waste with sulfur, using the compression molding technique.

Advantages of the technology offered

Results of preliminary inspection of mechanical properties and wear resistance of these composites are only slightly different from the characteristics of primary rubber.

Equipment

- mixer;
- hydraulic press.

Advancement of proceedings

Laboratory scale.

Patentability

Patent application No P-381 070 (2006) „Method to produce utility goods from comminuted rubber waste".

Market competitiveness

The current recycling offer is insufficient in relation to steady growing amount of vulcanized waste, especially waste tires.

Type of expected cooperation

Partial financing of research works. Assistance in performing an attempt to press bigger fittings.

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17) Hydrometallurgical recovery of materials from waste zinc-carbon and alkaline batteries

A brief description of the process

The proposed and verified on the big-laboratory scale process of hydrometallurgical recycling of zinc-carbon and zinc-manganese cells comprises a number of stages: mechanical disassembly and separation of cells, leaching, concentration and purification of solutions and obtaining products containing zinc and manganese. At the first stage intermingled primary battery waste is mechanically disassembled, allowing direct recovery of iron, constituting housing of these cells. From one ton of waste this process recovers about 220 kg of iron. Then by aerial separation is recovered polymeric plastic and paper, and remaining black mass is transferred for leaching with sulfuric acid(VI). This stage, performed at elevated temperature and under permanent stirring, results in creation of a mass containing manganese oxides and graphite and a solution of zinc and manganese sulfates. The resulting black mass is undergoes further technological processes. These processes produce material which can be used for production of new zinc-carbon cells. Obtained solutions are concentrated and separated with membrane techniques and heavy metals are separated out of them. At the last stage, with chemical and/or electrochemical methods, zinc and manganese are recovered from concentrated solutions (with 98 % efficiency). Solutions left from this process are turned back again to the process of dissolving black masses.

Advantages of the technology offered

The developed process of hydrometallurgical recycling of primary cells is characterized by:

- recycling efficiency compliant with EU regulations, *i.e.* exceeding 55 %,
- recovery of chemical compounds of zinc and manganese, directly applicable in the economy,
- production of new electrode material for zinc-carbon cells,
- significant reduction in mercury contents in battery waste,
- small amount of created waste,
- small energy consumption,
- small consumption of the leaching reagent.

Equipment

To perform 1/4-technical scale tests there is necessary to build a recycling line consisting of leaching tanks at least 1 m^3 in volume, filtration presses, a pumping system, *etc.*

Advancement of proceedings

Based on results of the works on the big-laboratory scale (there have been processed about 270 kg of battery waste) there have been specified parameters to perform a 1/4-technical scale test, which will allow to develop a technological documentation to construct a recycling line for zinc-carbon and alkaline cells.

Patentability

Patent applications protecting the developed solution are in preparation.

Market competitiveness

EU Directive No 2006/66/EU introduced for the first time the obligation to collect zinc-carbon and alkaline cells and reach 50 % recycling rate of waste materials from them. Hence, as of 26.09.2011 there will not be allowed to use simple recycling methods *e.g.* Waelz process, used in Poland.

This is why it became necessary to develop an alternative method to manage this waste, allowing to recover cathode electrode material (MnO_2 + carbon). It can be successfully used to produce new zinc-carbon cells. Cells produced from the recovered waste material have working parameters similar to commercially available cells. Taking into account the iron recovery level, repeated usage of MnO_2/C mixture and over 95 % zinc recovery, the estimated recycling level is at least 55 %. Increase in efficiency of this process is related to *i.a.* repeated turning back the obtained solution to the process, allowing to reduce the amount of waste. Obtained results indicate unequivocally, that the proposed method to recycle zinc-carbon and zinc-manganese cells meets the requirements set out for EU member states.

Type of expected cooperation

Participation in implementation works, construction of a pilot installation.

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18) Modification of waste from electric / electronic equipment

Waste from Electric and Electronic Equipment (WEEE) in nowadays a major problem. The developed technology allows to modify this waste with other plastics and/or glass fiber, allowing to obtain modified WEEE with properties comparable to primary plastics.

A brief description of the process

Composites are obtained by its processing into a granulate with the extrusion method and making of them various products with the injection molding method.

Advantages of the technology offered

The developed technology aims at modifying these waste plastics with other plastics and/or glass fiber. This way we aim at obtaining modified WEEE waste with properties comparable to primary plastics.

Equipment

- extrusion granulating line,
- injection molding machine.

Advancement of proceedings

Laboratory scale.

Market competitiveness

No similar solutions on the domestic market.

Type of expected cooperation

Partial financing of works. Carrying out of extrusion and injection molding tests on the industrial scale.

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19) Production of glycerol polyalkylethers as biofuel components

Glycerol di- and triethers obtained from glycerol, a by-product in biofuels production from vegetable oils (fatty acid methyl esters), can be used not only as an additive to biofuels or diesel oils, but also to gasoline, increasing its octane number. The presence of glycerol polyalkylethers in biofuel influences effectiveness of hydrocarbon combustion, by reduction of emission of noxious substances into the atmosphere. These ethers have also a positive influence on physicochemical properties of biofuel, by reducing its viscosity and temperature of cloudiness.

Process description

Glycerol polyalkylethers are obtained in a reaction of glycerol with olefins contained in the isobutene fraction (containing *ca.* 60 % isobutene), performed in the presence of an acid heterogeneous catalysts, at 80–120 °C and under pressure of 10–20 · 10^5 Pa. The process is carried out in the fixed-bed reactor. The product contains also isobutene dimers (isooctenes), a full-value raw material to produce isooctane, which can be separated from the ethers with flash distillation.

Advantages of the technology offered

Glycerol polyalkylethers are a very valuable additive to biofuels used in self-ignition engines.

The developed technology allows to dispose of market surplus of glycerol, derived from transesterification of triglycerides contained in vegetable oils.

In the Institute of Biofuels and Renewable Energy there were performed physicochemical investigation of the biofuel (from industrial process of rape oil transesterification) modified with *tert*-butyl glycerol ethers. A significant reduction in cold filter plugging point, viscosity reduction and increased cetane number was recognized.

Equipment

The glycerol ethers production proceeds in a column reactor with a catalyst bed, operating under pressure 10–20 · 10^5 Pa. Products can be separated by distillation in high-performance rectification columns.

The state of technology

The laboratory studies has been finished. The catalyst has been selected and the conditions to carry out the process have been established.

Patents

Patent No P-200 500 (2004) „Method to produce glycerin polyalkylethers”.

Patent No P-206 797 (2006) „Method to produce biofuel for self-ignition engines”.

Type of expected cooperation

Cooperation in research on a bigger scale and establishment of foundations to build a 1/4-technical installation. Assistance in the range of application research.

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20) Gliperol – a new biofuel

Product used directly as a biofuel or as a biocomponent for diesel fuel.

A brief description of the process

Gliperol is obtained in a cross-transesterification reaction between triacylglycerols of vegetable oils or fats and low-molecular-weight esters, *e.g.* methyl acetate, at temperature ≤ 110 °C, under normal pressure, except for the solvent recovery stage, which is performed under reduced pressure. It is a single-stage process, without the necessity to drain the glycerin fraction as a by-product.

Advantages of the technology offered

In the classical method to obtain fatty acid methyl esters (FAME), *i.e.* transesterification of triacylglycerols with methyl alcohol, the glycerin fraction emerges as a by-product, which must be purified and disposed of. In the proposed technology as a biofuel component is used glycerin in the form of ester derivative.

Production cost of the new biofuel is 30–35 % less than the cost to produce FAME and usage of glycerin as a biofuel component decreases ecological threat related to its purification and processing.

During Gliperol combustion in an engine the amount of greenhouse gases (CO_2, CO) and HC created is smaller than from combustion of petrochemical fuel or classical fatty acid methyl esters (FAME).

Equipment

The synthesis is performed in typical apparatus made of acid-resistant steel, employed to obtain fatty acid methyl esters using the classical method (with minor additions).

Advancement of proceedings

There have been developed foundations of the technology to obtain the new biofuel – Gliperol and initial application research has been performed.

Patentability

Patent No P-197 375 (2002) „Biofuel for self-ignition engines and the method to obtain biofuel for self-ignition engines".

Patent application No P-359 907 (2003) „Method to obtain biofuel for self-ignition engines".

Patent application No EP-1 580 255 A1 (2004) „A biofuel for compression-ignition engines and a

method for preparing the biofuel".

Patent application No P-378 096 (2005) „New biofuel components and the method to obtain new biofuel components".

Patent application No P-389 394 (2009) „Biofuel component, method to obtain it and its application".

Market competitiveness

No similar technology on the market. FAME production costs are so high, that their production without financial donations is unprofitable. The technology proposed allows to reduce the cost to obtain biofuel by 30–35 % compared to the cost of the classical FAME production method and to evade problems concerning disposing of the glycerin fraction.

Type of expected cooperation

Cooperation in development of the technology, taking into account the scale, ramifications concerning constituents and capabilities of the contracting party.

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21) Benzalkonium lactates

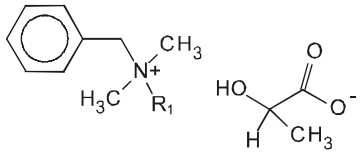
Benzalkonium L-lactate and benzalkonium D,L-lactate are ionic liquids with excellent biocidal properties. They contain an expanded ammonium cation, displaying biocidal properties and a mandelate anion, non-toxic and pharmaceutically acceptable. Biological activity of benzalkonium lactates against a number of microorganisms is from several to several dozen times bigger than active substances widely used in preparations available on the domestic market. Their biocidal action is most effective against the following microorganisms: *Staphylococcus epidermidis, Moraxella catarhalis, Bacillus subtilis, Rhodotorula rubra.*

They are food deterrents against insects *e.g.* khapra beetle *Trogoderma granarium* (larva), *i.e.* chemical substances, which act on taste organs of insects, reducing their appetite, up to total stopping of foraging, what eventually brings them to death.

They belong to the group of cationic surface active compounds. They display also electrostatic properties.

Benzalkonium L-lactate and benzalkonium D,L-lactate can be ingredients of:

- biocidal preparations,
- insecticidal preparations,
- and disinfecting/washing preparations.



$R_1 = C_{12}H_{25}$ (60 %), $R_1 = C_{14}H_{29}$ (40 %)

Benzalkonium lactates are thick liquids, soluble in water, acetone and ethanol, thermally stable, with decomposition temperature > 180 °C.

They have no toxic effect on warm-blooded organisms (toxicity class IV).

A brief description of the process

Benzalkonium lactates are obtained in reaction between benzalkonium chloride and a potassium salt of L-lactic (or D,L-lactic) acid, in aqueous environment at temperature 40 °C. The product is separated by distilling off water under reduced pressure and filtering off the by-product – potassium chloride.

In order to remove water it is necessary additional drying of the product at elevated temperature and under reduced pressure.

Advantages of the technology offered

The technology is simple, low-waste and substrates are cheap. The environment of the reaction is water and the by-product is potassium chloride.

The reaction yield is high.

Equipment

The apparatus set comprises a glass reactor with bottom draining valve, equipped with a high-speed mechanical stirrer, a thermometer and a dephlegmator (which can be exchanged for a distillation set) and a heating-cooling jacket, allowing to heat up and cool down the contents.

Auxiliary equipment comprises:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (to distillate off water from the post-reaction mixture and for final drying of the product).

Advancement of proceedings

There has been compiled documentation concerning physicochemical properties and analytic methods have been developed. Acute toxicity studies have been performed.

There have been performed trials to obtain benzalkonium lactates on the scale of 1.5 kg of the product.

Patentability

Patent application No P-380 976 (2006) „New quaternary ammonium salts of lactic acid and a method to obtain new quaternary ammonium salts of lactic acid".

Patent application No P-383 743 (2007) „Application of benzalkonium lactate as a food deterrent".

Patent application No P-382 950 (2007) „Application of benzalkonium lactate in washing and disinfection".

Market competitiveness

New ionic liquids are novel compounds with fungicidal and bactericidal properties. The effect of benzalkonium lactates is against some microorganisms many times more effective than commonly used benzalkonium chloride, so they can be applied in preparations in low concentrations.

Type of expected cooperation

Cooperation in compiling registration documentation, deployment and launching production of the preparation.

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22) Dialkyldimethylammonium prolinates

Didecyldimethylammonium L-prolinate and benzalkonium L-prolinate – ionic liquids containing an ammonium cation, giving them biocidal properties and an anion originating from L-proline amino acid. Biocidal activity of these compounds is comparable or greater than commonly used didecyldimethylammonium chloride and benzalkonium chloride. Their biocidal action is most effective against the following microorganisms: *Micrococcus luteus, Staphylococcus epidermidis, Staphylococcus aureus, Moraxella catarhalis, Enterococcus faecium, Escherichia coli* and two fungi: *Candida albicans* and *Rhodotorula rubra.*

Due to the high level of anti-microbial activity, obtained ionic liquids can be used in preparations in small concentration. They are probably low toxic to warm-blooded organisms, although appropriate tests have not been performed.

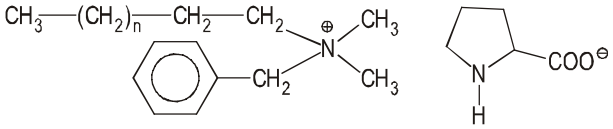
Dialkyldimethylammonium prolinates belong to the group of cationic surface active compounds. They display also electrostatic properties.

They can be constituents of:

- biocidal preparations,
- disinfecting/washing preparations.

They can also serve as catalysts in some types of reactions in asymmetric organic synthesis.

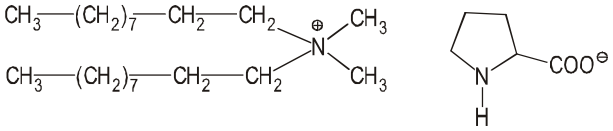
Benzalkonium prolinate



n = 9 60 %

n = 11 40 %

Didecyldimethylammonium prolinate



They are thick, waxy compounds soluble in water, methanol, methylene chloride and acetone.

A brief description of the process

Dialkyldimethylammonium prolinates are obtained in a reaction between benzalkonium (didecyldimethylammonium) chloride and a potassium L-proline salt in aqueous environment at temperature 60 °C. The product is separated by vacuum distilling off water, dissolving in organic solvent, precipitating and filtering off by-product, *i.e.* potassium chloride and concentrating the ooze. Dialkyldimethylammonium L-prolinates require additional drying at elevated temperature

and under reduced pressure.

Advantages of the technology offered

The technology is simple, low-waste and substrates are cheap. The environment of the reaction is water and the by-product is potassium chlorine.

The reaction yield is high.

The technology has been awarded with a silver medal at PALEXPO Exhibition (Geneva, 2010).

Equipment

The apparatus set comprises a glass reactor with bottom draining valve, equipped with a high-speed mechanical stirrer, a thermometer and a dephlegmator (which can be exchanged for a distillation set) and a heating-cooling jacket, allowing to heat up and cool down the contents. Auxiliary equipment comprises:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (to distillate off water from the post-reaction mixture and for final drying of the product).

Advancement of proceedings

There has been compiled documentation concerning physicochemical properties and analytic methods have been developed. No acute toxicity studies have been performed.

Patentability

Patent application No P-388 195 (2009) „New ionic liquids from the ammonium group, a method to obtain them and their application".

Market competitiveness

New ionic liquids are novel compounds with fungicidal and bactericidal properties. Due to their big efficiency, obtaining the desired effect requires only small concentration of these compounds in preparations.

Type of expected cooperation

Cooperation in compiling registration documentation, deployment and launching production of the preparation.

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23) Dialkyldimethylammonium mandelates

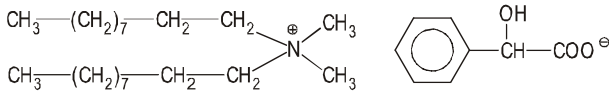
Dialkyldimethylammonium mandelates can occur in the form of a racemate *(R,S)* or optically active isomers *(S)*-(+) or *(R)*-(-). These compounds contain an expanded ammonium cation and a mandelate anion, biocidally active against microorganisms. For instance *(R,S)* benzalkonium mandelate is most effective against the following microorganisms: *Micrococcus luteus, Staphylococcus epidermidis, Staphylococcus aureus, Moraxella catarhalis, Enterococcus faecium, Escherichia coli, Proteus vulgaris, Pseudomonas aureginosa, Serratia marcescens* and two fungi: *Candida albicans and Rhodotorula rubra.*

Dialkyldimethylammonium mandelates belong to the group of surface active cationic compounds and display also electrostatic properties.

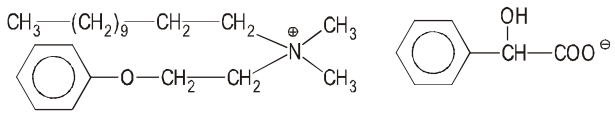
These compounds can be constituents of:

- biocidal preparations,
- disinfecting/washing preparations.

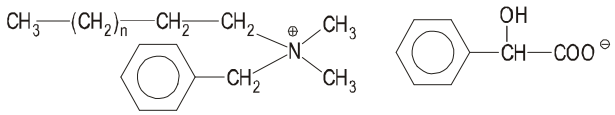
Didecyldimethylammonium mandelate



Domiphen mandelate



Benzalkonium mandelate



n = 9 60 %
n = 11 40 %

Dialkyldimethylammonium mandelates are thick, waxy compounds, soluble in water, methanol, methylene chloride and acetone, with decomposition temperature > 180 °C.

A brief description of the process

Dialkyldimethylammonium mandelates are obtained in a reaction between dialkyldimethylammonium chloride (bromide) with a potassium salt of mandelic acid [or *(R)*-(-) – mandelic acid or *(S)*-(+) – mandelic acid] in aqueous environment at temperature 60 °C. The product is separated by vacuum distilling off water, dissolving in organic solvent, precipitating and filtering off the by-product – potassium chloride and then concentrating the ooze. In order

to remove water, additional drying of the product in elevated temperature and under reduced pressure takes place.

Advantages of the technology offered

The technology is simple, low-waste and substrates are cheap. The environment of the reaction is water and the by-product is potassium chlorine.

The reaction yield is high.

The technology to synthesize these compounds has been awarded with a silver medal at PALEXPO Exhibition (Geneva, 2010).

Equipment

The apparatus set comprises a glass reactor with bottom draining valve, equipped with a high-speed mechanical stirrer, a thermometer and a dephlegmator, which can be exchanged for a distillation set and a heating-cooling jacket, allowing to heat up and cool down the contents.

Auxiliary equipment comprises:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (to distillate off water from the post-reaction mixture and for final drying of the product).

Advancement of proceedings

There has been compiled documentation concerning physicochemical properties and analytic methods have been developed. No acute toxicity studies have been performed.

Patentability

Patent application No P-388 194 (2009) „New ammonium ionic liquids, a method to obtain them and their application".

Market competitiveness

New ionic liquids are novel compounds with fungicidal and bactericidal properties. Due to their big efficiency, obtaining the desired effect requires only small concentration of these compounds in preparations.

Type of expected cooperation

Cooperation in compiling registration documentation, deployment and launching production of the preparation.

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24) Didecyldimethylammonium lactates

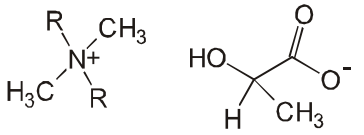
Didecyldimethylammonium L-lactate and didecyldimethylammonium D,L-lactate are new biocidal compounds, containing an expanded ammonium cation, giving them biocidal properties and a lactate anion, non-toxic and pharmaceutically acceptable. Their biocidal action is most effective against the following microorganisms: *Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis, Enterococcus faecium, Escherichia coli, Bacillus subtilis, Moraxella catarhalis, Rhodotorula rubra.*

Didecyldimethylammonium lactates are food deterrents against insects *e.g.* khapra beetle Trogoderma granarium (larva) and wheat weevil *Sitophilus granarius* (beetle), *i.e.* chemical substances, which act on taste organs of the insects, reducing their appetite, up to total stopping of foraging, what eventually brings them to death.

They belong to the group of cationic surface active compounds. They display also electrostatic properties.

Didecyldimethylammonium L-lactate and didecyldimethylammonium D,L-lactate can be constituents of:

- biocidal preparations,
- insecticidal preparations,
- disinfecting/washing preparations.



R = $C_{10}H_{21}$

Didecyldimethylammonium lactates are thick liquids, soluble in water, acetone and ethanol. They are thermally stable compounds, with decomposition temperature > 200 °C.

They have no toxic effect on warm-blooded organisms (toxicity class IV).

A brief description of the process

Didecyldimethylammonium lactates are obtained in reaction between didecyldimethylammonium chloride and a potassium salt of L-lactic (or D,L-lactic) acid, in aqueous environment at temperature 40 °C. The product is separated after distilling off water under reduced pressure and filtering off the by-product potassium chloride.

In order to remove water it is necessary additional drying at elevated temperature and under reduced pressure.

Advantages of the technology offered

The technology is simple, low-waste and substrates are cheap. The environment of the reaction is water and the by-product is potassium chlorine.

The reaction yield is high.

Equipment

The apparatus set comprises a glass reactor with bottom draining valve, equipped with

a high-speed mechanical stirrer, a thermometer and a dephlegmator (which can be exchanged for a distillation set) and a heating-cooling jacket, allowing to heat up and cool down the contents. Auxiliary equipment comprises:

- thermostat,
- membrane vacuum pump,
- vacuum evaporator (to distillate off water from the post-reaction mixture and for final drying of the product).

Advancement of proceedings

There has been compiled documentation concerning physicochemical properties and analytic methods have been developed. Acute toxicity studies have been performed. There have been performed trials to obtain didecyldimethylammonium lactates on the scale of 1.5 kg of the product.

Patentability

Patent application No P-380 976 (2006) „New quaternary ammonium salts of lactic acid and a method to obtain new quaternary ammonium salts of lactic acid".

Patent application No P-383 744 (2007) „Application of dialkyldimethylammonium lactate as a food deterrent".

Patent application No P-382 951 (2007) „Application of dialkyldimethylammonium lactate in washing and disinfection".

Market competitiveness

New ionic liquids are novel compounds with fungicidal and bactericidal properties. Due to their big efficiency, obtaining the desired effect requires only small concentration of these compounds in preparations.

Type of expected cooperation

Cooperation in compiling registration documentation, deployment and launching production of the preparation.

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25) Production of alkaline hydrogen peroxide solution for pulp bleaching

The subject of the offer is a technology to produce alkaline hydrogen peroxide solution, which can be used to bleach paper or textile pulp and to produce perborates and percarbonates. In a reaction of this solution with carbon dioxide it is also possible to obtain sodium bicarbonate solution and hydrogen peroxide suitable for concentration.

A brief description of the process

In the developed method, a diluted soda lye solution is enriched in hydrogen peroxide by electrolysis of gaseous oxygen (pure or from the air).

On the cathode occurs electroreduction of molecular oxygen to the ionic form of hydrogen peroxide:

$O_2 + H_2O + 2\ e \rightarrow HO_2^- + OH^-$

On the anode takes place either hydrogen oxidation: $H_2 + 2\ OH^- \rightarrow 2\ H_2O + 2\ e$

or oxygen release: $2\ OH^- \rightarrow 1/2\ O_2 + 2\ e + H_2O$

In the first case, electric energy does not have to be supplied (it can be even recovered). The reaction can then be represented by the following summary equation:

$H_2 + O_2 + OH^- \rightarrow HO_2^- + H_2O$

In the second case, electric energy needs to be supplied, but according to the summary equation less oxygen is consumed and no water is formed: $1/2\ O_2 + OH^- \rightarrow HO_2^-$

As a result of both the above overall reactions the number of hydroxyl groups decreases, but an equivalent number of them emerges in bleaching due to decomposition of HO_2^-.

Alkaline hydrogen peroxide solution with H_2O_2 concentration up to 7 wt. % and up to 14 wt. % of NaOH is ready to be used at the bleaching stages. The lye recovered from the bleaching is recycled to the electrolysis stage in order to enrich it in hydrogen peroxide again.

The electrolysis is performed in an aqueous solution of soda lye at the temperature of 50–60 °C under atmospheric pressure.

Advantages of the technology offered

- the method eliminates the necessity to purchase concentrated hydrogen peroxide, transport it and mix it with lye (independence from H_2O_2 suppliers and no risk of handling concentrated H_2O_2);
- the process is well scalable (device modularity);
- the product obtained is of high purity;
- the method is waste-free and safe;

- low energy consumption (possibility of recovering the energy released in the reaction).

Equipment

The basic reactor unit for oxygen electrolysis consists of a cathode, an anode and an ionic conductive membrane. Fittings from lye-resistant plastics work well. The electrodes used are made of carbon, carbon-nickel or carbon-platinum. The electrode separator is made of Nafion™.

Technology development stage

An electrolyzer has been tested on the laboratory scale (a few grams of H_2O_2 per hour) in two-week continuous operation, which gave a steady H_2O_2 current efficiency > 90 %, a steady mass ratio of NaOH to H_2O_2 in the product = 2:1, an adjustable product concentration of 2–5 wt. % H_2O_2, and simultaneous production of electric energy and useful H_2O_2 solution using a hydrogen anode.

Patentability

Patent No P-184 363 B1 (2002) „Method to obtain alkaline hydrogen peroxide solution".

Market competitiveness

Taking careful assumptions (current parameters of the electrolyzer process are not optimal), the total cost to produce H_2O_2 with this method in the form of alkaline solution is comparable to the cost to obtain the solution by mixing purchased H_2O_2 with soda lye.

Type of expected cooperation

At the present stage, it is purposeful to develop a new electrolyzer construction maximizing the electrodes' utilization (measured in grams of H_2O_2 per unit of time per unit of electrode area). Work should be conducted initially on the laboratory scale, then on the 1/4-technical scale.

We are interested in obtaining funding from its final user (paper mills, textile producers and chemical plants) for the further development of the technology in return for the rights to use the technology.

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ANLYTICAL SERVICES

1) Analysis and characterization of materials

Since 1997, the quality management system according to the PN-EN ISO/IEC 17025 standard has been implemented in all laboratories of the Department of Analysis and Characterization of Materials. Selected methods are included in the scope of accreditation, confirmed by the accreditation certificate No. AB 113 issued by the Polish Centre for Accreditation (PCA). Department is also notified as the approved laboratory that according to the Regulation of European Parliament and Council No. 648/2004 on detergents is competent to carry out the biodegradation tests required by the regulation (Official Journal of The European Union 2009/C 39/05).

The following studies can be carried out within the scope of accreditation:

- identification of polymers, plastics and plastics additives (*e.g.* fillers, stabilizers, plasticizers, antioxidants *etc.*) by infrared spectroscopy method (qualitative analysis). Such substances are identified, the IR spectra appear in the directories of the standard spectra.

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- determination of metal content by Flame Atomic Absorption Spectrometry (FAAS) method: barium (1–100) mg/l, cadmium (0.1–10) mg/l, chromium (0.2–20) mg/l, lead (1–100) mg/l, antimony (1–100) mg/l in aqueous solutions not requiring mineralization;
- determination of metal content by Flame Atomic Absorption Spectrometry (FAAS) method: barium (0.0015–0.15) % (m/m), cadmium (0.00015–0.015) % (m/m), chromium (0.0003–0.03) % (m/m), lead (0.0015–0.15) % (m/m), antimony (0.0015–0.15) % (m/m) in colourants of plastic materials coming into contact with food;
- determination of metal content by Flame Atomic Absorption Spectrometry (FAAS) method: barium (0.0010–1) % (m/m), cadmium (0.0001–1) % (m/m), chromium (0.0002–1) % (m/m), lead (0.0010–1) % (m/m), antimony (0.0010–1) % (m/m) in plastics and vegetable materials.

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- evaluation of inorganic, organic and total incrustation of cotton fabric after wash;
- evaluation of loss in tensile strength of cotton fabric after wash, in %, force range: 0.5–2500 N.
- evaluation of aerobic ultimate biodegradation of organic chemical products, including detergent products and surfactants by manometric respirometry in the range of 0–100 %;
- evaluation of aerobic ultimate biodegradation of organic chemical products, including detergent products and surfactants, with Dissolved Organic Carbon (DOC) Die-away method in the range of 0–100 %;
- determination of Chemical Oxygen Demand (COD) in the range of 30–660 mg/l;
- determination of Dissolved Organic Carbon (DOC) in the range of 0.05–4000 mg/l.

Determination of biodegradability, COD and DOC done acc. to law as of 9.01.2009 (Journal of Laws 2009 No 20 pos. 106), Council Regulation (EC) No 440/2008 of 30.05.2008, Regulation (EC) No 648/2004 of the European Parliament and of the Council of 31.03.2004, OECD Procedures No 301 and 209 and Standards No: PN-EN ISO 9408:2005, PN-EN ISO 7827:2001, PN-ISO 6060:2006 and ISO 8245:1999.

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- the studies of surface structure and morphology of solid samples by the Scanning Electron Microscopy (SEM) method.

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2) Analysis of organic compounds, polymers and plastic materials

- identification of organic compounds, polymers, plastics products, paints, glues, binders, *etc.* by spectrophotometric and chromatographic methods;
- identification of the structure of non-volatile organic substances, *e.g.* synthetic and natural polymers, biochemical and geochemical products by the Py/GC/FTIR method;
- determination of average molecular mass and molecular mass distribution of polymers by Gel Permeation Chromatography (GPC) method;
- organic synthesis process control by FTIR and UV/VIS absorption spectrometry methods;
- FTIR studies of the hardening and cross-linking of polymer materials (functional and structural groups determination);
- composition analysis of organic compounds mixtures (identification of volatile components) by GC/MS and GC/AED methods;
- determination of trace amounts of toxic substances (monomers and solvents) in plastic products and in other materials by GC method using head-space technique, flame ionization detectors (GC/FID), atomic-emission detectors (GC/AED) and electron capture detectors (GC/ECD);
- determination of CFCs and halons in aerosols by GC method;
- determination of the C1-C3 alcohols in household chemistry products and pharmaceutical products by the GC/FID method;
- determination of organic acids, hydrocarbons, alcohols, esters and ketones in the gas samples by GC/FID method;
- studies on gases composition in closed cells of polyurethane foam by GC/FID and GC/TCD methods;
- studies on migration of trace contaminants from plastics by spectrophotometric and chromatographic methods;
- purity control of raw materials and technological processes control with GC, FTIR and AAS methods;
- determination of water content by the Karl Fischer method.

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- molecular modeling of structure and IR, Raman, VCD and NMR spectra of molecules of technological importance;
- interpretation of the experimental and theoretical vibrational spectra of organic molecules.

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- determination of formaldehyde contents in cosmetic products and their raw materials by HPLC method (according to the Decree of the Minister of Health as of 16.07.2004, Journal of Laws No 206, pos. 2106 as of 22.09.2004);
- determination of the composition of fatty acids in vegetable oils and animal fats by GC method (according to PN-EN ISO 5508:1996 and PN-EN ISO 5509:2001 standards);
- determination of nitrogen contents by Kjeldahl method.

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- development of analytical methods and procedures involving high pressure liquid chromatography;
- determination of organic compound mixtures of especially complicated and difficult to analyze composition by HPLC method.

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3) Inorganic analysis

- determination of metal content in aqueous solutions, organic and inorganic samples and samples with mixed organic-inorganic matrix by Atomic Absorption Spectrometry (AAS) method, including:

– determination of metals in water and wastewater;

– purity control of raw materials;

– determination of metal content in paints and dyes for the manufacture of paints, in varnishes, plastics and colourants of plastic materials;

– chemical composition analysis of catalysts and aluminosilicates;

– determination of metals in vegetable materials and oils;

– determination of trace amounts of toxic metals (Ba, Cd, Cr, Pb, Sb, Hg, As) in the articles of plastics, cosmetics, detergents, *etc.*;

– determination of trace metal content in the articles of paper;

– studies on toxic metals migration from the colourants in plastic materials coming into contact with food and from utility products made of plastics (packaging, toys, stationery, *etc.*);

- determination of anions in inorganic samples, water and wastewater.

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4) Real life scale and laboratory scale testing of non-food market products, including consumer panel tests

- laundry products: evaluation of primary and secondary detergency washing performance, incrustation, loss in tensile strength, fabric greying and yellowing, fabric shrinkage, dye transfer, fabric whiteness, fabric softening effect;
- liquid dishwashing agents: evaluation of washing performance by the IKW test, determination of fat emulsification power;
- toilet cleaning agents: evaluation of lime scale dissolution power;
- scouring milks and powders: evaluation of cleaning performance and surface damage;
- oxygen and chlorine bleaches: determination of stain removal power, fiber damage, color maintenance and fabric yellowing;
- fabric softeners: evaluation of softening effect, change in fabric whiteness and fabric rewetting power;
- window cleaners: evaluation of cleaning power, dry matter and alcohol content;
- shampoos: determination of foaming power by Ross Miles method;
- product quality evaluation tests including consumer tests of household chemistry consumer chemicals, cosmetics, personal hygiene products, candles, cemetery candles and other domestic use products in panel groups;
- evaluation of activated sludge respiration inhibition by raw materials and final products;
- selected analytical and physicochemical tests of raw materials and final products.

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5) The structural studies of solid samples by the Scanning Electron Microscopy (SEM) method and qualitative analysis of their composition

- structural studies of solid samples in the magnification range of 5–300 000x;
- investigation of polymers, polymer composites and films made of PP, PE, PVC, PS, *etc.*;
- characterization of materials used in electrolytic and batteries cells;
- investigation of powders, sintered plastics and lacquer coatings;
- nanoparticles studies;
- studies of structural defects and impurities in materials and the environment;
- microanalysis of materials - elements from boron to uranium, detection level for light elements above 0.5 wt. %, for other above 0.3 wt. %.

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6) Physicochemical analysis

- Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) studies on physical and chemical transformations (*e.g.* melting, crystallization, glass transition, curing, and phase transitions) in polymers and other substances; purity determination, *e.g.* for pharmaceutical raw materials;
- determination of the oxidation induction time (OIT) by DSC method;
- studies on degradation and decomposition of materials by TGA method;
- determination of thermal stability of polymers and other substances by TGA method;
- determination of the oxygen index, flash point, ignition and flammability testing of various polymers and plastics (according to UL 94 and HTL-15).

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- determination of tensile properties;
- determination of flexural properties;
- determination of compressive strength;
- determination of Izod and Charpy impact strength;
- determination of dynamic thermomechanical properties (DMTA) in the temperature range from -160 °C to 500 °C;
- determination of hardness (ball indentation method and Shore A and D scale);
- determination of tensile-impact strength;
- determination of Vicat softening temperature;
- determination of the melt mass-flow rate (MFR);
- determination of temperature of deflection under load;
- determination of kinematic viscosity.

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- determination of particle size in the range from 5 to 5000 nm by Photon Correlation Spectroscopy (PCS) method;
- determination of the zeta potential.

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- determination of dynamic viscosity of liquids, viscosity and shear stress *vs*. shear rate, determination of plasticizing stress. Adjustment of experimental data to the rheological model;
- determination of viscosity according to PN-EN ISO 3219 standard;
- determination of rheological properties of viscoelastic materials. Determination of changes in: loss modulus, storage modulus, complex modulus, complex viscosity, phase difference angle as a function of frequency;
- monitoring of resin curing processes, according to ASTM D 4473-01 standard;
- monitoring of gelling process during (polyurethane) foam formation.

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- determination of relative hardness of coatings on a glass substrate or – in justified cases (*e.g*. following the method the coating is made) – on a metal substrate, according to PN-79/C-81530 standard.
- monitoring of film formation from aqueous dispersions of polymers and copolymers, according to PN-90/C-89415 standard.

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- determination of apparent viscosity of liquid polymers, resin emulsions or polymer dispersions using Brookfield apparatus (according to PN-ISO 2555:1999 standard);
- determination of apparent viscosity of petrochemical products (according to PN-83/C-04023 standard);
- determination of UV curability of coatings, adhesives and other materials (ICRI own procedure);
- accelerated ageing of polymers and coatings in cycles (1 cycle = UV irradiation + moisture condensation). Number of cycles and ageing conditions – as agreed with the client or according to the relevant standard;
- ageing of polymers, coatings and other materials in summer and winter conditions in climatic chambers providing fixed temperature and humidity or under variable conditions (in cycles);
- samples conditioning at fixed temperature and humidity, according to the relevant standard, before the actual examination described in the standard is performed;
- determination of the percentage share of open and closed pores volume in rigid porous materials (according to PN-ISO 4590:1994 standard, clause 9).

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- determination of static and dynamic contact angles, computerized calculation of surface free energy of solids based on contact angle data, determination of surface and interfacial tension with the hanging drop method.

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- determination of coating gloss at the angle 20, 60 and 85 (according to PN-EN ISO 2813 standard) along with the statistics and transfer of results to a computer using PC software;
- nondestructive determination of thickness of coatings placed on various substrates, such as ceramics, glass or plastics (according to PN-EN ISO 2808 standard). Thickness range 13–1000 μm;
- determination of elasticity of coatings placed on a metal substrate according to PN-EN ISO 1519 standard;
- determination of coating resistance to scratching (scratching of a sample with an appropriate stylus tip under a defined force 0–20 N);
- cupping test performed on coatings on a metal substrate according to PN-EN ISO 1520 standard;
- determination of abrasion resistance of coatings and polymeric materials with the friction wheels (Taber) method;
- determination of coating impact resistance with the falling weight method according to EN ISO 6272 standard;
- determination of coating-substrate adhesion with the cross-cut method according to ISO 2409 standard;
- determination of leveling characteristics of paints and coatings according to ASTM D 2801 standard;

- determination of viscosity of liquid materials according to PN-81/C-81508 standard (Ford viscosity cups);
- determination of surface drying time and degree of dryness according to PN-79/C-81519 standard;
- determination of coatings elasticity by bending method according to PN-76/C-81528 standard;
- determination of coating-substrate adhesion according to PN-80/C-81531 standard;
- determination of coatings resistance to water according to PN-76/C-81521 standard;
- determination of mechanical stability of aqueous dispersions and suspensions in a centrifuge in the temperature range from -10 °C to 40 °C (at up to 18.000 rpm);
- determination of sedimentation of aqueous dispersions according to BN-74/6351-01 standard.

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1) Process safety

We offer services concerning:

- comprehensive risk assessment concerning dangerous chemical substances and processes involving these substances;

The Regulation of Minister of Economy from 8 July 2010 concerning minimal requirements of Heath and safety due to possibility of explosive atmosphere in the workplace (Dz. U. No 138, item 931 from 30 July 2010) needs, that employee is obliged to assess the risk of presence of explosive atmosphere in the workplace,

- examination of materials and technological processes in order to establish how much they are harmful to the human health;

Industrial Chemistry Research Institute is on the list of the Regulation of Minister of Heath and Social Care from 12 July 1996 concerning bodies which are able to examine materials and technological processes,

- development of safety reports and emergency plans, according to the „Law on environment protection";

„Law on environment protection" (unified text Dz. U. No 25, item 150 from 2008) states, that operator of upper tier establishment is oblige to prepare safety report and emergency plan,

- development of environment influence analyses for chemical industry plants, in relation to their build-up or privatization;

„Law on environment protection" (unified text Dz. U. No 25, item 150 from 2008) states, that in the vicinity of towns and urban regions the build-up of establishments posing the risk of major accident is allowed under the condition, that it will diminish the risk.

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2) Preparation and verification of Material Safety Data Sheets (MSDS)

We offer our capacity in preparation of MSDS

Almost every company involved in production, import or placing on the market will sooner or later come across substances or mixtures requiring preparation of **Material Safety Data Sheets.**

If some hazardous properties of a substance to be placed on the market come into sight, *e.g.:*

- explosive, oxidative, extremely flammable, highly flammable, flammable;
- toxic or very toxic, harmful, corrosive, irritant, sensitizing;
- carcinogenic, mutagenic, toxic for reproduction (CMR);
- dangerous to environment;
- fulfilling PBT (persistent, bioaccumulative, toxic) criteria

or

- substance is not classified as dangerous but: contains at least one substance depicted in the relevant regulations as causing harm to human health or environment, present in concentration of at least 0.1 wt. % in case of non-gaseous substances or 0.2 vol. % for gases; or contains above the same concentration of CMR (cat. 1 or 2); or for which workplace exposure concentration limits were established,

a Material Safety Data Sheet in an official language of a country where product is placed on a market is required.

Preparation of that data sheet is an obligation of a manufacturer, formulator or importer (from outside EU).

Material Safety Data Sheet is dedicated for professional users and enables them to adopt all occupational safety, health and environmental protection measures. It also provides consumer (through proper labeling) with a complete information about potential risks which may arise from using a particular substance or mixture.

A format of Safety Data Sheet which forms a set of information about dangerous properties of substances or mixtures and rules and recommendations for their safe use was set out in a EU Commission Regulation 453/2010 of 20 May 2010.

It is possible to prepare a Safety Data Sheet individually, on a basis of relevant knowledge (in particular while being a manufacturer) or, on a basis of one being delivered by a supplier (in case of being an importer or trader).

Very often however a SDS prepared by a supplier doesn't fulfill the requirements of polish law. Direct translation of an original text results in missing requirements of polish law and lapse in verification of *e.g.* classification provided by manufacturer.

If you would like to be sure that Safety Data Sheet which is in use in your company and which you present to your customers fulfills the requirements of UE law regarding chemicals and a label was designed properly, and in the same time you are of the opinion that our ancestors were right inventing societal sharing of duties, you are invited to use our assistance.

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EXPERIMENTAL PRODUCTION

1) Experimental production

Services concerning:

- **mixing of loose materials**

An agitator of „Nauta" type, 1 m^3 in volume, ability to mix loose materials and packing in 50 kg sacks

- **grinding**

Pebble mills (200, 100 and 50 l in volume) - ability to grind and sift ground materials

- **conducting of chemical reactions**

Reaction apparatus sets including chemical reactors (1000, 500, 200, 100 and 50 l in volume), fit with slow-rotating stirrers, with cooling capability, deaerated through reflux condensers

- **distillation**

Simple distillation apparatus sets including a distillation tub (500 and 200 l in volume), fit with a heat exchanger, a condenser and a receptacle

- **rectification**

Apparatus sets including a rectification tub 1000 l in volume, a distillation column with filling, a phlegm separation funnel, a heat exchanger, a condenser and a receptacles

- **conducting of unique processes on the half-technical scale**

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2) Products offered by the Industrial Chemistry Research Institute

- **Konsil Z**
- **Konsil Z Super**

Two-component silicone waterproofing agents for external use on stone (sandstone, marble, granite and terrazzo) and for maintenance of masonry, walls, sculptures, monuments, tombs, bricks and other porous construction materials.

Konsil Z Super also features anti-fungus and anti-lichen properties.

Konsil Z and **Konsil Z Super** packaging available: 1 l, 5 l, 10 l, 30 l and 60 l.

- **Acid-based cleaning agent**

Agent for chemical cleaning of building facades, stone surfaces (sandstone, granite, terrazzo and clinker bricks) and skylights, industrial facilities, glasshouse walls.

Packaging available: 1 l and 5 l.

- **Leposil K1**

Two-component silicone binding agent used with putty and mortar to fill in creases and dents in sandstone, limestone, marble, brick and gypsum.

Packaging available: 0,5 l and 1 l.

- **West marine glue**

Two-component epoxy glue, used for cold gluing of wood, especially in boat-building.

Packaging available: 5 kg glue + 1 kg hardener.

- **Kolakryl**

Acrylic glue used in manufacturing of various adhesive materials such as tape, labels and wallpaper.

Sold by the kilogram.

- **Motofix – liquid seal**

Liquid polyurethane sealant used for sealing flat and threaded metal surfaces.

Packaging available: 4 kg.

- **Pollena Jod K**

Iodophor cleaning agent (killing bacteria, mold and viruses), used for sanitizing facilities, equipment and vehicles applied in transportation of farm animals.

Packaging available: 1 l (1.25 kg), 5 l (6.25 kg), 10 l (12.5 kg) and 30 l (37.5 kg).

- **Peel-off lacquer**

Lacquer used for insulating parts during plating (electro-galvanizing) of various products *e.g.* knife edges during silver-plating. It provides protection of transported metal goods from the elements.

Packaging available: 3 kg.

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INSTITUTE FOR CHEMICAL PROCESSING OF COAL

(Instytut Chemicznej Przeróbki Węgla)

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Institute for Chemical Processing of Coal (IChPW) was established in 1955 as an R&D centre of coal processing industry. The scope of the Institute's activity includes the following areas:

- biomass processing technologies (pyrolysis, gasification and combustion),
- thermal waste processing,
- dispersed heating systems,
- fossil, renewable & alternative fuels,
- coal & biomass fired power plants,
- coke making & carbochemistry,
- high temperature refractories for industry oven.

The Institute employs 240 persons including 13 professors and 34 doctors. Our works are addressed to economy, ICHPW is also an active partner in large strategic projects. The Institute has a management system according to ISO 9001. Our testing laboratories operate in accordance with the ISO/IEC 17025 system. Proficiency Testing Centre of the Institute, assures that it appointed, implemented and maintains a management system corresponding with the scope of activity and including the type and scope of the skill researches, which is offered. The system is compliant with the requirements of the accreditations set in the ISO/IEC 17043 norm and in the PCA DA PT-01 document. Partners of the Institute comprise largest domestic universities and many foreign institutes, including those from the USA, P.R. of China, Japan and the EU.

The main commercial partners of the Institute are: coal carbonization plants (coking and steel industry), power and CHP plants, industrial and municipal heating stations.

Examples of research themes and activities addressed by the Institute include:

- gasification of coal in fixed and circulating fluid bed,
- development and deployment of co-firing technology, procedures and certification in Poland (over 20 power and CHP plants),
- industrial application of a biomass gasification unit 5 MWth,
- development and dissemination of analytical standards for biomass,
- development of high efficiency dedusting system for medium size boilers (20 - 200 MWth),
- establishment of industrial supervised laboratories for power plants LABIOMEN,
- development and licensing for manufacturing high efficiency small capacity boilers in the range 25 - 500 kWth.
- coal drying in an impact dryer of 100 kg/h scale,
- carbon dioxide removal in an absorption reactor in the scale 20 - 100 m3/h gas input containing CO_2 (new project),
- Mathematical modeling and process simulations.

PROJECTS / SPECIAL AREA OF EXPERTISE

- Biomass and coal co-firing systems for municipal purposes, certification of solid fuels fired power boilers of small and medium power – 1100 certificates
- Biomass co-firing technologies – over 20 cases of “green certificates” implementation for the power industry
- Coal pyrolysis and gasification technologies in shaft, rotating and fluidised bed reactors (several plants)
- Valorization of waste organic products
- Industrial gases conversion technologies
- Establishment and management of National Network of Supervised Laboratories “LABIOMEN” – 44 licensed industrial research laboratories
- Accreditation of a group of testing laboratories at the Polish Centre for Testing and Certification – 114 accredited testing methods.
- Smokeless fuel and granulated fuels production technology based on coals and biomass
- Fluidized bed ash management technologies
- Coke-oven batteries construction, reconstruction and start-up technologies (21 batteries)
- Char production and coal powder for injection to a blast furnace preparation technologies (2 steelworks)

1) Biomass Gasification – Electricity and Heat Generation in Dispersed Sources

The conversion of biomass chemical energy into the energy of inflammable gas in the process of solid fuels gasification substantially increases the scope of solutions applied for energy biomass use. The application of process gas in gas CHP cogeneration systems, which cogenerate electricity and heat and/or cold seems especially attractive.

The IChPW has a technology of electricity and heat generation from biomass. The plant comprises: an innovative gasifier with a solid bed (GazEla), a system for dry purification of gas and an electricity generator. The Institute has implemented a bench scale plant of 60 kWt power and a demonstration scale plant of 1.5 MWt power.

The gasifier with a solid bed features a novel design enabling collection of gas directly from the gasification zone, a system for dry purification of gas and a dual-fuel piston engine. The plant enables generation of electricity and heat.

Such systems may be used in all places, where there is a demand for electricity and heat and also where local biomass sources exist. Potential buyers of the technology include timber processing plants (sawmills, briquettes and pellets manufacturers) and farms. The use of biomass – production waste – seems especially attractive, as it may be effectively used as a fuel for cogeneration plants.

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2) Removal mercury from coal using low-temperature pyrolysis

The process is based on thermal treatment of coal ('low-temperature pyrolysis') before combustion/gasification. Results of research (carried out at the Institute for Chemical Processing of Coal) has shown promise for the substantial reduction of mercury in fuel using the process of low-temperature pyrolysis (60 and 90% reduction for hard and brown coal respectively). The process allows for high efficiencies in Hg separation without exerting a significant influence on the properties of cleaned coal (slight decrease in volatiles content and in chemical enthalpy of the fuel and an increase in calorific value).

Plant for coal cleaning consists of drying and pyrolysis zones. Heat carrier for the process is a flue from additional coal combustion.

Coal fed into the system is divided into two streams. One stream is directed to a combustion chamber where the flue is generated, as the heat carrier in the process. The second stream of fuel (mercury removal) is directed to a fluidised bed dryer. After passing through the dedusting system (e.g. bag filter for separation of fine fuel particles carried from the drying unit), the flue gas from the drying system is partly recirculated to the dryer and partly released to the atmosphere through a heat exchanger, where the water removed from the fuel is condensed and the heat recovered. The dried fuel is directed to a pyrolysis reactor (indirect heated rotary reactor). From the pyrolysis reactor, mercury is swept with the pyrolysis gas and with an inert-carrier gas additionally fed to the system (the carrier gas is nitrogen in the concept considered here). The carrier gas with a high concentration of mercury is directed to a mercury separator, where Hg is extracted from the gas e.g., by adsorption in a fixed bed reactor. The flue from the pyrolysis reactor system is divided into two streams: one is recirculated to the system and the other cooled in a cooler, where the moisture contained in it is condensed and the heat recovered. The cleaned coal is directed to a storage yard or directly to combustion/gasification (the most favourable option because of the use of the physical enthalpy of the hot fuel).

Technology is under development, research work in large laboratory/bench scale and detailed technical-economic analyses are in progress.

Technology is dedicated to power and coal mining industries.

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3) KARBOTERM - waste plastics utilisation in cokemaking industry

The problem of utilisation of non-biodegradable waste plastics is the one of the non-fully solved environmental problems. In Institute for Chemical Processing of Coal it was elaborated the technology of waste plastics processing making possible to use them in coke production.

The essence of the technology is the thermal preparation of broken-up waste plastics in the presence of bitumens (hydrocarbons mixture). As the result of temperature (350 0C) a chain decay of polymer is observed. If the process is carried out in the presence of bitumens (waste plastics/bitum weight ratio = 4/1) the yield of liquid products from polymer decay is minimised. It is the two-stage process where we can control the hydrogen chloride release and therefore minimise the chlorine content in the product. As the result of waste plastics thermolysis the hot liquid product is obtained which is next directly cooled by contacting with a hard coal of natural moisture content. The final product is called the karboterm - it is the substitute of coal. A combustible process gas as well as hydrochloric acid are also released in the process.

The broken-up waste plastics from selective waste collection and municipal waste sorting-lines are a feedstock. In the technology also bitumens are applied (e.g. coal-tar pitch, asphalt, anthracene oil) received on a commercial scale as by-products in Polish coking and petroleum industries.

The karboterm is a solid fuel of full value recommended in cokemaking industry as a component for coal blend. The karboterm is a solid material of physicochemical properties nearing to hard coal. The amount of waste plastics in karboterm is about 20 %. The karboterm can be also applied in heat-generating and power industries.

The ecologically clean and market attractive Karboterm technology can be applied e.g. in coking plants.

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4) System for the automatic control of the coke oven battery's firing

„System for the automatic control of the coke oven battery's firing" has been developed in the Institute for Chemical Processing of Coal, based on the analysis of collected technological data (calorific value of the fuel gas, coal charge humidity, implemented schedule of coal chamber charging, crude coke oven gas temperature, temperature in the control heating flues, temperature alongside the pushed coke). The system selects valid temperatures in the heating flues and adjusts gas pressure in the side pipelines and duration of firing break. The amount of air flowing through the battery's heating system is reduced during the firing break thanks to some modifications in the battery's reversing system.

As our research and observation have proved, this method of adjusting the battery's firing system has, most of all, excluded the need for burdensome adjustment of the battery's hydraulic parameters with every change in production capacity level, or even coal charge parameters. In a natural way, temperature in the heating flues has been lowered in compliance with the changes in production capacity, and temperature distribution on the particular walls remained practically unchanged, with no need for adjustment elements exchange. Even though, the coke oven battery is still a device with limited possibilities of production capacity adjustment (because of its construction material, namely silica), implementation of the automatic firing control system has significantly improved this capacity and, most of all, has limited the influence of manual analysis.

Our experience has also shown that the developed method enabled a considerable lowering of heat usage for coking process (5-10%) compared with the previous methods of controlling the firing conditions.

Our system has been implemented and tested in several operating coke oven batteries in Poland.

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INSTITUTE FOR ENGINEERING OF POLYMER MATERIALS AND DYES

(Instytut Inżynierii Materiałów Polimerowych i Barwników)

Institute for Engineering of Polymer Materials and Dyes consists of:

- Institute for Engineering of Polymer Materials and Dyes in Toruń
- Branch House for Elastomers and Rubber Processing in Piastów
- Branch House for Paints and Plastics in Gliwice

INSTITUTE FOR ENGINEERING OF POLYMER MATERIALS ABD DYES IN TORUŃ

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Technological Laboratory

Laboratory performs assessment of physicomechanical properties of polymers and plastic products.

Post of resistance tests comprises of tensile testing machine (TIRA GmbH) with computer controlled that makes possible performing measurements with simultaneous plotting of data:

- mechanical properties at static tensile, compression and bending according to the standards PN-EN ISO 521 1-3, PN-EN ISO 178,
- tear resistance by a trouser tear Elmendorf tear strength according to the standard PN-EN ISO 6383-1-2,
- resistance to tear off of layers according to the standard PN-88/C-89099,
- index of the bond strength according to the standard PN-C-89258-1 p3.18,
- coefficient of static and dynamic friction according to the standard PN-EN ISO 8295,
- interadhesion of film layers according to the standard PN-71/C 89095.

Capillary plastometer (Dynisco) offers assessments of indexes of mass (MFR) and volumetric (MVR) flow of polymers according to the standard PN-EN ISO 1133.

Moreover we asses:

- impact resistance (Charpy, Izod and impact tensile method) according to the standard PN-EN ISO 179-1,
- impact strength assessed with falling dart method according to the standard PN-EN ISO 7065-1,
- change of linear dimension during heat treatment according to the standard PN-EN ISO 11501,
- gloss, light transmittance, haze according to the standard PN-EN ISO 13468-1, ASTM D1003-11,
- density with gas pycnometer according to the standard PN-EN ISO 1183-3,
- microscopic assessment of multilayered films,
- time of thermal stability of PVC blends,
- watervapour permeability (Dansensor apparatus) according to the standard PN-EN ISO 15106-1,
- gas permeability (e.g. oxygen, helium, nitrogen, argon) according to the standard PN-EN ISO 2556.

Concurrent twin screw extruder BTSK 20/40D is available for technological tests of manufacturing of composites of polymer plastics, by addition of other polymers, powder extenders and modifying agents. These composites are processed on injection moulding machine Battenfeld Plus 35/75 into profiles – bars, dumbbells, plates that are subjected to testing.

Tests and trials of extrusion of films made of various polymers and mixtures in each layer are preformed on the assembly line type 3xW25 for manufacturing of 3-layer films.

As our research activity covers also activation of films and sheets by corona charging, Technological Laboratory offers measurements of their free surface energy with Kruss goniometer and wettability with model liquids.

We sell testers – ink or stick - for evaluation of level of surface activation, with measuring range from 30 to 73 mN/m.

Section of Technological Testing

We develop new technologies for manufacturing of utility products made of polymer plastics. We produce ready profiles, containers and shapes in low-tonnage scale as well as granulates of

composites and nanocomposites based on polymers. In addition our staff offers its service in issues concerning choice of right raw materials for high-quality products.

Our Section of Technological Testing is equipped with:

- assembly line for extrusion of profiles (Barmag extruder L/D=45),
- assembly line for co-extrusion of profiles coated with monolayer (screw extruder L/D=32),
- assembly line for manufacture of polymer composites as granulate with concurrent twin screw extruder 2T40W with gravimetric dosage system,
- assembly line for manufacture of flat film of width up to 500 mm,
- stand for testing extrusion processes of polymer profiles with screw extruder Barmag L/D=45,
- assembly line for blowing extrusion for manufacture of containers (1 – 10 l),
- milling assembly for polymer waste – mills UR 250 and UR 16.

Equipment and machinery for plastics processing offered by IMPiB

Technological assemblies for manufacture of PE, PP, PS, PET, PVC films

Technological assemblies are designed for production of single and multilayered sleeve films. Design solutions of particular technological units (extruder, extrusion head, fused plastics filter, receiving or winder set etc.) are adjusted to properties and field of use of film as well as to the needs of a customer.

Technological assemblies for production of PE, PP, PVC pipes and profiles

We offer technological assemblies for production of pipes with diameters up to 400 mm and of profiles (sidings, window sills, profiles for construction industry, sheets and traceways for electroinsulating wires).

Technological assemblies for PE, PP and PS waste granulation

Our technological assemblies are designed to reprocess (regranulate) waste – in form of agglomerates or a milling. Reprocessing may be done either in cold or in hot regime, according to the demand of a customer.

Single and twin screw extruders

- single screw extruders for PE, PA, PS, PP, PET and PVC processing,
- concurrent cylindrical twin screw extruders for processing of PE, PP, PA, PS, ABS also with mineral fillers,
- backward cylindrical twin screw extruders for processing of PVC dry-blends.

Plasticizing units (cylinders, screws) of extruders are optimized for a particular uses and quality demands set for the product. Concurrent screws, because of their purpose, have segmented structure of a cylinder and a screw. Additional fittings of extruders e.g. controlling system, graphical visualisation and saving processing data are also possible.

Equipment UFP series for forming containers

This equipment is designed for blowing extrusion of PE, PP and PVC containers of volumes up to 5 dm^3. Additional fitting is possible e.g.: a set for regulation of a wall thickness of an extruded "hose" or a set conveying granulate to the extruder.

Intensive mixers MJI and MDI type

- one-stage MJI (with one chamber) of mixing capacity up to 1200 kg/h, designed for mixing powdered materials. Blends are used in food, pharmaceutical and other industries.
- two-stage MDI (with two chambers) of mixing capacity up to 1200 kg/h, designed for mixing powdered PVC with solid additives. Blends are used for profiles or pipes production

Equipment UR type for grinding PE, PP, PVC waste

Mills are used to grind various types of wastes (pipes, profiles, containers, foils, packs) made of all range of thermoplastic polymers. Capacity of mills reaches 1200 kg/h. This equipment may have additional features e.g conveyor sets for transportation a waste to the mill' funnel and sets collecting grinded waste (e.g. pneumatic sets with dust separators) and also soundproof casing.

Equipment A and AZ type for thickening of PE and PA films waste

A and AZ type equipment is designed to thicken clean and contaminated film' waste. It has low energy and water consumption, an agglomerates produced with A and AZ type equipment have bulk density of 0.4 kg/dm^3.

Equipment for activation of PE, PP, PA, PET, PVC films

Designed to run modification process of an upper layer (activation) of a film (up to 2500mm width), and pipes activators (up to the diameter of 1200 mm).

Training Activity of Institute for Engineering of Polymer Materials and Dyes

Institute organizes trainings and courses for entrepreneurs and personnel working in plastics processing industry. The scope of those trainings and courses is determined each time separately to meet needs of our customers. Lectures are given by scientific staff of our Institute, who are experts in plastics processing.

Training and courses:

- **Basics of plastics processing**

– plastics, properties and use,

– manufacturing of plastics products by extrusion.

- **Construction of equipment and tools for extrusion of plastics**

– screw extruders,

– one and twin-screw plasticizing systems,

– power transmission systems of screws, cylinders heating-cooling systems, control systems,

– assemblies for extrusion,

– control of extrusion,

– activation of films.

- **Practical problems of PVC processing**

– manufacture, types, properties of PVC, PVC v. recipe components,

- gelation of PVC,
- extrusion technologies, co-extrusion,
- plasticizing systems of extruders, construction demands and heads for PVC.

- **Extrusion Processing of Packaging Films**

- theoretical basis of film extrusion,
- technologies and equipment for film extrusion (blowing extrusion and flat films),
- control and stabilization of extrusion,
- optimization of the structure of multilayered films,
- films defects and methods of avoiding them,
- laboratory – methods of evaluation of properties,
- recycling of film waste.

- **Intellectual and industrial property**

- patents for inventions,
- copyrights and exclusive rights,
- protection of trademarks and utility patterns,
- rights resulting from registration of patterns, topography of integrated circuits, geographical sign.

Institute runs secretariats of following Standardization Committees:

KT 140 for Pipes, Profiles and Fittings made of Plastics

System standards relating to all aspects of areas of use of plastic pipes: drainage systems, sewage systems, water supply systems, heating systems, gas and industry systems as well as for test methods.

KT 168 for Plastics Products

Aspects related to plastics processing, plastics products, semi products including properties and test methods of thereof, porous and strengthened materials and self-adhesive tapes.

KT 175 for Paints and Varnishes

Paints and varnishes and products of a similar type and raw materials for paints and varnishes (excluding pigments and extenders) – terminology, classification, demands, test methods including test methods for various usage areas; preparation of steel surfaces prior to paint application and paint-like products.

KT 240 for Machinery and equipment for Processing Plastics and Rubber Blends

Machinery and equipment for processing plastics and rubber blends including: extruders and additional machinery, special purpose press, injection moulding machinery, blenders, machinery for waste processing and instrumentation and technologies related to those machines/equipment.

PRIK

Our institute is a proud member of a The Polish Association of Plastic Pipes and Fittings Producers (PRIK). PRIK activity focuses on integration of the branch of pipe and fittings producers. PRIK acts as representative body of the branch in contacts with administrative and legislative bodies, as well as other national and international organizations in issues concerning legislation and standardization, directives and recommendations on plastics processing, usage and recycling or pipes and pipe-like plastics profiles.

BRANCH HOUSE FOR ELASTOMERS FOR AND RUBBER PROCESSING IN PIASTOW

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Research and Development Activity

Our mission is R&D tasks activity leading to new technical and technological solutions, supporting development of the rubber industry and increasing its level of innovation and competitiveness, to keep up with or gain over foreign companies.

Main activities:

Our activity is focused on R&D in chemistry and technology of elastomers, in particular:

- elaboration and implementation of rubber processing, designing novel rubber products,
- tests concerning strengthening of, adhesion, crosslinking and miscibility of elastomers and other materials used by the industry,
- elaboration of manufacturing methods of elastomeric nanocomposites, structure and properties testing,
- elaboration of preparation methods of rubber blends for powder latexes and powdered pre-mixtures of latexes and extenders in continuous blending process,
- utilization of materials from renewable sources as components of rubber blends
- modification and synthesis of elastomers,
- improvement of test methods of elastomeric systems,
- exploitation of specialty elastomers in military and aviation industries,
- compatibilization of latex blends,
- elimination of the negative influence of the rubber industry on the environment,
- recycling issues and devulcanization of rubber.

Our partners represent all sorts of industries:

- car producers,
- aviation industry,
- military industry,
- agriculture,
- construction industry,
- mining,
- food processing industry,
- medical equipment producers.

Dissemination of Knowledge

Informative activity of the Elastomers and Rubber Technology Division includes gathering, elaboration, processing and dissemination of information about chemistry, physics and processing of elastomers.

Division possesses:

- collection of specialist books,
- wide range of specialist magazines, both polish and foreign ones.

We also edit magazine “Elastomery”, published bimonthly and focused on issues important for rubber industry. Both scientific and technical articles describing results of R&D investigations of polish and foreign research institutes and industry research teams are published in “Elastomery” magazine. “Elastomery” is listed in the Polish Scientific Committee register of leading scientific-technical magazines.

Articles are published either in English or in Polish languages, abstracts are always bilingual. All articles submitted to the editor are reviewed.

“Elastomery” are reported in Chemical Abstracts and Rapra Abstracts

Apart from publishing activity we also:

- prepare specification on given subject,
- prepare lectures and literature surveys,
- organize specialist courses and trainings concerning rubber industry for the process engineers, personnel of the factories test laboratories and for the technical surveillance personnel.

PCA Accredited Laboratory Labgum Accreditation Certificate No AB 147

Chemical Properties Testing Unit

- tests of raw materials for conformity with specifications,
- tests of rubber products that come in contact with foodstuffs,
- analyses of the composition of blends and vulcanizates for the estimation of their use in recipes, for monitoring the composition, to solve exploitation and technological problems,
- estimation of the presence of trace amounts of N-nitrosamines,
- identification of blooms on the surface of a rubber,
- tests of thermal properties of materials.

Physical Properties Assesment

Tests of:

- processing properties of latexes and blends,
- durability of rubber,
- basic physical properties of rubber,
- hardness, density, elasticity, wear resistance,
- resistance to liquids (fuel, oils),
- resistance to elevated temperatures (accelerated ageing) and to ozone,
- resistance to the influence of low temperature,
- relaxation and attenuation.

BRANCH HOUSE FOR PAINTS AND PLASTICS IN GLIWICE

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Paint and Varnish Laboratory

Activity of Paint and Varnish Laboratory focuses on technical consulting, assessment of properties of paints, varnishes, resins and binders as well as the development of technologies for paint industry. Our offer is addressed to producers and users of paints and varnishes.

We develop:

- new technologies of manufacturing of resins and binders for technical purposes,
- new manufacturing technologies of coatings for substrates (metal, wood, plastics, mineral) for specific purposes,
- technologies of removal of coatings.

We test:

- properties of new materials for synthesis of binders and coating materials,
- properties of pigments, extenders and additives,
- properties of liquid paints and dry coatings,
- resistance of coatings to weathering (in natural and accelerated conditions),
- recycling.

Implementation of:

- ecologically friendly technologies as alternatives to existing ones,
- new raw materials for production of coatings.

Expertise of:

- state of coatings applied to various substrates.

Production of:

- coatings materials for special purposes, developed and prepared according to customer demands.

Technical consulting.

Plastics Laboratory

The activity of Plastics Laboratory focuses on:

- development and implementation of masterbaches with PE, PP, PS and other carriers,
- development of manufacturing technology of thermoset and thermoplastics,
- physical and chemical modification of plastics,
- selection of raw materials for manufacturing of defined product,
- expertise of raw materials and product quality, solving of problems occurring during plastics processing ,
- physicochemical tests of plastics and products performed according to Polish (PN), European (EN) and other standards (ISO, DIN, ASTM),
- market overview,
- assessment of demands concerning quality of plastic products,
- expertise of innovation potential of technological processes of polymer production,
- development of fire retandancy of thermoset resins and polyolefines by using halogen-free additives,
- development of oxo-degradation technology,
- processing of biodegradable plastics and manufacturing of packaging made of them (PLA, photo-oxo-degradable plastics),
- testing of stabilisation and degradation processes polymers, mainly polyolefines,
- technology of material and plastics recycling (including reused plastics mixtures and wastes,
- development of technology production of single and multilayered sleeve films (blown and cast).

Laboratory equipment for plastics processing:

- rolling mill,

- press,
- Brabender plastometer,
- Brabender absorption meter,
- hot-cold fluid mixer.

Equipment for determination of flammability of polymer materials

- cone calorimeter,
- stand for testing of oxygen index,
- stand for determination of flammability classification.

Equipment for determination of physicochemical properties of polymer materials:

- Instron testing machine,
- absorption meter,
- plastometer.

Bureau for Standardization and Certification of Products (BNC)

Certification of products is performed according to the procedure comprising of:

- tests and evaluation of project quality (type),
- evaluation of suppliers quality system,
- supervision by periodical controls of suppliers quality system as well as testing and evaluation of the quality of the control samples taken from the suppliers and/or purchased on the market.

BNC is accredited by Polish Centre for Accreditation (PCA) and the scope of accreditation covers:

- paints and varnishes,
- plastics products, including pipeline systems,
- diluents,
- packaging.

The scope of accreditation is available on PCA and Institute's web sites – www.pca.gov.pl and www.impib.pl respectively.

Certification Unit is authorised to certify products for conformity with international, European and national standards, instructions, technical criteria and technical approvals.

Certification Unit is also authorised to certify products for conformity eco-sign "E". Eco-sign "E" is reserved by Institute.

Conformity certificates are valid for three years.

All tests covered by the scope of accreditation are performed by Accredited Laboratory (accreditation No AB 163) that operates within the organizational structure of IMPiB - Paints and Plastics Division. The tests may be also performed by other national laboratory possessing PCA accreditation.

Bureau for Standardization and Certification of products is responsible for ensuring confidentiality and impartiality of its staff, contractors, members of the Technical Committees and Certification Unit Council regarding all information gained during the certification procedures and supervision, except of the law enacts.

Analytical Laboratory

Analytical Laboratory is accredited by Polish Centre for Accreditation (PCA) No AB 163 and performs:

a) tests performed by accredited methods:

- properties of liquid paints,
- physicomechanical properties of coatings,
- evaluation of VOC levels in paints by means of Gas Chromatography,
- accelerated weathering tests of coatings and plastics (using light emitted either by xenon or fluorescent lamps),
- neutral salt tests to estimate corrosion resistance of coatings and zinc films,
- tests of child-resistance packaging,
- endurance tests of plastics products and pipes, fixtures and profiles made of plastics,
- tests of thermal properties of polymers by means of DSC and TGA,
- estimation of softening point by Vicat apparatus,

- estimation of the amount of vinyl chloride monomers by GC,
- estimation of concentration of Pb, At, Cd, Cr, As and Ba by means of AAS.

b) tests performed by non-accredited methods

- test of global migration into model liquids products made of plastics,
- identification of organic and inorganic compounds by means of FTIR and spectrophotometry,
- identification of composition of solvents – GC analysis,
- tests of viscoelastic polymers with DMA.

Disssemination of Knowledge

Paint and Plastics Division edits two bimonthly magazines in the field of science and technology devoted to paint and plastics entitled “Paints and Varnishes” (in Polish: Farby i Lakiery) and “Plastics Processing” (in Polish: Przetwórstwo Tworzyw”). Both magazines are listed in Polish Scientific Committee register of leading scientific-technical magazines. Articles are published in Polish; abstracts are published in Polish and English. All articles submitted to the editor are reviewed.

Paint and Plastics Division is a regular organiser of international conferences devoted to paints and plastics entitled “Advances in Coatings Technology “ and “Advances in Plastics Technology”. Each conference is organised every second year. Representatives of leading European and world enterprises present in English their latest achievements in the field of paints and plastics.

COOPERATION OFFER/DESCRIPTION OF TECHNOLOGIES

1) Removable, sustainable composites on the base of polymeric materials reinforced by micro- and nanofibres.

The usage of composites in modern industry, and other areas of economy, is growing especially in building and transportation (aircraft, train, car industry). For this reason, also supported by the growing environmental awareness, it is very important, that future composites have to be generally produced from renewable and sustainable row materials. Recent reports about negative role of carbon nanotubes on human health have brought more attention to lignocellulisic micro and nano-fibres as reinforcing material to polymers, which can be produced from renewable resources. Polymers from renewable resources such as: polyhydroxy alkanate and succinic acid can be converted to many commercial polymers and fibres. New and recently developed techniques for extraction of micro- and nano- cellulosic fibres i.e.: enzymatic, ultra sound steam explosion help to process lignocellulosic row materials to more fine and homogeneous fibres. These can be successfully used as excellent filler and reinforcing fibrous materials for modern composites, also can be designed to work under extremely conditions.

2) Development of low combustible and stable against biodeterioration polymer nanocomposites with nano-dispersed fillers including carbon nanotubes.

The important problem of many produced and applied composites is their flammability and non-stability against biodeterioration. In order to improve above mentioned features, composites with addition of flame retardants and biocides (to prevent them against virus, bacteria and fungi attack) need to be made.

Generally, these additives (very often more than 10 % w/w of flame retardants and biocides) decrease the physicomechanical properties of composites. The latest research showed, that nanodispersed flame retardants and nanobiocides significantly used below 10 % weight (concentration 2 – 3 times lower) have a positive effect; decrease flammability and biodeterioration ability of composites. There are many known examples of an effective use of carbon nanotubes, nano-clay and nano-melamine-polyphospate. Many of the nanofillers show also synergistic effect and in some case intumescent, fire barrier effect.

3) Application of an effective biocide against microbial attack as component polymers and coating materials.

In order to get protection against biodeterioration, many different biocides are being used in majority of produced polymers composites and coating materials. They are active against gram plus and gram minus bacteria, viruses and fungi. Many of the commonly used biocides are environmentally hazardous and they do not meet of REACH systems demands. The very wide application's area of polymers, paints and composites such as: building industry, transportation, agriculture and packaging demand to avoid decomposition and functionality decrease of the material due to biodamages. The problem of biodamages comprises a wide range of scientific and practical tasks. These are associated with protection of row materials, intermediates and products against damaging by bacteria, fungi, insects and rodents during long terms production, storage, transportation and the use in different climatic conditions. Biodamages can influence on properties of polymers, rubber composites, textiles, wood, leather, paper, building causing significant change in their functionality, quality reduction and in some cases even completely destroy them. Special attention will concentrate on natural biocides (which are more environmentally friendly) such as agrofine chemicals – like essential plants oils, bioactive polypeptides and their relatives, and relatives of 2 qinolino-carboxylic acids and some nano-compounds.

4) Mutli layer composites on the base of fabrics and rubber.

The textile-rubber goods, in which textiles are a main constituent, are designed to take advantage from properties of reinforces textiles and resistance of rubber coating in order to operate in environmental conditions. Besides properties of both bonded materials, durability of these good is determined by adhesion between both materials. In their production process the increase of bond strength between synthetic textiles and elastomers is usually achieved by coating of cords or textiles in the RFL bath. A modern, less awkward and recently developed way is incorporation into rubber compounds special chemicals called adhesion promoters e.g.: (Patent No. 187856 "Method of bonding textiles to rubber without impregnation")

Adhesion between rubber and cords (polyamide PA, polyester SP or viscose VISC) in all experimental compounds of carboxylated-butadiene rubber (XNBR) is seven times higher in comparison to adhesion between standard natural rubber compound and polyester (or polyamide) cords, but coated by RFL system.

Appropriate selection of fillers and curing agents (convectional or unconventional) ensures required properties for textile-rubber products. Usage of adhesion promoters is less complicated and inconvenient, that adhesive impregnation from technological and technical point of view.

Rubber coated fabrics can be used as a semi product for lining of driving belt with a driving strand made from oriented polyamide foil. Multilayer driving belts are used in many industrial branches.

5) Sealing mass on the base of polymer for modern building applications.

This proposal concerns the establishment of an innovative product, a sealing mass for production of tapes and sealing profiles with the usage of rubber waste. The use of rubber waste for production of sealing masses has a proecological effect.

Currently used sealing masses exposed to high temperatures i.e.: roof accessories, where temperature can easily reach 100 °C, increase their fluidity, what has an adverse impact on their functionality. Development of suggested technology should help to eliminate this serious disadvantage of currently used products.

In this proposal it is expected to investigate the influence of compound such as: resins, oils and fillers as well as multilayer (lamellar) fillers on the plasticization of rubber.

Lamellar fillers effectively improve barrier properties of the material by decreasing diffusion of gases and liquids. They also decrease migration of plasticizers to the surface of the product, what prolong the product lifetime by the increase in resistance against aging in environmental conditions. That is why lamellar fillers will be optimized for control viscoelastic and barrier properties of the materials.

The main aim of this proposal is to establish technology, in which the correlation between cohesion in sealing mass and its adhesion to the surface can be found.

The study of adhesion and cohesion properties of the sealing mass will be investigated as follows:

- tack – with the accordance to international standard AFERA 4015,
- adhesion – with the accordance to international standard AFERA 4001,
- cohesion – with the accordance to international standard AFERA 4012,
- destruction of the adhesive – tearing the layer of sealing mass from the surface,

  destruction of the cohesion – destruction of the sealing mass.

6) New technology of bisphenol A

A new technology for the production of the highest grade Bisphenol A (BPA) is offered, which can be further applied as the key component to obtain epoxy resins and polycarbonates, respectively. The last represent modern plastics commonly applied in building construction, electronics, optics, aviation and car industry.

Intellectual property of the offered BPA technology is protected by two European patents, No. EP 1809589, EP 2090562 A1 and one international PCT patent application No. PCT/PL2011/000010.

The older version of the technology in question was implemented industrially in the "Blachownia" Chemical Works, Kedzierzyn-Kozle, in the year 1978 (now PCC Synteza S.A.) and further became the subject of license exported 8 times to: China, India, Korea, Iran and Taiwan, within the years 1987-1999.

Among the years 2006 and 2009 a new, upgraded energy saving version of the technology was developed by the authors in the Institute of Engineering of Polymer Materials and Dyes, located in Torun. It is presently offered as the "Chemwik® BIS process".

The New BPA technology was verified industrially in the years 2008-2009 in a scale of 15 000 t/y, at PCC Synteza reference plant located in Kedzierzyn-Kozle, Poland.

The technological offer includes: licensing, basic design, technical services - like personnel training, author supervision on purchase and accomplishment of equipment and start-up of the plant, as well as further development and implementation of improvements for the licensee.

Two dedicated multimedia presentations are available for interested clients, whereas one presents the offered BPA process (35 min.) and the other visualizes of the PCC Synteza reference plant (40 min.), respectively.

7) New, anti-static paint for the production of surgical mattresses.

The invention relates to a technology of producing and applying a new, anti-static paint intended for coating of flexible polyurethane foams used to manufacture of mattresses for surgical tables. Compared to the previously used anti-static paint, the paint made according to the invention distinguishes itself by improved chemical resistance. This allows the surgical mattresses to withstand repeated disinfecting and maintain permanent electrostatic properties, with an extensive range of used disinfectants, containing such active substances as alcohols, aldehydes, peroxides or quaternary ammonium salts. The invention ensures more effective protection against microbiological contamination in hospitals.

8) Waterborne paint for decorative-protection painting of polyurethane foams for building industry.

The subject of offered technology is a new ecological paint for protection of foams against UV radiation used for thermo- and hydro insulation of roofs in building industry. The paint protects effectively the surfaces of polyurethane foams in the way friendly to the environment. Developed ecological paint fulfils high technical requirements for coating materials for protection of PUR foams. Although the paint does not contain organic solvents, the properties of developed coatings are the same like for classical solvent- borne coatings. A proper choice of wateborne binder – water polymer dispersion of glass temperature below 0° C and the development of optimal composition of paint enabled obtaining the paint of required technical parameters like very good adhesion to thermo insulating material and high resistance of coatings exposed to sun radiation and variable atmospheric conditions.

9) Technology of coating system containing white anti-static paint used for painting of industrial protective helmets.

An innovative white anti-static paint based on polyurethane binder has been developed. The paint possesses a surface resistance at the range of $10^7\Omega$, excellent adhesion to polyester-glass substrate and good impact and scratch resistance. The paint together with the developed white polyurethane primer can be used for painting of protective helmets in mining. Developed coating system has been already implemented in Polish industry.

10) New pigment compositions of low sun radiation absorption used mainly for coatings applied on roofs and building façades.

The subject of offer is a new technology of coating systems containing pigment compositions of defined absorption-dissipative properties decreasing the temperature of heating of objects under the influence of sun radiation. The colouristic of developed coatings was designed in accordance with market demand for paints used for roofs and façades.

11) The method of producing medical polymeric dressing based on chitin copolyesters.

For the research purpose, material compositions in the form of staple fibres of 5-7 mm coated with chitin copolyester in the form of an alcoholic solution were prepared. The solution was selected in the way, that amount of active substance on the non-woven surface was approximately 2 % w/w. The composite was pressed and circles with a diameter of 70 and 90 mm were cut out for further study of biological activity. Before pressing, non-woven was subjected to carding process, which increases its volume 15 times. Such a composite structure is different from the currently used gel dressings.

12) Method of manufacturing piezoelectric materials by using polymers.

The piezoelectric effect in the PP film modified with inorganic nanocompound (nanoclay) was discovered and studied. The generated voltage is similar to that generated by the piezoelectric PVDF films. The effect of piezoelectric voltage appears only in crystalline systems (both mineral and some organic). The piezoelectric effect depends on the correct orientation of unidirectional film combined with corona discharge activation.

13) Preparation of biodegradable PLA packaging.

The technology for producing thermoplastic film of polylactide PLA intended for the manufacturing of containers for packaging or food products storage was developed. Film is produced by extrusion of strip. The containers are manufactured by thermoforming. The material is modified by various additives in order to ensure suitable flexibility in further processing.

14) Development of the technology and production start up of mulitilayer fireproof barriers

The project aims to develop innovative, lightweight, flexible as well as rigid fireproof barriers with high thermal and fire insulation at the reduced thickness, also resistant to biodeterioration. Objective will be achieved by the use of swollen and functionalized vermiculite and wollastonite fibres, mineral fibres and binding agents on the basis of expanded silicates. To strengthen the effectiveness of fire proofing barrier they will be covered with Al films with swelling coatings. Innovation of this solution relies in the synergistic selection of components of barrier layers, which will gain a flexible and rigid barriers, easy to apply and shape, to be used in construction, transport, defence and fire protection.

15) Equipment for the manufacture of environmentally friendly polymeric composites using renewable raw materials.

Nowadays, manufacturing technologies and processing of polymer composites play a key role in many industries. Research on new polymer technologies, that help protect our environment, are areas subjected to a current priority of generated visions of technological development in various fields, such as chemical industry, processing and manufacturing of plastic products and creating a modern industry based on biotechnologies. New technologies of low-cost polymer composites with the required and pre-defined properties, are obtained by applying a large amount of cheap fillers, which also act as modifiers and allow to obtain the properties of these composites. Preparation of advanced polymer composites using natural materials with excellent properties will greatly expand the applicability of this type of material in various industries.

16) Equipment for laboratory testing of rheology, structure, technological and functional properties of polymer composites

The study of rheological properties of polymeric materials are designed to determine their flow and deformation under the influence of stress. Precision and control of conditions during the tests allows for an analysis of the relationship between the state of stress, strain state and their time derivatives. This provides the information required for classification of the rheological behaviour of the examined materials.

17) Equipment for the recycling of filled polymers.

The modern world is based mainly on plastics. Products made from them are an indispensable part of our daily lives. However, some important issues are related to the production of plastics, and these are the depletion of raw materials for their production, high production costs and difficulties associated with recycling. The consequence of this is to change the direction of production and testing of plastic products. Currently on the market, there are eco-friendly, innovative production technologies of thermoplastic composites with cellulosic fillers.

Our research will also focus on the development of the equipment for recycling of plastics from composites, and products made out of it, containing metals and nano-additives.

INSTITUTE FOR FERROUS METALLURGY

(Instytut Metalurgii Żelaza im. Stanisława Staszica)

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Institute for Ferrous Metallurgy (Instytut Metalurgii Żelaza) is a research entity with 65-year long tradition.

Mission of Instytut is to conduct research and development works as well as to render research, consulting and training services in favour of steel manufacturers, steel users and institutions, in that public institutions, related to the iron and steel industry.

Scientific and research activity of the Institute is mostly of the nature of the applied research, the result of which is implemented or utilized in the industry. Partially, the research is of the basic nature.

Basic research is carried out mostly prior to the intended utilitarian works and makes it possible to obtain initial understanding as to purposefulness of dealing with practical issue and problem solution are concerned. It also contributes to scientific development of the Institute personnel as well as development of research methodologies applied in the Institute.

Research works and services executed by the Institute cover the following fields:

- Investigation of technological processes including research carried out by means of advanced methods of physical and numerical simulation
- Development and implementation of new and improved metallurgical technologies in scope of:
  - primary processes, including hot metal, steel and ferroalloys production
  - continuous and conventional steel casting
  - steel products hot forming (long and flat products rolling, die and blacksmith forging)
  - cold working
  - heat treatment of steel products including direct treatment using the heat of hot working
- Development and implementation of the technologies of: waste recycling, sewage treatment, dedusting of waste gases, recycling of dusts and sludge in steel plants
- Development of technology of advanced processing and manners of products' properties adjustment to the requirements of consumers

- Development and improvement of steel and construction alloys; developing chemical composition and designing internal structure of material from the point of view of the required properties of product
- Development and implementation of new product ranges and improvement of quality of the manufactured semi-products and steel products
- Examination of chemical composition, properties and structure of materials, expert assessments of materials, including: tests of products for their compliance with standards, diagnostic material tests of power engineering equipment and analyses of steel products' defects.

Consulting activity of the Institute includes:

- Scientific consultancy in scope of research methodology, in particular material tests and analysis and interpretation of tests results
- Technical consultancy in scope of selection of equipment and units for steel manufacturing and steel processing
- Technical consultancy in scope of selection of steel (and to some extent other materials) for various practical applications
- Business consultancy including: macroeconomic analyses, marketing studies, financial analyses, strategic analyses, planning and assessment of efficiency of business undertakings, monitoring and analysis of implementation of the restructuring programmes.

1) Technology of new slag-forming MgO carrier.

In cooperation with the Company PEDMO S.A., the Institute for Ferrous Metallurgy developed manufacturing technology of new MgO carrier to be used in steel melting and ladle treatment as well as in foundry.

The developed material contains more than 60% MgO and is in form of a granulate of diameter 9-11 mm. It is characterized with high mechanical strength and moistness below 2%. The Institute developed two options of material: the first one mainly for slag foaming in electric furnace, containing carbon, and the second, universal, which may be used in all processes. Moreover, the manner of preparation of mix for granulation was developed (composition, binding agent, moistness and proportion).

Parameters of new material pelletizing in industrial conditions were developed by PEDMO S.A. and the latter is the owner of know-how in this regard. The present industrial experiences imply that regular and expert application of the new material in ladle furnace results in significant extension of the time of lining usage and does not deteriorate refining parameters of slag.

Both electrical steel melt plants and foundries are recipients of the material. Significant increase in demand would occur in the case of material application in converter process. At present the domestic demand is met by PEDMO S.A.

There are numerous cheaper substitutes in the market, of worse parameters, therefore increase in demand requires promotion campaign.

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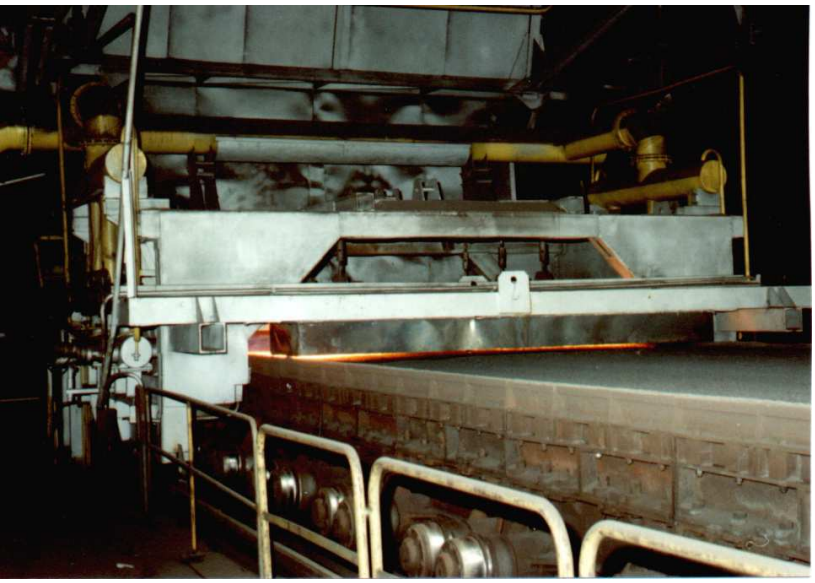
2) Energy-efficient ignition furnaces for ore sintering belts

Energy-efficient ignition furnaces designed and built by the Institute for Ferrous Metallurgy are recommended for iron and other metal ore sintering belts up to 4m wide (see below):



Ignition furnace characteristics

The energy-efficient ignition furnaces consist of steel structure, roof, refractory lining, battery of injector burners, piping, damping chambers and supporting tracks.
They have the following outstanding characteristic:

- low heat-consumption (50-70 MJ/ton of sinter) without adverse influence on physical properties of the sinter;
- concentration of energy in peripheral zones of the belt (better ignition at belt sides);
- construction costs lower by more than 50%;
- the use of special injector burners which eliminate the need of compressed air system for combustion and reduce electric power consumption;
- furnace cooling system is eliminated with consequent reduction in water and electric power consumption;
- simple and compact desing reducing thermal losses and facilitating maintenance and repairs (the weight of the furnace is 60-70% lower than of comparable conventional furnaces);
- the furnace is mounted on wheels for easy repairs, replacement of parts of the furnace itself;
- possibility of firing with gases with various heating values (7.5-35 MJ/m^3);
- lower environmental hazards (lower emissions of SO_X, CO_2 and NO_X and less noise).

Score of supplies

- supply of complete ignition furnaces;
- documentation of assembly of the furnaces;
- quality attestation for refractories used in furnaces;
- supervision of assembly and start-up of the furnaces.

Time of delivery

Delivery of the furnaces within approximately 6 months after the signature of contract.

Warranty

Warranty is given for the period of 12 months beginning from the date installation.

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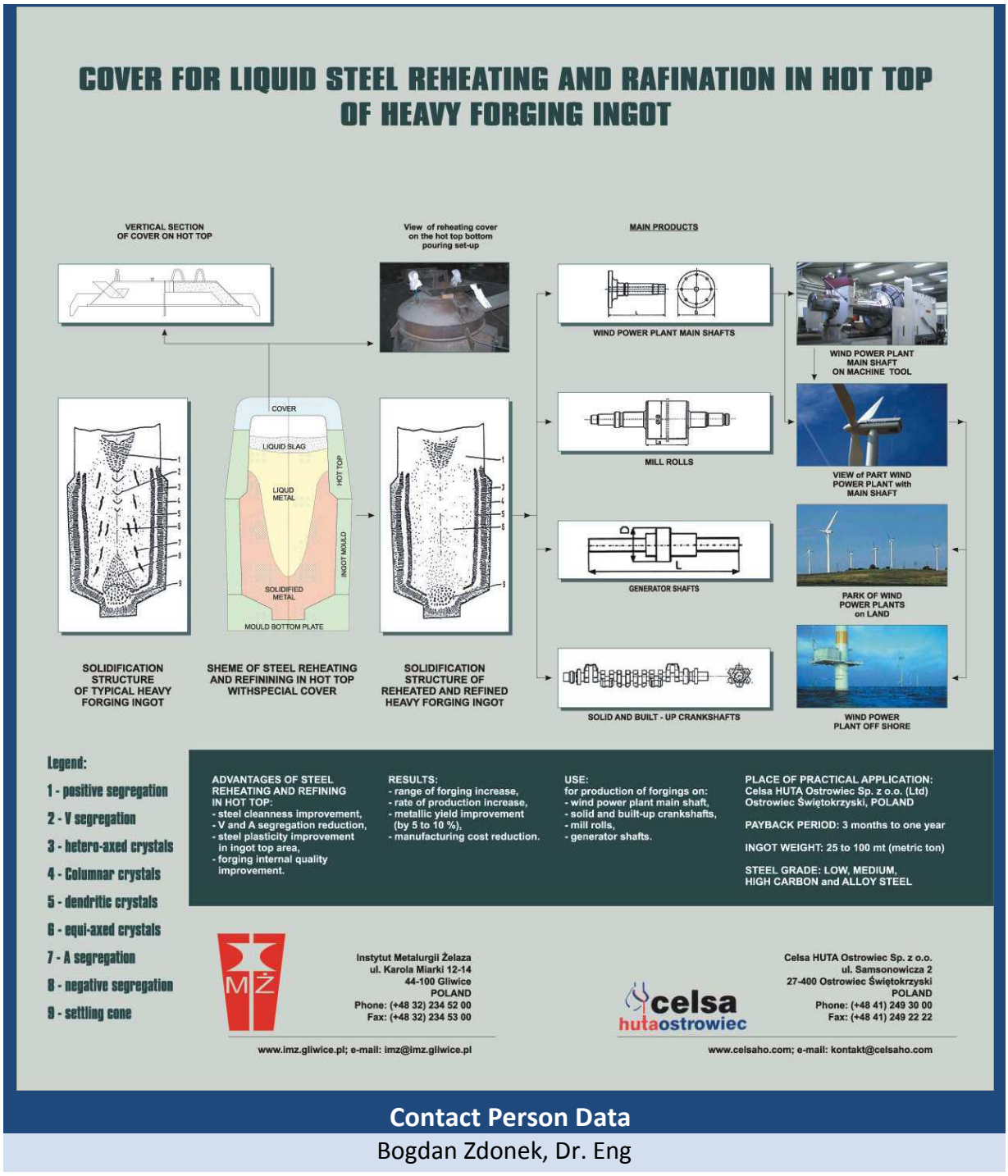
3) Method of Liquid Steel Reheating in Hot Top and/or in Tundish and Cover for this Aim

A liquid steel in hot top after bottom pouring it into mould assembly is reheated after pouring by the cover with high isolating refractory material till a moment of metal contraction in volume, and in a case for tundish, adequate insulating-reheating cover is used fo reduce heat loss and superheating of liquid steel during continuous casting operation. Above mentioned method results in high cleanness and internal quality of continuous casted bloom, billet and slab.



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INSTITUTE OF BIOPOLYMERS AND CHEMICAL FIBRES

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COOPERATION OFFER

We are an R&D unit active in biopolymers like cellulose, chitin, chitosan, keratin, starch, alginates and other, and preparation of chemical fibres for mainly special, non-apparel application. An exhaustive information on the Institute can be found under www.ibwch.lodz.pl. We would like to establish cooperative links with R&D and industrial units in Asia in following areas :

1. **Cellulose fibres**. In our Institute two proprietary processes have been developed for the manufacture of cellulosic fibres as alternatives to viscose process . The processes consist in modification of cellulose by either enzymatic or hydrothermal treatment which leads to cellulose directly soluble in alkalis. Fibres are spun from the solution in a wet-spinning process.
2. **Chitosan fibres**. A process has been developed to produce chitosan fibres. We run a small pilot scale line enabling production of chitosan fibres in amount of few kgs. per week. The fibres are mainly designed for uses in medical devices including implants.
3. **Biodegradable non-woven** directly spun from the melt of bio-based polymers
4. **Composite keratin materials.** We are active in the utilization of waste feathers from chicken breeding. Obtaining materials may be used for different purposes.

For above items know-how is available sufficient for up-scaling of the processes to pilot scale and further on to industrial scale. We are ready to give exhaustive presentations

INSTITUTE OF CERAMICS AND BUILDING MATERIALS

(Instytut Ceramiki i Materiałów Budowlanych)

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The only scientific-research institute in Poland which covers all areas of non-metallic science and industry such as well as mineral processing, production technology of ceramic materials and glass, refractory and building materials, mineral binders and concrete products.

RESEARCH AREA:

- glass, ceramics and bioceramics
- building and refractory materials
- mineral raw materials
- environmental protection
- development and improvement of materials production technology

LABORATORY TESTS:

- mineral raw materials
- glass and ceramics products
- refractory materials
- building materials
- environmental pollution

SERVICES:

- expert opinions and technical advisory services
- scientific and technical information
- specialist trainings schemes: www.icimb.pl
- power engineering and production engineering audits
- industrial measurements

CERTIFICATION:

- glass, ceramic and concrete products
- building materials
- factory production control (FPC)
- quality management systems

PRODUCTION:

- technical ceramics and composites
- building and refractory materials
- bioceramics
- frits, engobes and glazes
- ceramic pigments and colours

1) APPLICATION OF ROASTED LOW-CALORIE COAL-ASSOCIATED SHALES IN BUILDING TECHNOLOGY

The Glass and Building Materials Division of the Institute of Ceramics and Building Materials and the Department of Building Materials Technology of the Faculty of Materials Science and Ceramics of the AGH University of Science and Technology, basing on their research and development works, have elaborated an innovative technology: a method of roasting of low-calorie coal-associated shales or clays containing no combustible parts in an annular fluid layer, and a reactor with an annular fluid layer for their roasting.

Roasted low-calorie coal-associated shales are used in building as a low-weight concrete filler. A special area of their application is the cement industry, where the product obtained by means of the new technology may be used as a pozzolan additive. The additive consists of silty materials obtained from coal-associated shales or roasted clays, dehydrated in the process of roasting in a fluid layer.

The application of diverse mineral additives, including waste materials such as coal-associated shales, as well as improvements and changes of the technology of cement and concrete production, will allow to manufacture "a better composite from worse materials".

The necessary technological development in that area is made possible, for example, by using active hydraulic powders, by designing concrete composition that matches its applications more accurately, and by modernizing the technology of its production. To achieve this, it is necessary to develop theoretical foundations of properties and mutual interactions of concrete components, including pozzolan mineral additives.

Coal-associated shales - one of the components of the gangue obtained in the process of hard coal extraction - are materials with very promising future applications as additives in the production of cement and high-quality concrete. The gangue, including the shales, is stored in mine dumps in the areas where coal is produced. The waste is usually inert, but it may still pose a potential threat for the environment since the salts contained in the waste material are leached and thus constitute a source of pollution of the underground and surface waters and soil; moreover, the waste contributes to polluting the adjacent areas with the dust from the dumped material; also, thermally active dumps emit considerable amounts of air-polluting

gases (including CO and CO_2) and may endanger the local population in case of their insufficient protection.

The described invention has been submitted to the Polish Patent Office under the title “A method of roasting of low-calorie coal-associated shales or clays and a reactor for its application.”

The invention was part of the project entitled Patent protection and commercialization of innovative technological solutions in the field of plastering mortars produced on the base of Roman cement and of the method of coal-associated shale roasting within the "Patent Plus" Programme of the Ministry of Science and Higher Education.

2) INTERNAL PROTECTION OF CONCRETE AGAINST SULFATE CORROSION

The target area of the application of the invention are plants manufacturing cement concretes based on Portland cement.

Under the influence of water containing sulfates, Portland cement concrete undergoes dangerous destruction during exploitation that is connected with the loss of chemical and mechanical properties as the result of sulfate corrosion. The mechanism of sulfate corrosion consists in the destruction of cement matrix as a consequence of a series of chemical reactions leading to ettringite or gypsum crystallization and decalcification of CSH phase that determines concrete strength. As a result of these processes, a number of microcracks arise that weaken concrete in initial phase of corrosion and, in the final stage, cause destruction of concrete structures.

The disadvantage of the known methods of increasing the resistance of concrete to sulfates is the lack of the protection of the entire mass of concrete in the course of time. Cements established to be resistant to sulfate corrosion protect concrete only during relatively short exploitation time and do not warrant the protection of concrete structures made from these cements in the long run. In case of cellular concrete, they do not protect groundwater from contamination by sulfates.

The internal protection of concrete against sulfate corrosion consists in the addition of dicalcium silicate containing variable amounts of barium in solid solution in an amount of 3% to 10% by mass of cement to the concrete mix during its preparation. Barium forms solid solutions with dicalcium silicate in a wide range of compositions. The solid solution of dicalcium silicate and barium added to the concrete mix does not react with water during the initial maturation of concrete mass and during its treatment in autoclave. The reactivity of the silicate is activated after the migration of water into the concrete during its exploitation or after crushing concrete and its storage in an open area, for example on a heap, where it undergoes rapid hydrolysis releasing barium hydroxide.

The invention is part of the project entitled “Science for industry - the commercialization of inventions resulting from R & D” within the "Patent Plus" Program of the National Centre of Research and Development.

3) METHOD OF APPLICATION OF NANOSTRUCTURED, REFLECTIVE, COLOR AND/OR COLORLESS COATINGS ON GLASS AND COATING DEVICE FOR CARRYING OUT THE COATING PROCESS.

The main disadvantage of the known commercial methods of coating glass sheets for building windows is the lack of possibility to use such methods for the placement of colored or colorless durable protective coatings on a surface of glass items with irregular shapes, such as bottles, containers and the other glassware products, especially of common use.

The technology has been developed with the aim to obtain container and glassware glass products with metal (-s) oxide films characterized by solar control and decorative properties. Additionally, the thin film coatings obtained using this technology are bonded to the glass surface layer with strong chemical bonds. In effect, practically independent of metal oxide composition, the glass surface protective features can be obtained even with a coating thickness as low as about over 20 CTU (1 CTU ≈ 3-4 Angstroms Å, 1 Å =0,1 nm), endowing the glass product with the lubricity and surface damage resistance as well as impact strength increase of several % to about 20 %, depending on the thickness of the coating.

This feature is especially important in terms of avoiding the losses during filling and transportation of the glass containers. It also allows to increase the range of glass containers recycling, to obtain saving of the raw materials and energy cost and also, is advantageous for the environment protection.

With aim to avoid the drawbacks of the existing state of coating technology the present invention proposes applying to the common use glass products of the coloured or colourless metal oxide films characteristic of ability to decrease solar radiation transmittance, especially of the UV and NIR range. In accordance to this invention, the coatings on the glass products are produced by chemical pyrolysis method depending on whether they undergo dipping in the next high temperature treatment /or spraying the solutions of the metal oxide coating precursors immediately to the hot glass surface after the products are formed. Thus obtained metal oxide coatings are colourless or coloured and reveal resistance to the outside atmospheric conditions and cleaning agents of common use for glass. The coatings obtained in this technology are able to reflect and also selectively absorb solar radiation of UV and NIR ranges which are responsible for degradation of the contents of the glass packages.

This coating technology allows to apply the durable metal oxide films with solar control and mechanical protective properties on the surface of glass items commercially produced. The application of this technology is especially advantageous when applied “on-line” immediately after the formation of the glass products and it also allows to obtain uniform coatings on the glass products with complex shapes.

4) PRODUCTION TECHNOLOGY OF AUTOCLAVED AERATED CONCRETE

Autoclaved aerated concrete is a light-weight and warm building material that possesses high strength parameters. It is used for construction, insulation and insulation-construction purposes in civil engineering.

Depending on local conditions, various production technologies of autoclaved concrete are applied, according to the following formulas:

- binding material (cement + lime or only lime),
- aggregate (sand or fly ash from burning brown or hard coal or sand + fly ash),
- porosity adsorbent (aluminium powder or aluminium paste),
- surfactant facilitating the blending process of elements and the reaction of the porosity adsorbent with elements concrete mix,
- water.

We also offer to develop formulas fit for AAC technology with other raw material as specified by the Customer.

The production technology of autoclaved aerated concrete is characterized by low-wear raw materials and energy-efficiency as opposed to other technologies of wall building materials production. This is the result of low concrete density and appropriately conducted processes. It is a waste-free, environmentally friendly process.

Elements from autoclaved aerated concrete can be applied in the housing industry 1-2 concrete family for erecting walls and, moreover, in industrial and public facilities. It should be emphasized that houses form AAC are built in all European countries, as well as on other continents in different climate zones, and in seismic areas the advantages of this material has been put to a test.

The properties of masonry elements from autoclaved aerated concrete are covered in the EN 771-4. The concrete density in the dry state range from 300 to up to 750 kg/m^3, the compressive strength, respectively 1,8 – 8,0 MPa. It is possible to make warm single-ply outer walls U≤ 0,3 W/m^2K from autoclaved aerated concrete of low density classes: 300, 400, 500,. Single-ply walls are recommended particularly in one, two-family buildings, terraces, in which the insulation properties of autoclaved aerated concrete may be taken full advantage of. It is possible to make layered walls from AAC also in combination with insulation and brickwork.

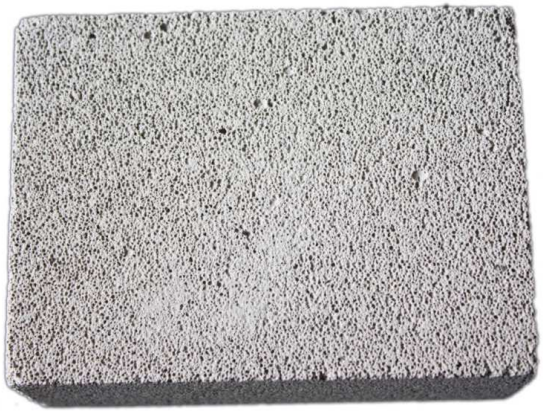
A wide range of products is offered for building walls: elements of small-dimension as well as elements for carrying lintels, beam-and-block flooring. These are elements fit for thin joints with the thickness of 1-3 mm (to adhesive mortars). Elements of small-dimension may have smooth surfaces, with shaped faces adapted to the feather and, additionally, with a handgrip facilitating bricklaying.

ICiMB provides the production technology of autoclaved aerated concrete, including:

- establishment formulas adjusted to the raw materials the Customer has at her/his disposal
- establishment the course of technological process
- selection of machines and devices about the determined output capacity.

Moreover, we offer the contact and cooperation with Polish companies that manufacture and design AAC as well as manufacture machines and devices.

We develop the technology production of AAC with the use of fly ashes from burning biomass with coal and fly ashes produced from coal combustion in fluid boilers involving concurrent flue gas desulphurization (details enclosed). Currently, development works are being conducted. The technology drawn has received numerous awards at international exhibitions.



5) LEAD FREE COLOURS FOR GLASS DECORATION

The harmful activity of lead compounds present in ceramic colours forces to seek solutions eliminating harmful agents both during the colours production stage as well as during their application.

The characteristic feature of the invention is that the colours made according to this technology do not contain lead compounds and their chemical composition guarantees giving shine to decorated surface and intensity of colour comparable with colours based on lead fusing agents which were previously used. The solution according to the invention implies 6 pallets of colours for firing in the temperature range from 800°C to 1250°C.

- on-glaze metallic ceramic colours for decorating porcelain
- ceramic colours for decorating ceramic tiles
- on-glaze ceramic colours for decorating porcelain
- under-glaze colours
- majolica colours
- colours for decorating glass using the fusing technique

The colours manufactured on the basis of these developed technologies are applied by various ceramic factories as well as small and medium-size companies.

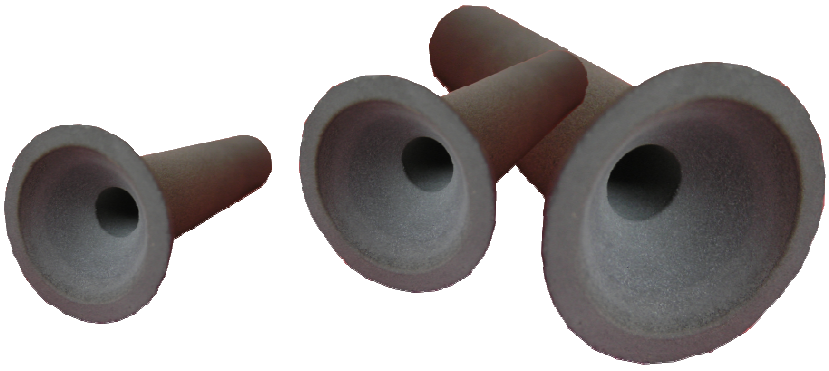
The colours are produced by Institute of Ceramics and Building Materials. A particular attention should be paid to colours applied for glass decoration.
The worked out colours became base for starting of new production of glass tiles and strips, decorated from the fitting side.

6) SPOUT INSERTS OF CERAMIC – METALLIC COMPOSITE ZRO_2 –Mo

The subject of the invention are spout inserts made of new refractory material from zirconium-molybdenum (ZrO_2-Mo) composite for application in casting of molten soda-lime glass. The composite is a sintered product based on zirconium–oxide (ZrO_2) with content >80% mass. and molybdenum (Mo) with content up to 10% mass. Addition of molybdenum improves mechanical strength of the ceramic matrix of the composite and improves erosion resistance of composite, while keeping its high refractoriness.
The composite material used for spout inserts were is statically formed under pressure ~ 200MPa and pressureless sintered in an atmosphere at 16000C.

Composite material for spout inserts features:

- high apparent density >5g/cm3,
- low open porosity <10%,
- high cold crushing strength >400 MPa
- high corrosion resistance to molten soda-lime glass



7) AGRO-SINTERS CERAMIZED FERTILIZER COMPOSITES

The invention involves ceramized fertilizer composites referred to as agro-sinters. A characteristic feature of agro-sinters produced in the form of granulate with the dimensions of 1 to 5 mm is their slow decomposition in the soil environment, accompanied by gradual, long-term feeding to the soil of the macro- and microelements released, which are necessary for correct plant development.
This gives agro-sinters a significant advantage over the commonly used artificial NPK fertilizers which dissolve easily and can be washed out quickly by atmospheric precipitation.

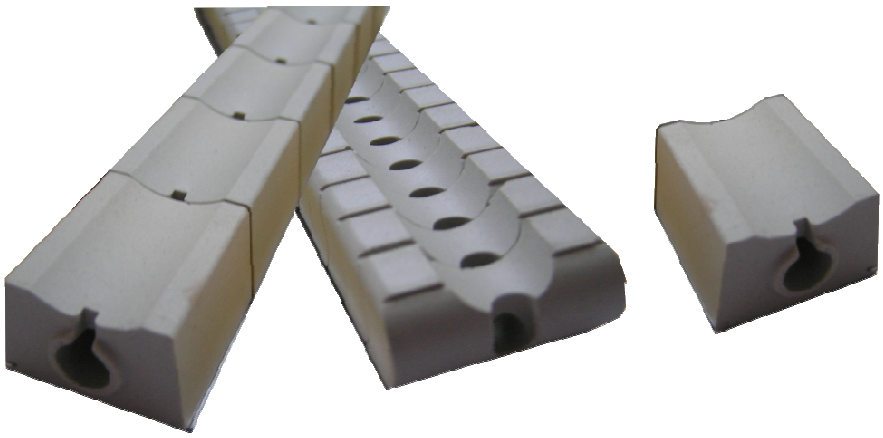
Argo-sinters also de-acidify the soil, increasing its pH and decreasing hydrolytic acidity, as well as improve soil structure.
Due to their prolonged action over several years, they can be used to improve soil structure and the balance of the soil components in places where agrotechnical procedures are no carried out frequently: In the areas of forest plantations, recultivated wasteland, waste dumps, dunes or other undeveloped land.
The basic components of agro-sinters are clays, mineral waste material and accompanying minerals. The production methods involves granulation of the material set and heat treatment of the granules at the temperature of 700^{o}C.

8) CERAMIC BACKING USED TO PROTECT ROOTS OF WELD WITH INERT GAS, IN SPECIAL WELDING

Welding high-alloy steels (such as for instance duplex and superduplex), nickel alloys stainless steels, steels for power engineering, copper alloys and titanium alloys requires inert gas protection of weld root. This problem is solved either by direct blowing of the inert gas on welded spot and double-sided welding or by using copper backing conveying the inert gas to the weld root, with a shape adapted to the shape of the welded elements. Normally, such backing is used to weld specific joints and it is impossible to change its shape.

The ceramic backing for welding with inert gas protection of the weld root that has been developed presents the following features:

1. a segment structure making is possible to form long sequences and to convey gas along the welding line (variant a);
2. a shape making it possible to weld curved surfaces (variant b) with diversified radius;
3. possibility of multiple use;
4. diversified thermal conductivity making it possible to adapt the device to the type and thickness of the plates welded (table);
5. possibility to obtain a uniform joint and a varied weld surface from the backing side;
6. reduction of the amount of gas used, making single-sided welding possible.



9) INSTALLATION FOR SCRAP TIRES COMBUSTION IN CEMENT KILNS

Institute of Ceramics and Building Materials, Building Materials Engineering Division in Opole offer its own technology and full technical documentation for system of scrap tires delivery to cement kilns (scope of documentation supply: mechanical construction, electrical, automation and control). The solution is developed for tires (dimensions Qmax1200 x 400mm, G max = 4,0 t/h) or rubber waste that can be delivered as an alternative fuel to the inlet chamber of so-called cold end of the cement kiln. Tires, after weighing are inserted through a sluice into the kiln. Transportation and dispensing system is connected to kiln control system operating in automation. Burning tires as an alternative fuel is an environmentally friendly action because it allows for the safe liquidation of waste and the recovery of thermal energy contained there. This solution allows us to save non-renewable reserves of conventional fuels and at the same time to reduce the size of the landfills storage area. Depending on the preferences of the investor and the tires stock locations, there are two basic solutions, as mentioned below, concerning the transportation from the ground level to the level of the dispensing system on the heat exchanger tower:

- An inclined conveyor with especially shaped sills, to prevent tires from slipping onto tape (photo)
- Vertical elevator with protruding handles, especially designed for hanging tires

Transportation is carried out horizontally by means of roller conveyors, and is controlled automatically. Weighing device is usually located on the tower exchangers allowing for controlled dispensing of tires to the kiln. The installation is equipped with a system for technological and movement security.
The installation was developed by an engineering- research team of the Institute of Ceramics and Building Materials from the Department of Process Engineering in Opole. Our Division conducts investment supervision and commissioning of the installation.

Examplary technological parameters of the cement kiln with co-incinerated waste tires:

- Heating fuel substitution technology - up to 20%
- Heating value of scrap tires - approximately 26 kJ / kg
- The number of tires dispensed into the furnace – up to 2.5 t / h
- Substitution of coal dust from tires 1Mgw /1Mg tires

Requirements for burning tires:

- Coefficient of air excess in the chamber is 1.15 -1.20
- Real air consumption 9.6 -10.0 m3n/kg tires

10) PRODUCTION TECHNOLOGY OF WARM MORTAR - TERMOR N

OF IMPROVED THERMOINSULATION PROPERTIES AND HIGHER EFFICIENCY

The wall is a composite comprising different materials, starting from masonry elements, and mortars for construction purposes, as opposed to the previously used glue and plaster. There is no doubt that all the components must be selected with due care in order for the best effect to be achieved.

ICiMB CEBET has designed the heat-insulating TERMOR N mortar.

The mortar is produced in the form of dry elements (cement, lime, fly ashes, fine powder from autoclaved aerated concrete, polystyrene foam or perlite, refined additions). Before on-site application, it only take to mix it with water. This mortar is characterized by a favorable thermal conductivity and better working properties in terms of mixing, adhesion to base, productivity output.

This mortar is intended for the construction of outer walls from small-dimension elements of autoclaved aerated concrete or other materials with similar thermal conductivity. Thickness of the joint of 8-10 mm. With heat-insulating mortar it is possible to join elements with the admission of greater deviations in respect of target dimensions (± of 3 mm to ± of 5 mm). The amount of mortar required for the preparation of, for instance, a $1m^3$ wall from AAC blocks with the thickness of 36 cm is c. 18 kg. Termor N Mortar is not applied for foundation construction and underground walls. It warrants thermal homogeneity of walls, without the formation of "small bridges of cold" at joint interfaces. This reduces the power consumption required for heating buildings and helps protect the atmosphere and environment. Buildings erected with the use of autoclaved aerated concrete are long-lasting and energy-efficient.

Basic Technical Properties

Dry blend:

- bulk density - ≤ 500 kg/m^3
- working life - 3 months from the date of the production

Mortar hardened:

- density (max) - 580 kg/m^3
- compressive strength - ≥ 3 MPa
- bending strength (min) - 1,15 MPa
- adhesion to base - ≥ 0,3 MPa
- thermal conductivity λ
  - in the dry state -0,13 W/(mK)
  - in-service humidity state -0,15 W/(mK)

Our offer for the manufacturing of Termor N:

- selling know-how for production,
- elaboration of documentation for production line,
- consultation at all phases of implementation,
- testing of finished products.

11) PRODUCTION TECHNOLOGY OF THIN JOINTMORTARS

Thin joint mortars are intended for the construction of walls of small-dimension elements from autoclaved aerated concrete and allow for thin joints with the thickness of 1 - 3 mm, or other materials about with a similar thermal conductivity. It allows to obtain thermally homogeneous walls.

Thin joint mortars are produced in the form of dry blends on the basis of cement. Preparing mortars on the building site is simple and consists in mixing mortars with water in a container with a mechanical agitator until homogeneous consistency is obtained. Mortars are designed for the connection of elements with similar dimensions and shapes (acceptable deviation from ± 3 mm to ± 1 mm).

Basic Technical Properties

Dry blend:

- bulk density	-	1300 - 1500 kg/m^3
- working life	-	3 months from the date of manufacture

Fresh mortar:

- time of retaining working properties retention	-	exceeding 3 hours
- time for elements readjustment/until full setting	-	7 minutes

Hardened mortar:

- compressive strength	-	≥10 MPa
- adhesion to base	-	≥0,3 MPa

Thin joint mortars are registered under the patent No. 185365 „Dry glue mortar blend, dedicated for the connection of elements from autoclaved aerated concrete. Thin joint mortars is simple in preparation and application on the construction site.

The considerable thermal homogeneity of walls made with the thin joint mortars enables to reduce the power consumption for heating the building.

The dry blend is much more efficient as opposed to the traditional mortar.

The amount of mortar required for the preparation of, for instance, 1 m^2 wall from blocks from autoclaved aerated concrete with the thickness of 36 cm is :

- 40 kg of dry components of the cement-lime mortar at the traditional method of building walls

- 8 kg of the dry blend of the mortar for thin joints

Our offer for the production of thin joint mortars:

- marketing license
- elaboration of documentation for production line
- consultation on all phase implementation
- testing of finished products

INSTITUTE OF ELECTRONIC MATERIALS TECHNOLOGY

(Instytut Technologii Materiałów Elektronicznych)

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ITME has already had a certain experience in R/D collaboration with Asian countries, realized through exchanges of scientists (Japan), participation in international fairs and scientific conferences(China, Japan, Taiwan), execution of common research programs. (Japan, Qatar) or execution of research projects commanded by Asian companies.

We are interested in developing scientific and R/D cooperation and execution of common research projects in following areas:

- novel materials for electronics and photonics such as: graphene, meta-materials, topological insulators, self-organizing materials, photonic crystals and gradient composites.
- glass and ceramics fabrication with desired mechanical and optical characteristics (transparent, laser) , and optical guides, photonic crystal fibers, diffraction lenses included.
- epitaxial structures on silicon, silicon carbide, III/V compounds, YAG and GGG oxide crystals for electronic and photonic devices.
- development of innovative lasers, photo detectors, diodes and transistors.
- ITME offers also:
- The realization of research requested by industrial partners.
- Development and eventually small scale production of materials, epitaxial structures, active and passive components according to requirements.
- Highly qualified consultants in the area of technology and characterization of materials and components.

A short description of our Institute is included in the appendix and more detailed information concerning the Institute of Electronic Materials Technology can be found on our webpage http://www.itme.edu.pl

INSTITUTE OF HEAVY ORGANIC SYNTHESIS „BLACHOWNIA”

(Instytut Ciężkiej Syntezy Organicznej „Blachownia”)

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Institute of Heavy Organic Synthesis „Blachownia" (ICSO) is a research Institute of organic chemistry sector. For 60 years it has been a successful partner for both, domestic and foreign organizations, within the range of developing, implementing and improving chemical processes, production and sale of chemical goods. ICSO belongs to the top research units in Poland. Institute carries on the R&D and implementation works within the scope of chemical sciences, performs the research and chemical analyses. The confirmation of Institute’s competence and experience are numerous publications, patents and implementations. During its activity the Institute has implemented nearly 900 technologies into the industry, obtained almost 1,5 thousand patents in Poland and abroad, signed 14 contracts for export of technologies (among others: China, Iran, Korea, Spain) and published about 2 thousand of scientific works.

ICSO performs scientific research and R&D works concerning the chemical processes, especially in the range of:

- organic synthesis and technology
- acrylic, phenolic and epoxy resins with their properties modification, polycarbonates and others
- separation of gases, hydrogen and pressure processes
- processing renewable raw-materials
- petro- and carbochemical processes
- homo- and heterogenic catalysis
- chemistry and technology of polymers and plastics, their modification and processing
- surfactants and household chemistry
- auxiliaries for various branches of industry
- chemical analysis
- physical chemistry
- chemical engineering
- environmental protection and waste utilization.

INSTITUE OFFERS

- scientific research
- research and development works
- chemical technologies
- analytical and design services

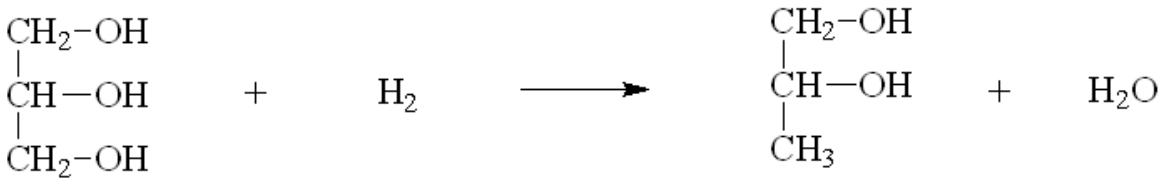
In order to meet the expectations of industrial partners processes offered by ICSO, technical solutions, branch products and provided services are brought into line with worldwide standards. Institute obtained and maintains a Quality Management System ISO 9001 and performs analyses according to a Good Laboratory Practice (GLP) rules.

1) An innovative process of propylene bioglycol production

Process Description

The innovative technology for production of propylene bioglycol through hydrogenation of glycerol deriving from biodiesel production from fatty raw material.
The technological line process comprises three stages:

- glycerine purification through distillation under reduced pressure
- hydrogenation of glycerol to propylene glycol on the catalyst in a heterogeneous flow reactor:



- purification of the product through distillation.

Process Advantages

The presented technology for manufacturing of propylene glycol is an innovation on a national and world scale. As particularly innovative in the proposed technology must be considered:

- the use of renewable and easily available resource for production which is glycerin fraction (a by-product in the used on a wide scale biodiesel production technologies)
- method for purifying of the glycerol fraction dedicated specifically for the needs of the process and providing glycerin with the desired quality and favorable price
- the developed by ICSO heterogeneous catalyst used in hydrogenation of glycerol to propylene glycol with high selectivity and activity, produced from easily available raw materials and with high regenerative qualities (waste-free)
- to obtain an environmentally friendly product with high added value
- diversification of raw materials for the chemical industry based on propylene bioglycol
- no solvents and toxic substances in the process
- the use of small quantities of non toxic by-products in the process
- concept of the reaction system, conducting of process and product emission
- optimized flow of the process streams for the total utilization of the raw material and energy.

2) A new generation of epichlorohydrin technology with use of bioglycerin as a raw material

Process Description

Innovative method of epichlorohydrin production uses totally different raw-material base than the traditional process, which utilizes chlorine and propane of petrochemical origin. The new process uses hydrogen chloride (hydrochloric acid) and glycerin, the main waste product of rapidly developing biodiesel industry.

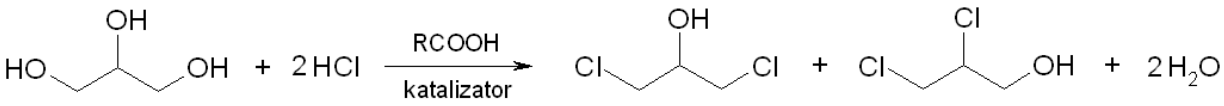
The method is based on the replacement stages of propylene chlorination stages to allyl chloride ones and via well-known reaction of glycerin with hydrogen chloride, allyl chloride converts to dichloropropanols:

glycerin + hydrogen chloride (gaseous) ⟶ **dichloropropanols**

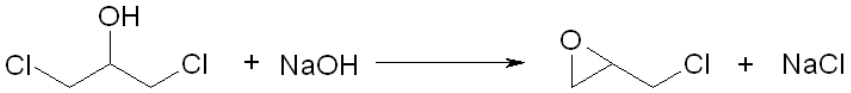
final stage of dichloropropanols conversion proceeds just as in the traditional method:

dichloropropanols + alkaline agent ⟶ **epichlorohydrin**

Obtaining epichlorohydrin with the use of renewable glycerin is two-staged process based on the following chemical reactions:



Glycerin chlorination



Dichloropropanols dehydrochlorination

Process Advantages

- simplification of the technological process in comparison with the traditional one
- basing the method on less expensive, renewable raw-material - glycerin
- significant decrease of energy factors (steam and electricity)
- radical decrease of waste products amount (chloroorganic compounds)
- radical decrease of sewage amount
- non-toxic and non-flammable substrates and half-products are used

Economic Aspects

- several times lower raw-material unit cost
- considerable reduction of waste products amount (mainly glycerin derivatives which are easier to utilize)
- multiple reduction of the sewage amount, which are additionally less toxic (lower content of AOX)
- substantial lowering of variable costs of the new EPI production method in comparison with the traditional one.

3) EPOXY RESINS

Product Quality

Several types of high performance epoxy resins can be obtained in the process offered. The table below presents exemplary quality parameters for Epidian® 6 and Epidian® 012 and Epidian® 011B.

Specification	Epidian® 6	Epidian® 012	Epidian® 011B
Appearance	clear liquid	clear flakes	clear flakes
Epoxy value, val/100g	0.52 - 0.55	0.10 - 0.125	0.19 - 0.22
Epoxy equivalent	182 - 192	800 – 1000	455 – 526
Viscosity at 25oC, mPa·s	12,000 max	-	-
Hydrolyzing chlorine content, %	not more than 0.02	not more than 0.02	not more than 0.08
Colour, Hazen scale	not more than 50	not more than 50*)	-
Colour, Gardner scale	<1	<1*)	<2**)
Softening point, oC	-	93 - 105	63 - 80
Non-volatiles content, %	not less than 99,9	not less than 99,9	not less than 99,9
Bromine content, %	-	-	not less than 20

*) 40% solution in dioxane **) 40% solution in butyldiglycol

Other types for special applications: other conventional epoxy resins, various modified epoxy resins, epoxy – novolacs based on phenol and o-cresol novolacs can be also offered.

Process Description

Liquid epoxy resin (Epidian®6) synthesis is a two-stage process: during the first stage, epichlorohydrin reacts with bisphenol A in the presence of the sodium hydroxide. During the second stage – dehydro-chlorination, the reaction is finished and the chlorine content of the resin is reduced. After dehydrochlorination the resin is washed. Water from washing is further utilised and the solvent is recovered from organic phase.

Solid epoxy resin (Epidian®012) and brominated epoxy resin (Epidian®011B) are obtained through the polyaddition, in which bisphenol A (or respectively tetrabromobisphenol A) is reacted with Epidian®6 in the presence of highly active catalyst. The process runs continuously or periodically depending on needs.

Process Advantages

- High product quality, with low hydrolyzing chlorine content and bright colour
- Stability and repeatability of product properties
- The process is environmentally safe. No off-gas is removed outside the synthesis process. Sodium chloride is recovered from aqueous solutions in the solid form, whereby the presence of organic in the effluent is practically eliminated.
- Low consumption of raw materials and utilities
- Highly active catalyst in polyaddition process.

4) Concentrates of Fire-Resistant HFAE Hydraulic Fluids for Mining Industry

(two types: emulsyfing and microemulsion)

Benefits

- approved by Polish Central Mining Industry Institute (GIG)
- passes approval testing at 0,5 - 2 % concentration in mine specific water
- licensed/produced in Poland
- biodegradation in accordance with ISO 7827 and OECD 302B
- compatible with all commonly used longwall fluids
- stable in water hardness up to 750 ppm $CaCO_3$

Mixing

The fluids are delivered as concentrates and mix with water for use in roof supports. The products mix easily with water of all types. Recommend concentration is 1 % for both type of concentrates (emulsyfing and microemulsion).

Typical Properties of concentrates

Appearance		clear amber solution
pH		9,5
freeze point		-3 °C
viscosity @ 40 °C (mm^2/s):		
	emulsyfing	60
	microemulsion	40

TYPICAL PROPERTIES of emulsion/microemulsion

Appearance	white emulsion
	clear microemulsion
Rust prevention	passes at 0,5 - 2 %
	(ISO 12922, 7th Luxembourgh Report)

Contain bacteria and fungi preventive additives.

May contain a dye for easy underground leak detection.

5) VPSA O_2 and VSA-O_2 Process for Production of Oxygen with the Purity of 90÷95 %Vol. from the Air and 92±1% vol. O_2 in standard

Application

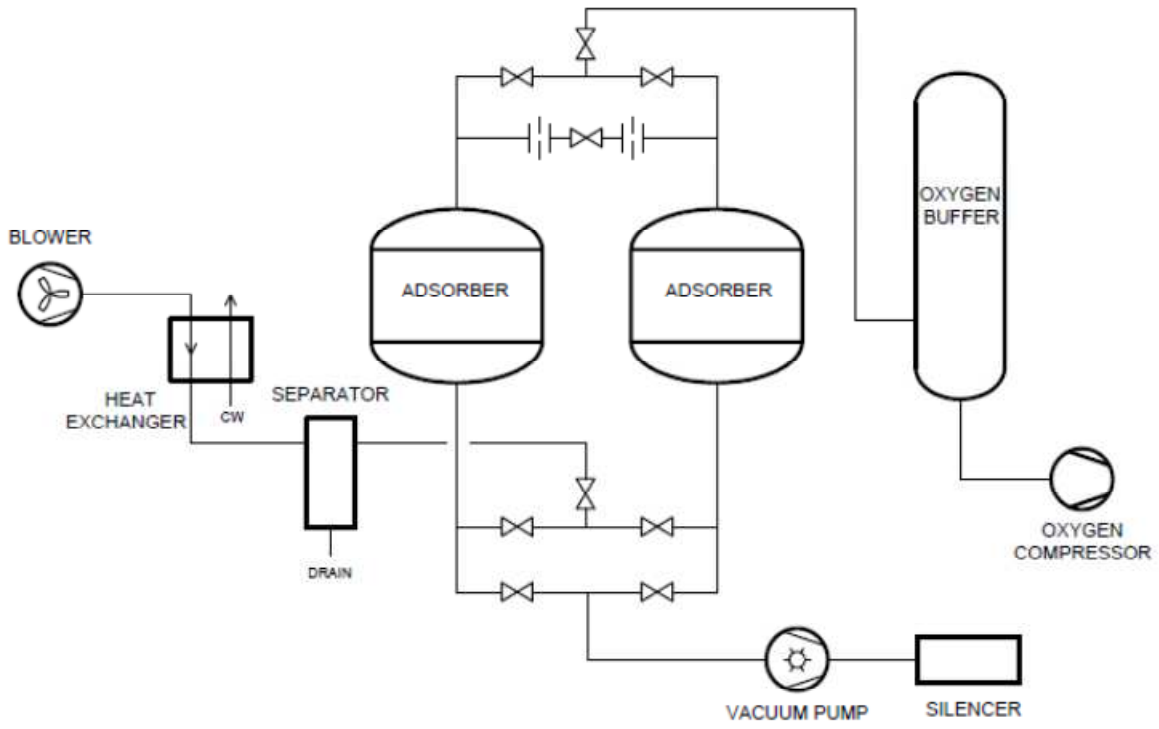
The process for production of oxygen with the purity of 90 - 95% vol. from air at the place of application can be employed in:

- Oxygenation of fish ponds
- Metallurgy and metallurgical industry – iron-making, sintering, oxidative smelting of metals, metallurgy of copper, nickel and zinc
- Glass-making industry and ceramic industry: thermal treatment of glass, concrete, magnesite, glaze, high-performance ceramic lining, etc
- Environmental protection: oxidative purification of waste water, potable water treatment, incineration of wastes, treatment of cellulose waste water
- Biochemistry: bio-fermentation processes
- Bleaching of cellulose, substitute for chlorine

Process description

Capacity: 100÷5000m^3_N/h.

The air is compressed under pressure of 150 - 180kPa abs in a blower and then cooled to 30^oC and separated in three section adsorber where VPSA process is employed. The adsorber is filled with new generation zeolite molecular sieve – LiLSX. Desorption of adsorbed nitrogen is conducted under pressure of 50kPa. In addition rinsing of molecular sieve, with use of oxygen. Energy consumption no more than 0,4 kWh/1Nm^3 92±1%vol O_2.



Advantages

The plant needs no operators. The initial investment and operating costs are low. Oxygen produced is dry (its dew point is -70C) and its concentration reaches 90-94% with the impurities being nitrogen and argon.

References

Trout Farm, Spain (07.2008) - oxygen purity: 92%$_{vol}O_2$, capacity: 150 m^3N/h

6) Two-stage PSA process for production of oxygen with purity of 99,7÷99,9% vol. O_2

Application

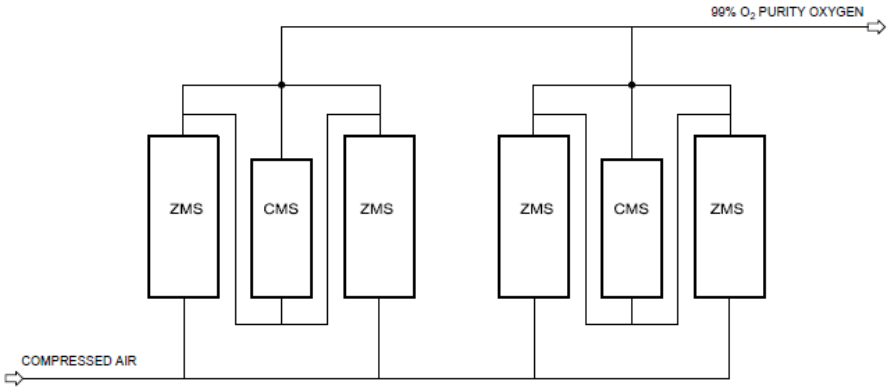
Oxygen production from atmospheric air at the place of application to cut thick steel details in machine-shops, shipyards, steelworks and scrap yards. Oxygen with high purity can also be used in hospitals and ambulances.

Process description

Production capacity: 20 ÷ 100 m^3_N O_2/hour.

Atmospheric air is compressed to the pressure of 500kPa of volume, filtered, cooled down to the temperature of 20°C, drained and separated in I° PSA installation filled with zeolite molecular sieve. The oxygen with purity of 95% of volume, contaminated only with argon, is manufactured. The oxygen is still purified from argon in the II° PSA installation filled with MSC-3A carbon molecular sieves. The oxygen with purity of 99,7÷99,9% vol. O_2, created in desorption phase, is obtained. The oxygen is compressed and partly turned back to II° PSA process to wash out the argon.

In another technology 99% purity oxygen is produced in one stage PSA with use of carbon molecular sieves (CMS) and zeolite molecular sieves (ZMS).



Advantages

- the possibility to manufacture oxygen with high purity at place of application
- low investment costs
- low exploitation costs
- no problems with wastes
- possibility to adjust the size and capacity of the plant to the needs of client.

References

Two plants with capacity of 25 m^3_N /h of oxygen with purity of 99,7÷99,9/vol. O_2 in Kopalnia Węgla Brunatnego (Brown Coal Mine) „ Konin".

7) VPSA-N_2 and PSA-N_2 Pressure Swing Adsorption process for production of nitrogen with purity of 99,999%vol. from air

Application

Swing pressure VPSA-N_2 process for production of nitrogen with purity of 99,999% vol. from air at the place of application can be employed in:

- food packing
- metallurgy and aluminium processing
- food storage
- after liquefying in:
- cryogenics
- inert atmosphere protection
- used tyres processing with use of cryogenic method

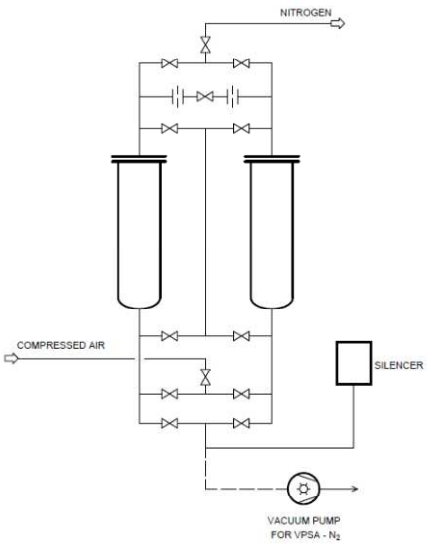
Process description

Capacity: 10÷500m^3_N/h.

The air is compressed in a compressor to 700÷800 kPa, filtered, cooled to 20^oC, dried, and separated in two adsorber PSA plant with use of carbon molecular sieve – MSC-3A. PSA-N_2 process utilizes two stage desorption of adsorbed oxygen where during the second stage oxygen is desorbed under pressure of 20kPa. In addition rinsing of adsorbents with nitrogen is employed.

Advantages

Low cost of high purity nitrogen production. There is no need to use Deoxo process.



References

Biodiesel Works Wratislavia -	purity	99,9%$_{vol}N_2$
	capacity	200 m^3N/h

8) Pressure-Swing Adsorption (PSA) Process for Hydrogen Recovery

Application

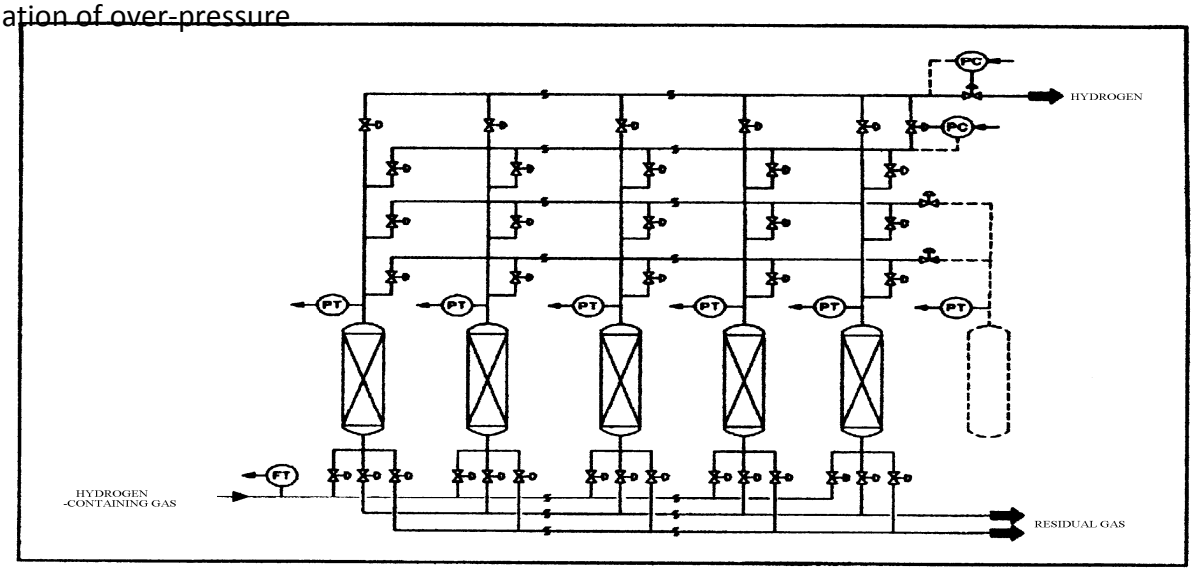
Hydrogen recovery from a variety of-gases:

- gas resulting from steam reforming or semi-combustion of methane
- coke-oven gas and purification coke oven gas for gas engines
- ammonia purge gas and argon recovery
- high purity hydrogen from methanol

The scale available is from 500 to 50 000Nm^3/h of H_2.

Process description

The PSA process is effected in plants comprising 3-12 adsorbers filled with activated carbon and zeolite molecular sieves. The process combines adsorption at an elevated pressure and desorption at a close-to-atmospheric pressure, using special procedures for gas purging and elimination of over-pressure.



By-products

No by-products arise in the process: all the products resulting from gas separation are utilized.

Process novelty

Novel technique for gas purging and elimination of over-pressure; computerized plant control system.

Process advantages

- High purity of hydrogen: 99.9 – 99.999% mol.
- Increased purity of hydrogen (99.9999% mol) on request.
- High efficiency of hydrogen recovery: up to 90%.
- Low investment and operational costs.
- Complex process control.

Commercial plants

– 10.000 Nm^3/h of H_2 for OXO synthesis at the ZAK S.A. (Nitrogen Works)

– 50 Nm^3/h pilot plant for high-purity H_2 (99.999% mol) at the Instytut Ciężkiej Syntezy Organicznej “Blachownia” (Institute of Heavy Organic Synthesis “Blachownia”).

9) *KOTAMINA PLUS* - anti corrosion and anti scaling agent

Application

Kotamina Plus is a high-efficient multi-functional product based on thermo-stable alkylamines Primene ^{TM} for chemical treatment of boiler water in energy systems in the power industry.
The quality of water decides about efficiency of heat exchange and economics of performance of energy systems. The up to now idea of water conditioning consists in addition of protective formulation into boiler feed water, most often hydrazine and phosphates.
ICSO has developed technology with application of multifunctional amine formulations, which improve heat exchange in the boiling and condensation processes, reduce operating deposits and decrease corrosion. Kotamina has been used in several plants in Poland since 1993. Application of the new technology KOTAMINA PLUS for chemical treatment of boiler water, based on thermostable amines (PRIMENE TM) produced by Rohm and Haas might be a breakthrough in boiler water conditioning in energy systems in power industry.

Description

The application method consists in proper continuous addition of Kotamina Plus to the boiler feed water or to the make-up water.

Advantages

Kotamina Plus is a new product, which combines long-term experience from industrial application of Kotamina and research efforts of international consortium co-operating in the EUREKA project: E! 2426 BOILTREAT.

The advantages of application of Kotamina Plus may be summarized as follows:

- Improvement of boiler performance
- Reduced failure frequency of power units
- Savings on water and fuel
- Reduced resistance of flow within a system

Kotamina Plus offers:

- exceptional protection against corrosion and deposit formation
- competitive technology both in economical and ecological aspects, giving considerable improvement of water quality and reduction of raw materials consumption, and decreasing contaminants emission to environment
- higher efficiency of boilers performance and extended life of equipment

References

Numerous electric and thermal-electric power stations in Poland use Kotamina protective agent. Kotamina is used in electric power stations with total power of about 5 000MW. In thermal-electric power stations and heat-generating stations Kotamina is used with the of the total systems capacity of over 400 000 m3. The list of reference plants includes among others electric power stations in Połaniec, Bełchatów, Adamów, Dolna Odra, Pomorzany, Konin, and thermal-electric power stations in Chorzów, Tychy, Łódź, Kielce, Elbląg, Białystok.

Kotamina Plus has already been successfully implemented in Połaniec, Białystok, Elbląg.

10) PHENOLIC RESINS

Application

Phenol formaldehyde resins are widely used as binders, adhesives, modifying and laminating agents in different branches of industry, including manufacture of wooden derived boards, insulation materials from mineral and glass wool, electro-insulating and construction laminates, insulation foams in buildings and coal mines, foundry, refractory and friction materials.

Advantages

- Versatile range of resins of both types - resol and novolacs
- High quality - the characteristics is designed to ensure expected functional parameters of the final products, including good mechanical strength, high water, heat and flame resistance
- Special care is taken as regards environmental safety. The products with very low free monomers are available.
- Flexibility and innovation - modification and adjustment of the process and resin characteristics to meet the specific application requirements and changing market needs
- Proved methods for quality control
- Processes for resins manufacture are commercialized
- Performance of the resins has been proved in industrial applications
- Close co-operation of research team with resins producer and end user
- Research background - more than 30years of research experience, well equipped research facilities, including computer-aided synthesis, advanced analytical methods (TG, DSC, HPLC, GPC, GC,GC-MS, FTIR)

References

ZTS Erg S.A. Pustków, Poland - Versatile range of products is produced, capacity up to 35,000t/yr.

Raw materials

phenol	from the cumene method
formalin	technical grade
catalyst	basic catalyst of technical grade
modifiers	technical grade

11) ISOBIS – New generation of Bisphenol A manufacture process

Application

Bisphenol A is a raw material for:

- production of plastics, in particular polycarbonates and epoxy resins
- production of flame-retardants (mainly tetrabromobisphenol A and recently bisphenol A phenylphosphates)
- thermal stabilizers of PVC
- production of phenoplasts
- unsaturated polyester resins
- polysulfones, polyetherimide and polyaryl resins
- plastics antioxidants
- production of raw materials for polyurethane synthesis.

Process Description

Synthesis of *p,p*-BPA isomer through phenol and acetone condensation method in liquid stage in acidic environment with two-stage separation and purification system of synthesis product and by-product concentration control system consisting of parallel running isomerization and catalytic distillation with simultaneous phenol regeneration.

The continuous process for the *p,p*-BPA manufacturing is divided into three stages:

1) *p,p*-BPA isomer synthesis in two flow reactors operating in series with intercooler control of the reaction temperature and concentration of water, acetone and by-products;

2) separation of *p,p*-BPA isomer in the form of adduct with phenol from phenol solution through suspension crystallization method and thermal adduct decomposition, as well as purification of crude *p,p*-BPA isomer through fractional crystallization;

3) by-products concentration control in technological streams circulating in the *p,p*-BPA isomer synthesis unit and in the unit of its separation and purification based on parallel realized processes of partial isomerisation of by-products contained in mother liquor with catalytic distillation of mother liquor from suspension crystallization.

Process Advantages

- High quality of Bisphenol A
- Appropriate combination of synthesis, separation and purification units connections and process parameters
- Control of by-product concentration to obtain high selectivity and capacity of *p,p'*-BPA isomer
- Competitive raw material consumption figures
- Competitive energy consumption
- No waste problems
- No batch-operated centrifuges, instead of them continuous filters
- Increased catalyst lifetime

References

ICSO “ Blachownia” having 40 years of experience in R&D of BPA process, 7 contracts for granting license to foreign partners for the process to manufacture of Bisphenol A is now offering a new generation process, protected by patents and patent applications, distinguished at numerous international inventions fairs and exhibitions (Intern. Exhib. of Invent. "Geneva Inventions" 2012 **–** golden medal, Intern. Exhib. of Invent. -SuZhou 2008 – silver medal, Seoul Intern. Invent. Fair 2010 – gold prize, The Belgian and Intern. Trade Fair for Techn. Innov. 2008 – golden medal).

INSTITUTE OF NATURAL FIBRES AND MEDICINAL PLANTS

(Instytut Włókien Naturalnych i Roślin Zielarskich)

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The **Institute of Natural Fibres and Medicinal Plants** is an interdisciplinary research centre with international standing, involved in complex research on obtaining and processing of fibrous and herbal raw materials.

The Institute is involved in a number of national and international research projects; cooperates multi directionally with numerous research centres worldwide; works for agriculture, environment protection, construction, transport, food and pharmaceutical industries and medicine.

The Centres for Excellence CELLUBAST and Medicinal Plants in Nutrition and Medicine, Accredited Flammability as well as Textile Laboratories (Polish Centre for Accreditation No. AB 225) operate at the INF&MP. These centres and laboratories use the state-of-the-art equipment allowing for conducting flammability tests of different materials, including textiles, specific for the area of application and physico-mechanical tests of these materials

The main fields of INF&MP activities:

- Biotechnology,
- Breeding new cultivars of fibrous and medicinal plants, agronomy and preliminary processing,
- Extraction and processing technologies of natural fibres and their modification for textile and non-textile applications,
- Agro-fine chemicals obtained from plants, nutrients and dietetic products,
- New applications for oil cultivars of fibrous plants (dietetic and medicinal products),
- Bio-fuels obtained from fibrous plants,
- Development of renewable, biodegradable raw materials for industry,
- Technologies of fire- and bio-retardants production,
- Environmental protection in natural fibres processing,
- Recipes and technologies for Polish herbal medicinal products,
- Complex research on biologically active substances i.e. quality evaluation, development of analytical methods and their validation as well as stability testing,

- Pharmacological and microbiological testing of herbal raw materials and products,
- Expert's reports on new food products in terms of human health or life hazard,
- Expert's reports and consultations for state and local government authorities and commercial companies,
- Research on herbal plants, herbal products, plant medicines, dietetic and functional food.

The research conducted at the Institute covers also utilization of polluted land by cultivation of non-food crops, use of co-products from processing of textile raw materials and modern composite materials based on textile raw materials. We are also involved in production of textiles made of natural fibres and blends.

Nanotechnology (nano-fibres from natural resources and nano-modifiers for intumescent fire retardant systems) is also of interest for the Institute's research staff. The outcomes of this work are patented fire retardants and fire retardant systems developed at the Institute – ***Fobos*** and intumescent varnish for wood ***Expander FR*.** Another fire retardant product developed at the Institute is fire barrier composite resistant to long time effect of temperatures reaching 1200^{o}C used as a filling in steel fire door.

Another field of research conducted at the INF&MP is determining the physiological effect of fibres, fabrics and other textile products on human organism.

We would like to present 3 technologies from our catalog:

1) "Methods of manufacturing cellulose fibers and nanofibers containing silver nanoparticles" (PCT/PL2007/000007)

Cellulosic fibres, due to their excellent properties ensuring comfort in use are commonly used in production of garments, hygienic materials and wound dressing. Use of these fibres as wound dressing requires bactericidal and bacteriostatic properties. Such properties are given to wound dressing by textile finishing process introducing superficially active bactericidal pharmaceuticals. This method is expensive, changes physico-mechanical properties and often the colour of wound dressing and causes relatively easy transmission of pharmaceuticals into human body, assuming that these are the wound dressing for homogenized use, e.g. bandages. Such wound dressing require relatively high amounts of pharmaceuticals offering relatively low biocidal effect obtained at complicated finishing process.

Taking into account the negative features of manufacturing biocidal wound dressing by finishing method, a new method of biocidal wound dressing manufacture was developed using cellulosic fibres containing the biocidal agent in the structure of fibres. The fibres are characterized by permanent biocidal properties and wound dressing made thereof can be washed many times with no negative effect on biocidal activity. This effect was obtained by homogenous distribution of nano particles of silver in cellulose solution. Homogeneous distribution of nano-sized silver particles in fibre structure ensures excellent bactericidal and bacteriostatic properties of fibres at low silver content. Experiments conducted shown that introduction of silver particle into spinning solution of cellulose by "*in statu nascendi*" method allows to obtain fibres with bactericidal properties even if the silver content in the fibre is 0.01%. The same bactericidal and bacteriostatic effect can be shown introducing silver into the spinning solution in the form of powder of nano particles in the amounts of one hundred times more. Thus, introducing silver into the fibre by the "*in statu nascendi*" method allows to obtain fibre with excellent biocidal properties without negative effect on physico-mechanical properties and without any colour changes. The biocidal effect of these fibres is permanent and does not change as a result of multiple washing or dry cleaning due to a permanent presence of silver in fibre structure. Additionally, the biocidal effect is obtained at silver content many times lower in the fibre as compared to effects obtained by other methods of introducing of biocidal substances into the fibres.

The fact worth special emphasizing is that process of introducing of silver nano particles into the fibres is fully environmental friendly – causes no pollution of the natural environment.

2) Butter modified with flaxseed oil and its production method (PCT/PL2007/000003)

Butter is a high fat product obtained in a process of churning of extracted and properly prepared cream. It is a product consisting of the same components like milk but found in a different proportion. It contains also precious natural vitamins: A, D, E and K. A commonly known butter is an easy-to-digest product of unmatched nutritive value. Butter that we present here confirms the above thesis, combining classical advantages of butter and cold-pressed flaxseed oil, contributing qualities that cannot be found in any other vegetable fat. In production of the oil no preservatives or improving substances were used.

The methods by which the flaxseed oil is produced have specially been developed for this product, based on scientific knowledge and production experience. The flaxseed oil “Linolia” used in this product is a new assortment of oil. It is obtained from new cultivars of oil flax, specially selected for its applicability for production of edible flaxseed oil. The proportions of fatty acids contained in the oil, provide the high rank among products with positive effect on cholesterol and lipid metabolism in human body. “Linseed butter” is reccomended to everybody, especially for eldery people. A specific taste of butter, given by the flaxseed oil, surely will find customers using it in direct consumption or in cooking or baking.

3) An intumescent fire retardant and the methods of its manufacture (PCT/PL2005/000057).

A technology of a new, effective intumescent fire retardant system, which contains modifiers in nano scale has been developed for protection of wood and lignocellulosic composites against fire. It does not change a natural appearance of protected material thanks to transparency of a coating.

The fire retardant varnish provides coatings, which swell and increase their volume as the result of heat or flame and create a thick carbonized and porous layer. This perfectly isolates the covered material from the excessive rise of temperature and oxygen penetration and thus protecting flammable materials against thermal decomposition and in consequence against loss of mechanical properties.

The solution is very effective as compared to conventional intumescent fire retardants. The performance of the coating is achieved by proper selection of carbonizing, foam-forming, dehydrating agents and modifiers, including very effective high dispersion components in nano scale.

Application of modifiers in form of nanoparticles significantly improves the fire retardancy and thermal insulation effectiveness of the system. High degree of particle dispersion causes changes in decomposition processes as well as combustion of coating. In consequence, the time of carbonized layer formation is reduced, also the structure of carbon skeleton improved towards small-cell structure (this allows reducing the amount of system used and by this reducing the costs of protection).

Intumescent system effectively protects wood and different wood derivatives (plywood, particleboard, high and low density fiberboard) in non-flammable degree, at only 250-350 g/m^2 of the system applied.

Forming an intumescent carbonized coating effectively protects materials against thermal decomposition by delaying ignition, reducing the amount and rate of released heat, effective heat of combustion, and mass loss rate, which are important in the initial phase of potential fire.

The fire retardant and coating formed by this system does not emit toxic substances and poses no threat to the environment nor to human health. This allows for the system application in places permanently occupied by people.

It can be used in different branches of economy, especially in construction industry (roofs, flat roofs, struts, beams, supporting structures, suspended ceilings, etc. in housing, public buildings, warehouses and on factory sites) and transportation.

INSTITUTE OF NON – FERROUS METALS IN GLIWICE

(Instytut Metali Nieżelaznych)

Instytut Metali Nieżelaznych

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Institute of Non-ferrous Metals in Gliwice would like to present its interest in establishing a wide cooperation in the area of research and technology transfer with the countries of South East Asia.

The Institute of Non-Ferrous Metals in Gliwice (IMN) is the main research and development centre of Polish non-ferrous metals industry, of a very wide scope of activity covering processing of non-ferrous ores and other mineral materials, pyro- and hydrometallurgical processes of metals recovery from ores and concentrates as well as recovery of by-product metals, waste treatment and utilisation, new alloys and composites, processing of metals and alloys, environmental protection, analytical chemistry of metals.

The Institute provides services in most areas related to non-ferrous metals (such as Cu, Pb, Zn, Al, Mg, Ag, Re, Se, Co) production and application, such as development of technologies for enrichment of a wide range of materials, especially non-ferrous ores, coal, waste and secondary materials; pyrometallurgical processes of metals production from ores, concentrates, scrap and waste; hydrometallurgical technologies for production of primary metals as well as by-products metals; basic and applied research into new metallic materials and composites, such as amorphous and nanocrystalline soft magnetic materials and intermetallic compounds; development of new technologies for production of cast, rolled, extruded and drawn products from metals and alloys; as well as research works and application studies into manufacturing, modernization and testing of primary batteries, rechargeable batteries and fuel cells.

The Institute produces also specific machines and equipment, including automated flotation machines of various sizes for non-ferrous ores enrichment, of cell capacity up to 100 m^3. The range of the products offered by IMN covers also small batch production of modern products (sintered metal filters, electric contacts, welding dies, brazing alloys, soft magnetic, amorphous and nanocrystal cores, Cu and Ni based amorphous alloys), certified reference materials for spectroscopic and chemical analysis, lead alloys, zinc compounds and water purificators, etc.

In our opinion cooperation between our Institute and partners from South East Asian region could be fruitful for both parties and we are ready to start discussion on the possibilities and scope of potential cooperation.

INSTITUTE OF NUCLEAR CHEMISTRY AND TECHNOLOGY

(Instytut Chemii i Techniki Jądrowej)

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Institute of Nuclear Chemistry and Technology (INCT), located in Warsaw, Poland, is an interdisciplinary institute started in 1983. General director is Prof. A.G.Chmielewski. The INCT is Poland's most advanced institution in the fields of radiochemistry, radiation chemistry, nuclear chemical engineering and technology, application of nuclear methods in material engineering and process engineering, radioanalytical techniques, design and production of instruments based on nuclear techniques, environmental research, cellular radiobiology, *etc*. It has 270 employees , including 15 professors, 13 associate professor; 56 senior scientists (Ph. D) and 21 Ph. D. Students. The Institute is listed in the category I of scientific institutions group in accordance to the Ministry of Science and Higher Education The results of work at the INCT have been implemented in various branches of the national economy, particularly in industry, medicine, environmental protection and agriculture. Basic research is focused on: radiochemistry, chemistry of isotopes, physical chemistry of separation processes, cellular radiobiology, and radiation chemistry, particularly that based on pulse radiolysis method. With its nine electron accelerators and 3 Co-60 sources in operation and with staff experienced in the field of electron beam application, the Institute is one of the most advanced centers of science and technology in this domain. The Institute has four pilot plants equipped in six electron accelerators: for radiation sterilization of medical devices and transplantation grafts; for radiation modification of polymers and semiconductors; for removal of SO_2, NO_xf and VOCs from flue gases; for food hygiene. The electron beam flue gas treatment in EPS Pomorzany with the accelerators power over 1 MW is a biggest radiation processing facility ever built. The Institute trains many of IAEA's Fellows and plays a leading role in agency regional projects. Because of its achievements, the INCT has been nominated the IAEA's Collaborating Centre in Radiation Technology and Industrial Dosimetry (www-naweb.iaea.org/na/collaborating-centres.html).

The INCT has begun the implementation of several projects in the program "Innovative Economy" POIG, granted on the basis of high evaluation of the Institute's achievements.

The mission of the INCT is the implementation of nuclear energy for social development, health and environmental protection.

The Institute represents the Polish Government in Euroatom Fuel Supply Agency, in Fuel Supply Working Group of Global Nuclear Energy Partnership and in Radioactive Waste Management Committee of the Nuclear Energy Agency (Organization for Economic Cooperation and Development).

Scientific Council has rights to grant D.Sc. and Ph.D. degrees in the field of chemistry,and the Institute carries out third level studies (doctorate) in the field of nuclear and radiation chemistry.

The INCT also is editor of the international scientific journal "Nukleonika" (www.nukleonika.pl) .

INSTITUTE OF PRECISION MECHANICS

(Instytut Mechaniki Precyzyjnej)

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Institute of Precision Mechanics, one of the oldest and best known Institutes in Poland, is a research and development centre, focussed on methods of improvement of metal products by enhancing their corrosion resistance and raising their mechanical properties, especially fatigue strength, and wear resistance in service processes involving friction.

The Institute conducts scientific and technical research, the aim of which is first of all the development of new technological methods, as well as commercial service and implementation activity.

The Institute offers, among other, the following:

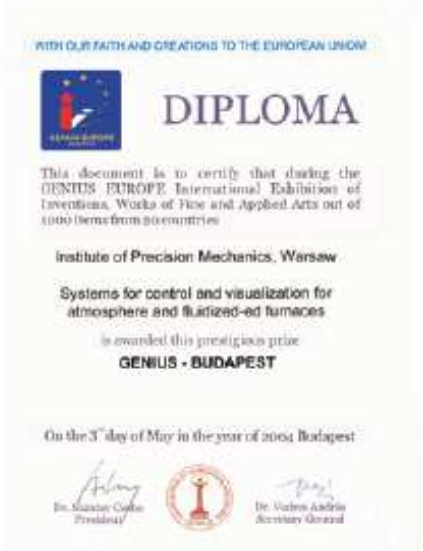
- methods of mechanical and chemical preparation of surfaces for deposition of protective
- coatings, along with equipment and chemicals
- methods of depositing of electroplated, varnish, thermal spray and immersion metallisation-type coatings and chemicals for their deposition
- methods of heat and thermo-chemical treatment of tooling and machine components, as well as accomplishment of these processes on a semi-technical scale
- work in the field of material strength, including, among other, fatigue and friction testing and measurement of stresses
- cleaner production methods, recovery of raw materials, methods of wastewater decontamination in surface treatment of metals

An integral part of the Institute is the Scientific Council which has the necessary authorisation and confers degrees of Doctor of Technical Sciences in the field of materials engineering.

Within the scope of its activity, the Institute cooperates with the industry since many years. Among the big industrial plants, the following should be mentioned here: Z.M. Tarnów, HSW Stalowa Wola, WSK Rzeszów, Z.M. Siemianowice Śląskie, MESKO S.A. Metal Works, Radom Arms Factory, Z.M. „BUMAR-ŁABĘDY" S.A., Z.M. „NOWA DĘBA", Warsaw Mechanical Works "PZL-WZM", PZL – WOLA S.A. Mechanical Works and the Warsaw Radio Factory "RADWAR".

The Institute cooperates very closely with Polish research centres: technical universities, institutes of the Polish Academy of Sciences and industrial research institutes. Within this scope of cooperation, the Institute conducts shared research and markets own intellectual property and products. Such cooperation is carried on with, among other, Warsaw Technical University, Poznań Technical University, Gdańsk Technical University, Mining and Steelmaking Academy, the Institute of Fundamental Technical Problems of the Polish Academy of Sciences, Electrotechnical Institute, Industrial Institute of Automation and Measurements, Institute of Nuclear Problems, Institute of Electronic Materials Technology, Częstochowa Technical University, Silesian Technical University, Military Technical Academy, Institute of Service Utilisation Technology, Institute of Physical Chemistry of the Polish Academy of Sciences.

International cooperation is carried out by research collaboration, as well as by direct sale of own developed methods, equipment and services. Special emphasis in international cooperation is placed by the Institute on technical research collaboration, accelerating and raising the level of research carried out. Currently, the Institute cooperates with several research centres and laboratories of big industrial plants, among other with the Technische Universität (Chemnitz, Germany), Helsinki University of Technology (Helsinki, Finland), Instituto Superior Technico (Lisbon, Portugal), Technical University (Lyngby, Denmark), Institute of Materials (London, UK), Commissariat à l'Energie Atomique (Fonteney-aux- Roses, France), University of Southern California (Los Angeles, USA), Pye Metallurgical Consulting Inc. (Meadville, USA), Nitrex Metal Inc. (Québec, Canada), National Institute of Aviation Technology (Moscow, Russia), Karpenko Physico-Mechanical Institute UAS (Lviv, Ukraine), E.O. Patton Welding Institute (Kiev, Ukraine), Physical-Technical Institute National Academy of Science of Belarus (Minsk, Belarus) and other centres.



The Institute coordinates or participates in major international programmes and research projects, among other in the "Education in Ecological Surface Finishing (TEMPUS JEP)", "Cleaner Technology and Eco – Management Transfer Programme for the Electromechanical Industry in Poland" (0160/Denmark), "UE Network of Integrated Scenario Analysis of Metal Coatings" (ISA-COAT), "Model for Multi-pollutant Impact and Assessment of Threshold Levels for Cultural Heritage" (MULTI-ASSET) as well as in the Visegrad Programme "The Improvement of Safety and Equipment and Application of Corrosion Protection". The Institute presents its work by publishing articles in internationally circulating periodicals, such as "Journal of Materials Science", "Physico-Chemical Mechanics of Materials", "Materials Science and Technology", "Surface and Coatings Technology", "Galvanotechnik", "Transactions of the Metal Finisher's Association of India" and other, as well as in several domestic journals. Papers by scientists of this Institute are delivered at many international and domestic research and technical conferences.

The Institute is itself the publisher of a technical-research quarterly "Inżynieria Powierzchni" (Surface Engineering), as well as monographical research materials, published in book form. The "Inżynieria Powierzchni" is a periodical encompassing all of Poland, which also publishes works by foreign authors. The monographic publications present, among other, habilitation (post doctorate) dissertations by employees of the Institute.

KOREA INVENTION PROMOTION ASSOCIATION

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The modern technology of heat treatment of cardiovascular stents

Gold medal with mention

The Institute very actively participates in international and domestic standardization activity. Employees of the Institute lead the ISO TC107/SC7 Sub-Committee: „Metal Coatings and other nonorganic – methods of investigation" and participate as experts in the proceedings of the ISO TC/156 Committee: "Corrosion of Metals and Alloys", as well as the ISO TC35/SC12 Sub-Committee: "Paints and Varnishes – preparation of steel substrates for deposition of paints and similar products". The Institute also sponsors three domestic technical Committees: KT-106 (concerning corrosion and corrosion protection), KT-262 (concerning heat treatment of metals) and KT-273 (concerning mechanical security equipment. The Institute presents its achievements at international fairs and exhibitions, earning gold medals and other distinctions, among other at the International Innovations and Inventions Fair (e.g. in London, Nuremberg, Brussels, Seoul and Moscow). Taking part in domestic competitions, the Institute has repeatedly been awarded the prestigious title of Champion of Technology, the last time for „Development of multicomponent surface layer, resistant to wear and corrosion, obtained in conditions of glow discharge".

1) GLOW DISCHARGE ASSISTED NITRIDING AND NITROCARBURIZING IN THE AUTOMOTIVE INDUSTRY –

EXAMPLES OF PRACTICAL APPLICATIONS

A brief description of the technology

1. INTRODUCTION

The automotive industry in Poland is among the fastest developing recently. Fundamentally important for automotive components are quality, service life and enhanced user properties.

Fulfilling these requirements in practice, given the need to limit manufacturing costs – depends to a great extent on surface engineering processes. These processes yield service properties for components made from different grades of steel, aluminum alloys, as well as titanium alloys, nickel alloys and more recently magnesium, working in conditions of corrosion, friction, wear and oxidation at elevated temperatures. Classical heat treatments, such as hot dip galvanizing, electrochemical and electroless deposition of metallic coatings, phosphating, chrome plating, electrophoresis, gas and vacuum carburizing processes, anodic oxidation or induction hardening are all widely used in the automotive industry. These processes have made possible the modern vehicle with among other features, a 12 year warranty on bodies, as well as longer life and better engine performance, largely due to reduction of friction in the power train. Surface engineering technologies are designed to control microstructure, chemical and phase composition, residual stresses, and surface topography of outer layers on treated components from the viewpoint of achieving the required service properties. Among these properties are wear and corrosion resistance, improved fatigue strength and heat resistance. Achieving such properties represents the most economical means of meeting requirements placed on structural materials, over on a wide range of operating conditions [1-10].

Such requirements are very often met by glow discharge treatments, including glow discharge nitriding and nitrocarburizing processes. These methods utilize non-equilibrium low temperature and non-isothermal plasma formed in conditions of glow discharge.

The result of glow discharge nitriding of steel depends predominantly on process parameters such as: chemical composition of gas mix and its pressure within the reaction chamber, and on the location of the load: at the cathodic potential or in the plasma zone. These factors affect both the type of particles responsible for the formation of the surface layer, as well as the physico-chemical phenomena taking place at the interface of low temperature plasma and treated component. Phenomena such as cathode sputtering and chemisorbtion, in turn, affect the diffusion processes, controlled by the temperature of glow discharge nitriding.

Thus, the following factors have a fundamental effect on the results of glow discharge nitriding:

- Type of glow discharge, i.e. dc or high frequency (so called pulsed plasma) because in the latter case, there is a higher proportion of active nitrogen particles (atomic nitrogen, N^+ and N_2^+ ions, as well as NH radicals) and, consequently a higher concentration gradient
- Location of the treated load at the cathodic potential bias or the plasma zone, which, in turn, determines the effectiveness of cathodic sputtering. Most effective is placement at the cathode potential [11-14].

By selection of the chemical composition of the nitrogen–hydrogen gas mix and type of electrical activation of the gaseous environment, it is possible to control the phase composition of the nitrided layers, their surface topography and microstructure, and in this way their user properties. Given the advantages of these processes, such as:

- Potential for treatment of components with complex geometry
- low consumption of electrical energy and reactive gases
- elimination of labour-intensive finishing treatment after the process
- full control of microstructure, phase and chemical composition, surface roughness and state of residual stresses in the layers formed, as well as their diffusion character
- possibility of treating diverse steel grades, including austenitic, at temperatures as low as 400ºC this treatment is increasingly widely used in the automotive industry.

2. APPLICATION EXAMPLES

The advantages of glow discharge nitriding and nitrocarburizing be obtained under conditions of precise process control in which surface phenomena at the interface of reactive atmosphere – treated material and layer growth kinetics are controlled by selecting process parameters: temperature, time, pressure and atmosphere composition, as well as surface activation resulting from the phenomenon of cathode sputtering.

Application possibilities may be extended by pulsed-plasma nitriding with higher frequency current [6].

The new, improved version of the pulsed plasma process developed at the Institute of Precision Mechanics has global potential. It was first applied in 2006 at the AMP Paradowscy SJ company in Ursus/Warsaw, Poland. The equipment was developed along with the process (Figs. 1 and 2).

Fig. 1. General view of equipment for glow-discharge nitriding of valves

Fig. 2. Pulsed-plasma nitrided automotive valves

The output of the installation is 6 thousand valves per 24 hours (ca 1.2 million pieces annually). The equipment is designated for nitriding automotive valves using glow discharge generated by pulsed plasma. Performance tests on the valves have shown that this method offers increased service life for the valve seat and stem and prevents the formation of carbon deposit in the seat zone. Fig. 3 shows the microstructure of the nitrided layer formed on automotive valves. These valves are characterized by good corrosion and wear resistance [9].

The method, by comparison with processes previously carried out at the same plant, i.e. chromium plating and salt bath nitriding, is superior also from the standpoint of workplace safety; it is environmentally friendly.

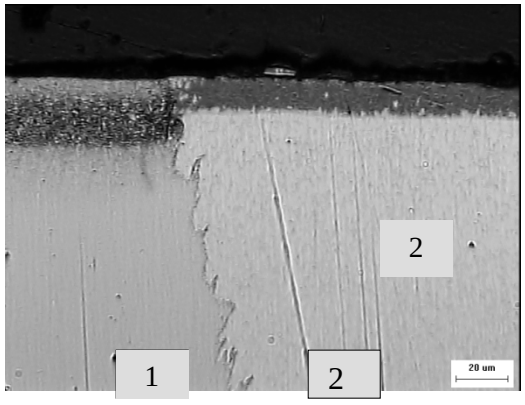

Fig. 3. Microstructure of nitrided layer obtained on automotive valves by pulsed-plasma nitriding. Magn. 250 X. Nitrided valve X45/X53 – place of welding: 1 – valve made of martensitic steel H9S2 – surface hardness HV after nitriding – 1020 HV0.2, thickness of layer – 24 µm; 2 – austenitic steel 21-4N – surface hardness HV0.05 after nitriding - 890 HV0.2, thickness of layer – 12 µm

A typical example of the use of the ferritic nitrocarburizing with plasma is the camshaft for the DAEWOO 1.6 GLI engine. Previously, the process was induction hardening using 10kHz generators. The depth of hardening was 3 to 7 mm on the cam lobe and on the opposite side (taking into account stock for finish grinding). The hardness was 47 HRC and 52 HRC, respectively. Induction hardened camshafts were used in engines with mechanical cam follower control (to limit play).

Fig. 4. Equipment for glow-discharge nitrocarburizing of camshafts at DAEWOO (a) and view of camshafts for one load of 140 pieces for nitrocarburizing treatment

Improvements to engine design using hydraulic cam followers and multi-point injection of fuel produced the need for a method which would ensure the formation of layers with improved tribological properties. For this reason, the ferritic pulsed plasma process, meeting all the above requirements, was selected [10]. The method was awarded a First Degree Award by the RS-NOT Organization in the 'Master of Technology' competition in Warsaw in 1999.
From investigations carried out in actual industrial service conditions it follows that the surface hardness of layers formed of the order of 500 – 560 HV1 has a significant effect on wear properties. Special equipment was developed and built for pulsed-plasma ferritic nitrocarburizing process on camshafts (Fig. 4).

The next example of application of ferritic glow discharge nitriding of cast iron components is cylinder liners for high compression engines (Fig. 5) which, after a road test of 100,000 km, showed less wear than chromium-plated liners. It should be added that in the case of cast iron, besides good wear resistance, nitrocarburized layers ensure resistance to seizure in conditions of insufficient lubrication [15].
Fig. 6 presents the installation designed by IMP for glow discharge nitriding of crankshafts, at the Diesel Works in India; Fig. 7 shows the microhardness profile [15]

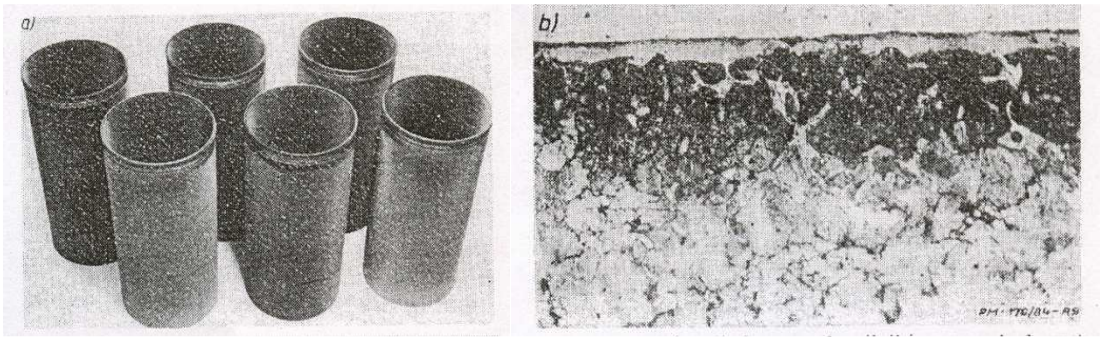

Fig. 5. Cylinder liners for automotive engines after glow-discharge nitrocarburizing (a) and microstructure of layer produced on W1C grade cast iron (b). Magn. 200 X. Hardness after nitrocarburizing - 600HV1

Fig. 6. Equipment designed by IMP for glow-discharge nitriding of crankshafts

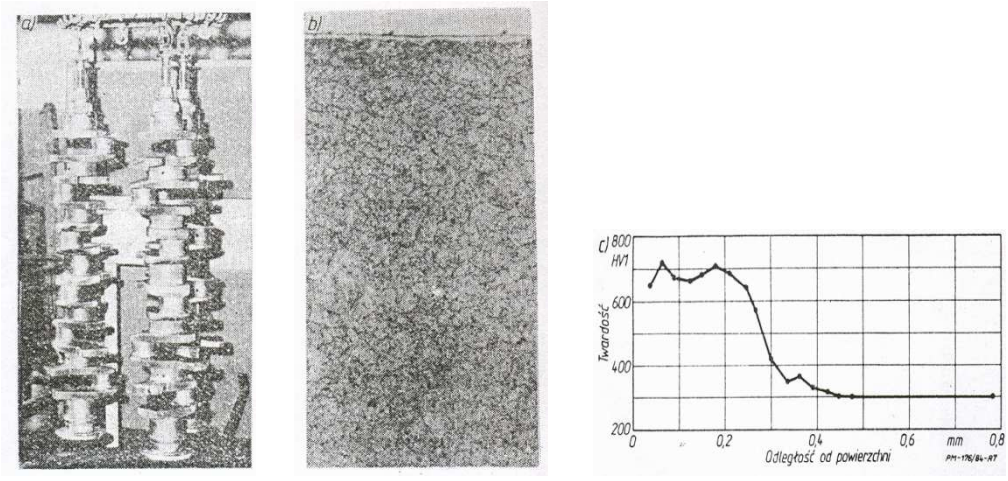

Fig 7. Crankshafts made of 25H3M grade steel after glow-discharge nitriding (a), microstructure (b) and hardness profile (c) in nitrided layer; hardness after glow-discharge nitriding - 600HV10. Magn. 200 X.

Fig. 8. Examples of nitrided piston rings

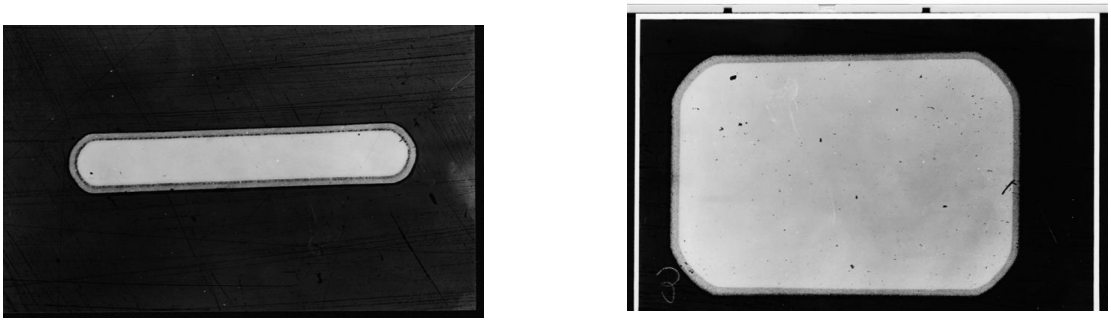

Fig. 9. Examples of nitrided layers produced on piston rings by glow-discharge nitriding . Magn. 100 X

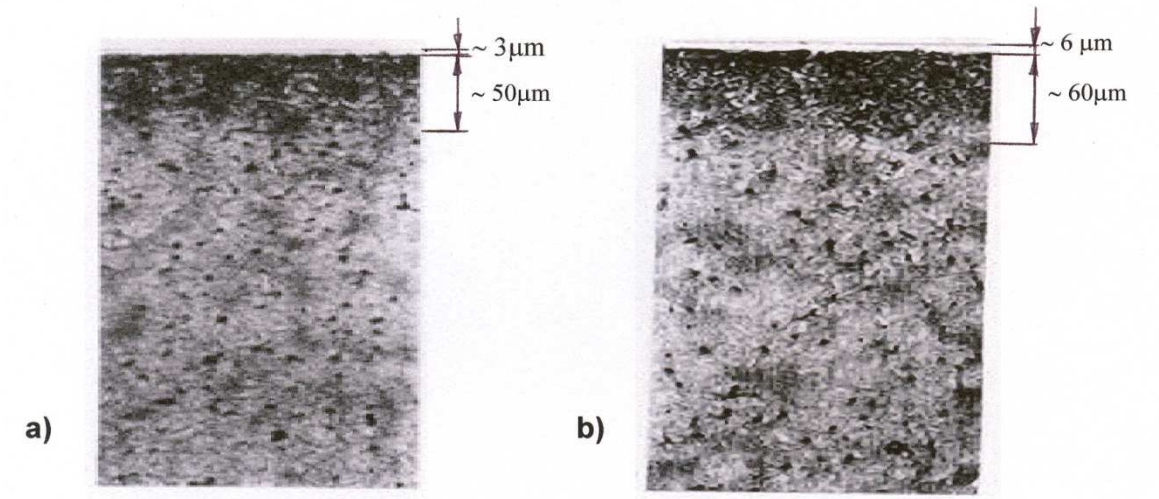

Fig. 10. Effect of reactive atmosphere pressure on microstructure of layers produced on piston rings made of ductile cast iron, grade S-14 by glow-discharge nitriding. Process parameters: a – temperature - 480 °C, treatment time - 6 hours, pressure 1.7hPa, b – temperature - 480 °C, treatment time - 6 hours, pressure – 2.5hPa

Another application example of the glow discharge nitriding process is piston rings. This method is competitive with the currently used chromium plating, because the layers formed are characterized by good wear and corrosion resistance, as well as meeting the requirement for surface roughness [16]. Moreover, the relatively simple possibility of local (selective) nitriding, achieved through masking, proved to be an effective means of avoiding deformation of piston rings with special shapes.

Fig. 11. Glow-discharge nitrided gear wheels made from grade 31CrMoV9 steel for electric locomotives produced by General Electric (Germany). Photograph taken at AMP Paradowscy S.C. in Kunowo

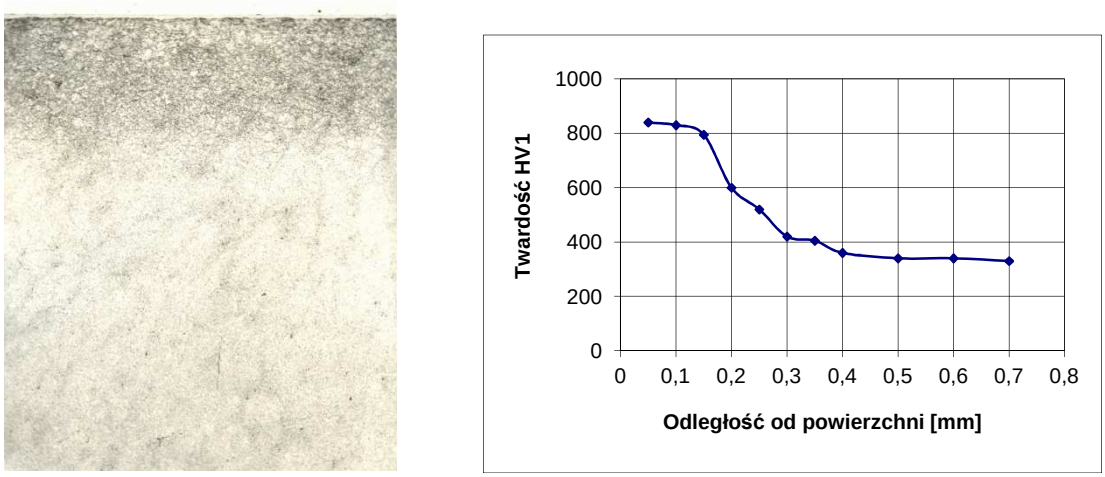

Fig. 12. Microstructure and hardness profile of glow-discharge nitrided layer. The layer was produced on a gear wheel made from grade 31CrMoV9 steel. Equipment for the treatment was developed and built by IMP, installed in the AMP Paradowscy S.C. plant

Figs 8 and 9 show nitrided piston rings, and Fig. 10 their microstructure. The next example of application of the glow discharge nitriding method is gear wheels (Figs. 11 and 12). [17].

3. FINAL REMARKS

The scope for glow discharge nitriding and nitrocarburizing is broadening. The processes also constitute the basis of future hybrid processes, combining these processes with other surface engineering methods. This will give the treated material unique properties, such as resistance to oxidation at elevated temperatures, thermal shock and overloading, as well as reduction of the coefficient of friction [16-18]. Such properties are important in, among other things, engine components, exhaust systems and power trains, i.e. those working in extreme conditions. A significant challenge to broader application of the technology is the enhancement of resistance to contact fatigue (pitting), especially in the case of gears. Intensive investigations in this field are being conducted at the Institute of Precision Mechanics.

2) PEEN–IMP - new shot peening technology and device for ceramics and metals with high hardness surface layers

A brief description of the technology

The main aims of the PEEN-IMP technology and device invented in Institute of Precision Mechanics were the reduction of exploational costs of shot-peening process and the widering of fields of application of shot-peening process on hard materials such like ceramics, high hardness steels, steel elements coated by hard PVD and CVD layers.

Basic ideas of the PEEN-IMP technology - worked surface is placed inside of upper part of the closed working chamber is treated "from underside" by strong stream of mixture of air with shot, shot after realization of work falls down because gravitation and it mixes again with stream of air, mixing process of particles (crumbled shot or powder) with stream of air follows in lower part of working chamber, stream of air and shots has vertical direction "from down to top" and moreover a stream is introduces into circulated movement, the most profitably into movement on a cone surface.

It is possible to introduce additionally powders of some chemical elements refining treated surface to the working chamber, also in form of liquid solutions.

Shot-peening process under the PEEN-IMP technology in comparison with actual well known processes marks considerable shortening of shot return road to circulation, 200-250 times decrease of required quantity of shots, 50-times decrease of a level of required pressure (even to 0,05 Mpa), use of powders (considerably smaller from shot), also in form of liquid solution. The decrease of required quantity of shot allowed the use of expensive bearing balls and other expensive shots e.g. sintered carbides and tungsten.

3) The technology of the vacuum brazing of the “ honey comb” seals in gas directing apparatuses of aircraft engines

A brief description of the technology

The technology of the vacuum brazing of seal rings in form of a "honey comb” to the internal surface of gas directing apparatuses applied in the most modern aircraft engines is the object of the invention. These elements works in changed thermal tension and mechanical conditions, as well as in atmosphere of corrosive gases. They are also exposed onto constant long-lasting dynamic burdens. Directing apparatuses are produced in a form of very precision casts from nickel based alloys consisted from body and blades. The “honey comb” seals are used as the seals between gas directing apparatus and shaft because very responsible character of work – they are ones of the most modern solutions. The seals are made from the Hastelloy alloys with the structure of a "honey comb” – they are soldered perpendicularly by edges of individual cells to cylindrical surface of apparatus.

About complexity of problem testifies the fact, that in distinction from typical soldered connections, in which the joint is a flat surface, in this case the solder among two different alloys on the nickel base can be compared with the simultaneous brazing of thousands' thin-walled capillary tubes.

The worked out technology concerns by productions of joints by of solders Ni-Cr-B -Si in form of tapes and pastes produced from powders with a suitable adhesive and it consists from following technological processes.

- nickel-plating of apparatus bodies;
- spreading of solder;
- tacking of the “honey comb” seals with apparatus body before the brazing;
- vacuum brazing;
- cleanings of surface after brazing;
- quality control

The working out technology for serial production makes a possibility to obtain high quality products fulfilled the conditions defined by air-equipment users, with a retain of criterion of minimization of defects in production process.

4) Nanocrystalline Cobalt Alloy Plating for Replacement of Hard Chrome

A brief description of the technology

The present invention relates to the pulsed electrodeposition of nanocrystalline cobalt-phosphorous(nCo-P) coatings, as a viable alternative to electrolytic hard chrome plating.

This technology uses pulse plating to control the nucleation and growth of grains within the coating, creating a nanocrystalline structure.

The nCo-P coating application does not cause hydrogen embrittlement of high-strength steels, which is a significant problem with electrolytic hard chrome plating. Performance testing showed that the nCo-P coatings demonstrated superior salt fog corrosion behavior compared to the hard chrome coatings.

As a result of Hall-Petch strengthening, nCo-P alloys display significant increase in hardness relative to their coarser grained counterparts due to their ultrafine grain size. A further increase in hardness, can be obtained by annealing the as-deposited coating to induce the precipitation of cobalt-phosphites from the supersaturated solid solution at elevated temperatures.

The process is non hazardous and produce stable coatings free of hexavalent chrome. It meets the requirements of ELV, RoHS and WEE directive.

An application of the invention is recommended particularly for automotive and aerospace components

5) WibroTermoFluid® - fluidal heat treatment method

A brief description of the technology

The method of the fluidal heat treatment of metal elements is the subject of invention (patent application in Patent Office of Poland under Nr P-392916 since 2010.11.10).
There are known methods for heat treatment of metallic elements, which consist of fluidization of heated, granular and chemically inactive bed with the technologica atmosphere.

Such way requires the use of large quantities of technological atmosphere for fluidization, several times larger quantities of technological atmosphere, than it would be necessary to perform only the treatment alone. This is the reason of high production costs. . The purpose of this invention was to develop the way to perform treatment with reduced costs, through decrease of the usage of technological atmosphere. The core of fluidal heat treatment, according to our invention, consists of fluidization of granular, heated and chemically inactive bed with technological atmosphere in the retort, which is elastically mounted, mostly vertically, and subjected to mechanical vibrations of specified amplitude and frequency. Performed tests have shown that with optimal choice of strings and vibrations amplitude and frequency, the consumption of technological atmosphere decreased to 50% without the decrease of treatment's quality. This lessened quantity of technological atmosphere would not be enough to fluidize the bed by itself, but is enough to fulfill the needs of heat treatment process. This treatment method, according to our invention may be used interchangeably with the old method in technologies of fluidal heat treatment.

6) Nanostructured Co-P coating as a diffusion barrier in electronics

A brief description of the technology

The invention relates to the preparation of cobalt alloy electroplanting coatings with phosphorus using the method of galvanic current pulse. Depending on the characteristics of the current deposition is possible to obtain coatings of amorphous or nano-structure (5 to 20 nm).
They provide excellent diffusion barrier under gold coating used in electorinc circuits utilized especially at elevated temperatures (above 200^{o}C) which allows their use in automotive, military and aerospace characterized by electronic components operating temperatures to 400^{o}C.
Co-P (2 – 8% of the masses) coatings exhibit better barrier properties than those used Ni-P coatings in both SnPb solders and leaf free. SnAgCu solder contact angle for the Co-P coatings is three times smaller than the Ni-P coatings. Co-P/Au immersion coatings exhibit lower diffusivity of lead-free solders and the absence of intermetallic compounds, which greatly improves the performance of connections.
Corrosion tests in nitric acid vapor shower a good resistance coatings Co-P/Au-Co already at small thickness, respectively 0.1 and 0.3 um Au-Co, which indicates the possibility of such a multilayer coating to cover the pins and contacts, especially with due to the high hardness of the Co-P coatings at elevated temperatures and similar to the Ni-P coating, ductility which would significantly reduce the thickness of the gold coating.

7) Nickel-Tungsten Alloys as Protective Coatings for Glass Moulds

A brief description of the technology

Application of rationally selected protective coatings for glass moulds is remarkable method of production yield increasing, particularly if small dimensional tolerances and increased surface quality of product are required.

These necessities concern significant part of glass manufacturing branch e.g. lightweight containers, optical devices, colour picture tubes, displays, vacuum accessories, glass insulators. Within required physical and mechanical properties of coatings the most important are abrasive wear resistance, high temperature resistance, ability of appropriate heat extraction from the product and ability of proper and reasonable surface finishing

Only specially designed permanent coatings may be applied in such a case. Structure stability, high ductility, high cathodic electrochemical potential and thermal anisotropy which prevents from rapid heat extraction outside regions of warmest glass there are ideal features of such a coating.

It was found that Ni-W alloys of 20-40 wght% of tungsten content have excellent mechanical, thermal and chemical characteristic which let use them as protective coating for various purposes and exclusively for glass panel plunger application.

Studies the Ni-W alloys electroplating process shown that satisfactory results of treatment on a industrial scale may be reached applying the bath of high content of hydrocarboxyl acids /particularly citric acid/ with high tungstenes content which lessens the coating hydriding. Stable process of electroplating is gained by soluble nickel anodes implementing and less than usually applied acidity of the bath /pH 3.8-5.5/.This modified plating technology of plunger has been applied in practice

Independent research of Ni-W alloys considered for other specialized applications /MEMS, LIGA processes, catalysis, shielding gaskets/ indicate low coating surface attraction to environmental impurities in hot work conditions.

INSTITUTE OF SECURITY TECHNOLOGIES MORATEX

(Instytut Technologii Bezpieczeństwa)

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Institute of Security Technologies MORATEX in Łódź exists since 1953. It develops modern designs and technologies of textile technical goods and implements them to the industry. In 90s the R&D workload has been moved towards developing of personal life and health protection means for individuals exposed to threats from bullets, fragments, impacts, harmful chemical or biological agents and unfavourable factors, as fire, temperature, water etc. The works focused mainly on solutions related to technologies dedicated for services subordinated to the Minister of Interior and Administration and to Minister of National Defence.

Since 1999, according to the decree of Prime Minister, the Institute is the R&D body supervised by the Minister of Interior and Administration. Starting with that moment all the effort of the Institutes management and employees is driven to satisfying the expectations and requirements of the Police, Fire Service, Border Guards and The Government Protection Bureau. Executing the tasks set, with co-operation with those services, MORATEX developed in 2001-2006 new and modern uniform assortment, equipment and means of individual protection.

The quality management system, compliant to the requirements of the Standards: PN-EN ISO 9001, PN-N 19001 has been implemented to the Institute and confirmed by certificate from The Polish Centre for Testing and Certification.

The Institute has been awarded the Notified Body position by the European Committee within the scope of directive 89/686/EEC – Personal Protective Equipment, ID No. 1475.

The quality of newly-developed goods is confirmed by the certificates from accredited Certifying Bodies, including: CIOP, WITU, CNBOP.

The Products Certification Department works at the Institute, to issue certificates of conformity of the products offered by the suppliers of textile protective goods and uniform elements.

High level and modernity of material, technical and design solutions of developed products, are proven by positive opinions of end users as well, as the medals and awards from both domestic and international organisations. The novelty of scientific and technological

solutions is confirmed by the protection rights assigned by the Polish Patent Office. The Institute has gained more than 100 patents and more than 140 utility model reservations.

www.moratex.eu

Key Project WND-POIG.01.03.01-10-005/08

„Modern ballistic body armours and covers for transportation means as well as for buildings, made on a basis of textile composites"

Realisation: 01.09.2007 – 30.06.2012
Project Value: 12 940 000 PLN
European Union Fund: 10 999 000 PLN

The Key Project is realised within the frame of INNOVATIVE ECONOMY, NATIONAL COHESION STRATEGY 2007-2013, Priority 1 - Research and development of new technologies, Axis 1.3 - Support for R&D projects for entrepreneurs carried out by scientific entities, Subaxis 1.3.1 - Development projects.

http://ergobal.poig.eu

THE COMPONENTS DEVELOPED:

7 variants of ballistic inserts for bullet- and fragment-proof vests

Type of ballistic panel	**Ballistic resistance according to PN-V-87000:1999 Standard**	**Ballistic resistance according to PN-V-87000:2011 Standard**
Composite	K2 , K4	K3/A [7,62x39mm; PS; $720^{\pm 15}$ m/s]
Ceramic & Composite of type I	K2 , K4 , resistance to SS109 bullet	K3/A [7,62x39mm; PS; $720^{\pm 15}$m/s] K3/B [5,56x45mm; SS109; $950^{\pm 15}$m/s]
Ceramic & Composite of type II	K2 , K4 , resistance to 54R bullet	K3/A [7,62x39mm; PS; $720^{\pm 15}$m/s] K3/C [7,62x51mm; FMJS; $840^{\pm 15}$m/s] K5/A [7,62x51mm; AP; $820^{\pm 15}$m/s]

THE PROTOTYPES DEVELOPED:

3 prototypes of bullet- and fragment-proof vests
2 prototypes of quick-release bullet- and fragment-proof vests;
a prototype of two-part bullet- and fragment-proof vest (vest and hip belt).

FINAL SOLUTIONS DEVELOPED:

The bullet- and fragment-proof vest dedicated for the area of internal security.
The bullet- and fragment-proof quick-release vest dedicated for the area of internal security.

Modular quick-release bullet- and fragment-proof vest dedicated for the area of internal security.

Hybrid ballistic helmets

Resistance to bullets as well as to fragments complies with PN-V-87001:2011 Standard.

Helmet protects the head at front – above the eyebrows level, at sides – above the mid-ear level behind the cheekbone, and at back – above the occiput, for the V50 > 600m/s at the acceptable dynamic deflection (trauma) below 20 mm (class O3).

Ballistic shield

7,62x51 308 Winchester FMJ at the bullet velocity of $V=828^{\pm 15}$ m/s;

7,62x39 AKM PS 43 at the bullet velocity of $V=710^{+15}$ m/s.

The Project realised within the frame of INNOVATIVE ECONOMY, NATIONAL COHESION STRATEGY 2007-2013, is co-funded in 85% by the European Union from the European Regional Development Fund and in 15% by the Polish Ministry of Regional Development.

CAMOUFLAGE TEXTILE MATERIALS

One common title „Camouflage textile materials" covers the following material and design solutions submitted for protection to the Patent Office of Republic of Poland: W.120169 „Camouflage woven fabric" and P.396078 „Antistatic openwork knitted fabric". They are products made with methods: weaving and knitting. They are dedicated for masking men and their individual equipment under visible, IR and radar spectra. The properties originate from proper both qualitative and quantitative selection of compound materials i.e. basic yarns (background material) and conductive yarns (with due share of metal and soot). The design itself of each material is no less important to reach specified properties. The application of optimum weaving and knitting pattern allows for suitable arrangement and deterioration of each yarns group on the surface of final product i.e. fabric/knit. An extra trump of the materials is low weight, rare among such products full of functionalities, masking men and their individual equipment.

The camouflage textile materials, have been developed within the frame of Key Project no. POIG.01.03.01-00-006/08 co-financed from the funds of European Regional Development Fund under Operational Programme Innovative Economy.

PROTECTIVE VEST

The vest protects against small arms bullets, fragments, knife, needle and stab according to:

– bullet-proofness class 3 according to PN-V-87000:1999 Standard „Light ballistic armours. Bullet- and fragment-proof vests. General requirements and tests.",

- knife- and stab-proofness class 1 according to procedure PBB-08:2006 ITB „MORATEX" „Impacting tests. Determining the resistance of personal armour to an edge – procedure compliant with NIJ STANDARD 0115.00
- needle-proofness class 2 according to procedure PBB-12:2008 ITB „MORATEX" „Impacting tests. Determining the resistance to puncture with needle"

Due to its innovative design, the vest features ergonomic shape which allows for easy adjustment to the wearers silhouette. An interesting solution is disjoint, yet durable way of fastening the vest on shoulders which prevents undressing the officer by an attacker. A special way of joining two elements of back belt and mounting it on back part of vest was introduced. It is a system of thin ropes, holes, technical bands and metal frames. Whole vest is covered with MOLLE band system MOLLE.

The protective vest was submitted to Patent Office of Republic of Poland, to gain the protection rights for utility design, application no. W-119599, dated 22.12.2010.

Weight of L-size vest is ca. 6.6 kg.

METAL FORMING INSTITUTE

(Instytut Obróbki Plastycznej)

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The Institute performs research, development, implementation works and participates in domestic and international projects on non-metallurgical metal forming. The Institute has well experienced and creative staff backed with advanced computer systems, modern scientific and research facilities.

High quality of the research and development works is ensured by the Quality Management System conform with ISO 9001:2008 and the Accredited Investigation Laboratory meeting the requirements of PN-EN ISO/IEC 17025:2005.

The Institute's scope of activity includes:

- innovative technologies, machines, devices and tools for: net shape forging, orbital forging, extrusion, forging by the TR method, stamping, spinning and flow forming, forming of precision metal powder parts, including the application of nanotechnology,
- mechanizing and automating devices, special centres and production lines,
- computer designing, modelling and simulation of processes and tools,
- research of metal structures and properties,
- heat and thermochemical treatment,
- standardization activity,
- scientific and technical information – databases, publications, among others, "Metal Forming" periodical,
- assessment of machine and device conformance,
- consulting, training and promotion activity,
- manufacturing of prototype machines and devices,
- manufacturing of parts by the metal forming methods.

Achievements of the Institute:

- licences sold to many countries of the world,
- hundreds of modern technologies, machines and devices implemented in industry,
- many publications and patents, both in Poland and abroad,
- many individual and team prizes, awards and medals,
- membership in important scientific organizations and networks,
- status of the Centre of Excellence of the Metal Forming Institute.

The Metal Forming Institute offers:

- elaboration and implementation of technologies,
- design, execution and implementation of devices, machines and tools for metal forming processes,
- investigation of technologies, devices, machines and tools,
- investigation of metal structures and properties,
- technical consulting.

The Institute participated and coordinated many EU and nationally funded projects like:

- Framework Programme funded projects (FP5, FP6, FP7) like NANOMINING,
- EUREKA funded projects like NEGFORT,
- projects within the Innovative Economy Programme (POIG) like I-Centrum, NANOMET,
- development projects,
- Institute's own research projects.

1) NANOMINING

Nanomining is a project dedicated to the development of new nanocomposites using materials from mining industry

The NANOMINING Project is carried out within 7th Framework Programme of the European Commission within joint EU-Mexico call Adding Value to Mining at the Nanostructure level, NMP Program Priority: NMP.2010.1.2-4.

Project background:

Silver nanoparticles and silver based nanostructured composites are being frequently used in a variety of biomedical and industrial applications, such as an antimicrobial agents, lead-free solders, electric contact materials, gas-sensitive sensor, etc. The most complicated Silver using problems to be considered in the Project are:

- recovery of silver from ore waste materials;
- the controlled synthesis of metal nanoparticles of well-defined size, shape and composition;
- nanoparticles incorporation to desired implant surfaces
- synthesis of Silver based nanostructured composites for industrial purposes.

Project goals:

The main goal of the Project is to develop:

- Clean and efficient procedure of silver recovery from waste: Combined Mechanical Activation – Thermal Oxidation Processing of jarosite type residues to alleviate and accelerate the following precious metal leaching;
- Combined nanotechnology of biological synthesis (using Mexican plants) of Ag nanoparticles and its deposition on implant surfaces by electrophoretic, spraying and other techniques;
- Nanostructuring technology of Silver based nanocomposites manufacturing for electrical contact applications.
- Pilot production and trials of developed Ag nanoparticle modified implants and Ag based nanostructured composites:

- Hydroxyapatite Ca10(PO4)6(OH)2) coated implants which are widely used in orthopaedic surgery because of their good biocompatibility related to the osteoconductive properties of calcium phosphate coating;

- Ag-SnO contacts for electrical systems; these composites combine high resistance to welding and to electric arch erosion of the refractory phases with the high electric and thermal conductivities.

Currently, IT infrastructure of the Institute is modernized, as part of the project entitled **"I-Center" – computer centre for managing research processes in the Metal Forming Institute in Poznan**, implemented under the Operational Program Innovative Economy 2007-2013, Priority 2 Infrastructure of R&D.
In the "I-Center" project, a computer center for managing research processes in the Metal Forming Institute in Poznan is created. The project aim is to create an innovative ICT infrastructure, fostering the development of the Institute by supporting the management of research projects and a wide sharing of results for scientific, research, economic and educational purposes.
The Project will result in consolidation of resources and structures of managing research processes, utilizing the available human resources, research equipment, repository of knowledge and the creation of an informational service platform.

Certificate ISO 9001:2008:

In the Metal Forming Institute a Quality Management System according to ISO 9001:2008 is applied (certificate GDK0003185 Lloyd's Register Quality Assurance Limited– LRQA).
The System is applicable to design of manufacturing processes, machines, installations and tools for metal forming and research works. Manufacture of parts by metal forming methods. Collecting, processing and distribution of scientific and technical information.

INOP possesses a testing laboratory designed to fulfill metal forming industry needs, certified by the **Polish Centre of Accreditation PCA** (Certificate AB 105, expiry date 12.01.2015), performing its activities in accordance with norms PN-EN ISO/IEC 17025:2001 and ISO 9001:2008.

Prizes and awards:

- Diplomas of the Minister of Science and Higher Education for the Metal Forming Institute for projects awarded with medals of the 4th and 5th International Warsaw Innovation Show, IWIS 2010 and IWIS 2011:
- Method for manufacturing of nanocomposite graphene-like greases and unit for manufacturing of nanocomposite graphene-like greases and unit for manufacturing nanocomposite graphene-like greases- Gold Medal with distinction
- Method for hemming of sheet metal products, especially thick ones, and unit for hemming of sheet metal products, especially thick ones- Gold Medal
- Unit for surface treatment of top layers, especially of metal- Silver Medal.

- Method for stamping shaped elements of metal sheet and unit for stamping shaped elements of metal sheet- Gold Medal
- Method for the modification of top layers of working surfaces of machine parts- Silver Medal
- Method for increasing the strength properties of bearing sleeves and unit for increasing the strength properties of bearing sleeves- Silver Medal Protection of the inventions is provided due to the realisation of the project entitled “Protection of industrial property in the scope of manufacturing and introducing graphene-like particles” included in the Innovative Economy Programme, Sub-action 1.3.2, Support of the protection of industrial property created by scientific entities as result of R&D works.
- The promotion emblem, “Now Poland” of the fourth edition of the “Now Poland” (‘Teraz Polska”) competition for innovative ventures, for the solution, “Innovative numerically controlled MWS-700 machine for rotary forming of complex parts of machines” implemented in FLAKT Bovent Ltd in Ożarów Mazowiecki. (Warsaw June 6, 2011)
- Award of the President of the National Economic Chamber „Innovatica” 2010 in the category of „ Innovative product – innovative technical or technological salution” for the Innovative technology of crimping the coupling ends of transmission shafts
- Gold Medal of International Fair Trade Poznan 2009, 2010 and 2012 in category: “Transfer of the scientific research findings into economic practice” for:

- „Technology and device for flow forming complex products of metal sheets” implemented in Flakt Bovent Sp. z o.o. (2009)
- „The technology of forming rings for flexible buffers” implemented in Więcborskie Zakłady Metalowe WIZAMOR Sp. z o.o. (2010)
- “Automatic line type UR 291 for manufacturing the front beam of railway wagon trolley together with an innovative technology of spatial bending” implemented in INTERMECH Ltd. in Stalowa Wola (2012)

- A prize in the category of "Technology of the Future" in the IV edition of competition, "Polish Product of the Future", organised in 2000 with the honourable sponsorship of the Prime Minister, for the elaboration entitled "New Technology of obtaining high density precision parts of powder alloy materials in mass production"
- Distinction in the category of invention in the field of product or technology economic prize of the Wielkopolska Region 2003 for the elaboration and implementation of production technology for high-density precision parts made of iron matrix alloy powder materials for the demands of automotive, machine and other industries".

2) Rotary forming of axisymmetrical parts

The Metal Forming Institute offers elaboration and implementation of rotary forming technologies and machines. The methods of rotary forming of products on a rotating templet by means of roll are spinning and flow forming. Manufacturing single parts or short production series by traditional stamping is often very expensive. Manufacture of the same element by methods of rotary forming is much quicker than stamping and the tooling cost is much lower. The technologies of rotary forming allow for manufacturing high quality axisymmetrical parts with high productivity.

Spinning and flow forming are performed on special machines - spinning machines and flow forming ones. Lathes can also be adapted for the realization of spinning and flow forming processes.

MWS 700 spinning machine

Spinning machines do not require large forces on the forming roll. Forming products with curved side walls and the application of complex radial-motions require very precise control of the spinning roll. Most often a hydraulic templet or computer control are applied.

Flow forming machines require the application of large forces, therefore their construction is adequately compact and robust. Flow forming is effected mostly on products with rectilinear side wall and, consequently, the control system is simpler.

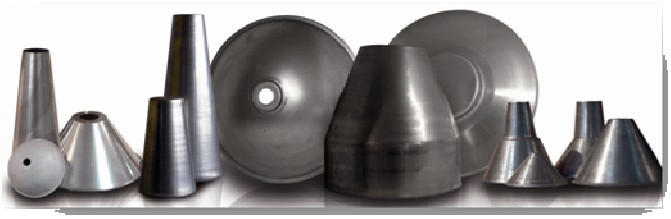
Elongating flow forming is superior to drawing with thinning in that it requires lower forces and the flow forming machine takes less room than a vertical press. On a flow forming machine, execution of a cone can be effected in one operation, while execution on a press requires at least several operations.

Advantages of the products made by rotary forming:

- good dimensional accuracy,
- high surface quality,
- improvement of strength properties - in the case of flow formed parts,
- complex shapes of products.

Effects of implementation of the rotary forming technologies:

- reduction of labour intensity of production,
- reduction of material consumption,
- reduction of electric energy consumption,
- reduction of manufacturing cost.
-



Parts made by rotary forming

The spinning machine MWS 700 with innovative tool head is used for forming from metal sheets complex shaped products used for ventilation, air conditioning and cooling devices. The spinning machine with the technology was implemented in Fläkt Bovent company from Ożarów Mazowiecki and replaced the manufacture of products made so far from a few separate parts, welded afterwards. The machine meets the requirements of the Machine Directive 98/37/WE and the Low Voltage Directive 2006/95/WE (designation CE).

The spinning machine MWS 700, together with the technology, has been awarded Gold Medal of the Poznań International Fair 2010 in the category of "Transfer of investigation results to the economic practice", as well as the Polish Promotion Emblem, "NOW POLAND" 2011 for innovative undertakings. The invention used in the machine entitled: "Method for stamping shaped elements of metal sheet and unit for stamping shaped elements of metal sheet", (no. patent application: P.389731, date: 1 December 2009r.), was awarded with Gold Medal of the IV International Warsaw Invention Show IWIS in 2010.

The Metal Forming Institute offers:

- elaboration and implementation of rotary forming technologies,
- design, execution and implementation of machines for rotary forming,
- adaptation of lathes for spinning and flow forming,
- technical consulting.

3) Innovative technology and devices for plastic forming of the coupling ends of transmission shafts

The Metal Forming Institute offers innovative technology and special devices, THC-17 and THC-19, intended for cold plastic forming of solid coupling transmission shafts applied in harvesters.

The new technological process consists in forming the tube ends by the method of push broaching, in operations of the tube end diameter reduction and forming an end with hexagonal cross section.

THC-17 device

The devices work in the semi-automatic mode with a productivity of 6 pcs per minute. The devices meet the requirements of the Machine Directive 98/37/WE and the Low Voltage Directive 2006/95/WE (designation CE).

THC-19 device

The device for forming tube ends consists of a horizontal hydraulic press, a tube holder (to prevent buckling), a tube transfer feeder and an auxiliary table. The tubes are stored on a supply table from where they are taken by the operator and placed in the feeder paws. Next, they are moved by the feeder to the working zone of the individual operations and, after the process of end forming is completed, they are dropped to a container.

The technology and devices, implemented in the production of coupling transmission shafts for harvesters manufactured by CNH Polska, Płock, have replaced production of shafts welded of a tube and two ends made by the methods of machining.

Innovative technology and special devices, THC-17 and THC-19, are intended for cold plastic forming of solid coupling transmission shafts applied in harvesters.

- THC-17 device is intended for forming tube ends with the diameter of 38 mm and length
  of 2000 mm, in 4 operations.
- THC-19 device is intended for forming tube ends with the diameter of 76 mm and length
  of 2000 mm, in 6 operations.

Implementation of the technology and devices has resulted in:

- better dimensional accuracy,
- better smoothness of the shaft end surface,
- better strength properties and life time of the transmission shafts,
- higher productivity,
- less material consumption,
- less labour demand in production,
- lower manufacturing cost.

Formed tube ends

The technology and devices have been granted ”Innovatica” 2010 award of the President of the State Economic Chamber, in the category of “Innovative product – innovative technical or technological solution”.

The Metal Forming Institute offers:

- elaboration and implementation of the technology,
- design, execution and implementation of the devices for cold plastic forming of the tube ends,
- technical consulting.

4) Forging crankshafts by the TR Method

The common feature of the TR - Method is that the normal working stroke of a press is used to generate horizontal as well as vertical force. In this way, in specially designed TR forging devices, combined upsetting, bending and squeezing operation with simultaneous gripping of the bar enable such items as crankshafts to be formed. The devices are extremely simple, compact and versatile and can be installed on forging presses of capacity up to 100 MN.

Advantages:

- material savings,
- diminished labour consumption,
- high quality of forgings (i.a. proper grain flow),
- possibility of forging bigger crankshafts on relatively smaller forging presses .

Crankshaft forging

Licensees:

Thyssen; Kloeckner; Krupp – Germany, Sulzer – Switzerland, Italsider – Italy, Forjas y Aceros de Reinosa S.A. – Spain, Endo Co; Japan Steel Works; K.E.F. – Japane, Wuhan, Forging Works – China, Hyundai – Korea, Alfing-Kessler – Germany, Ellwood – USA.

The Metal Forming Institute offers:

- design, manufacture and implementation of forging devices
- elaboration and implementation of forging technology
- technical consulting
- licences.

5) Innovative metal powder parts forming technology

Powder metallurgy is a highly developed manufacturing method of precision parts; the method consists in: mixing chemically pure or initially alloyed powders, die pressing and sintering of compressed parts in a protective atmosphere. This technology allows to obtain homogenous structure without defects and intermetallic intercalations.

Metal powder parts

Due to the application of the technology, the following effects have been obtained:

- high abrasive wear resistance,
- high abrasive strength, crushing strength and compressive strength of the product made,
- obtained product density up to 7.7 g/cm^3 for iron powder parts,
- reduction of production energy consumption,
- possibility of forming parts with complex shape and parts working in hard exploitation conditions such as gears,
- possibility of application for products of any shape, any destination, particularly for ones of required high strength like gears, bearings, etc.

Advantages of the technology:

- good mechanical and tribological properties of products,
- repeatable dimensional accuracy,
- elimination of finishing machining,
- high degree of raw material utilization,
- positive environmental impact,
- reduction of manufacturing cost.

The technology has been awarded following prizes and awards:

- Award of the Wielkopolska Regional Authority in the category of “Invention in the field of product or technology of the Wielkopolska region economic prize”,
- Nomination to the economic prize of the President of the Republic of Poland in the category of “Invention in the field of product or technology”,
- Award in the 4th edition of the competition “Polish product of the future”,
- Award in the Stanislaw Staszic competition “Research and development entities for the economy and society”.

The technology can be applied for the manufacturing of the following products:

- parts of shock absorbers, sleeves, elements of pumps and brake systems for the automotive and aircraft industry,
- bearings, rings, racks, latches for the industry of household appliances,
- elements of locks for doors and windows for the building industry,
- machine elements, gears, spacing sleeves, bearing rings and others.

The Metal Forming Institute offers:

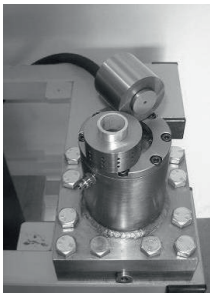
- elaboration of the technology for manufacturing of products made of iron powders,
- a circular line for forming powder material sleeves with the outer diameter of up to 22 mm and height of up to 10 mm,
- technical consulting,
- short series production of iron matrix powder material parts.

6) Method for increasing the strength properties of bearing sleeves and unit for increasing the strength properties of bearing sleeves

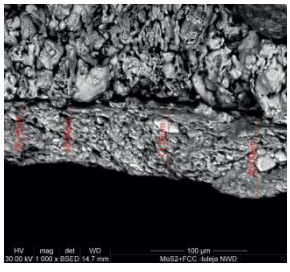
Increasing the strength properties of bearing sleeves in the process of surface layer modification with the use of pressure device, results in lower friction coefficient and prolongation of the sleeve working time. The process consists in modification of the inner layer of the bearing sleeve with solid lubricant nanoparticles, in most cases with graphene like molecules of molybdenum disulfide.

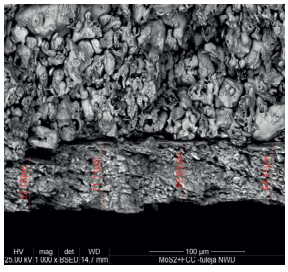
The process is carried out in the PC-1 pressure device, which was designed, made and tested in the Institute. The modification process is based on infiltration of solid lubricant nanoparticles into the pores of a bearing sleeve made by powder metallurgy; the remaining particles form a lubrication film on the inner surface of the sleeve.

Pressure device PC-1 for modification of the surface layer



Impregnation socket of the PC-1 device





Example of sleeve surface layer after modification process in PC-1 device

Effects of implementation:

- increase of durability and working life of bearing sleeves,
- decrease of friction coefficient, improvement of tribological properties,
- reduction of energy consumption and decrease of operating costs,
- possibility of application of bearing sleeves in extreme environment (aircraft or rocket engines),
- reduction of production and operating costs.

The invention entitled: “Method for increasing the strength properties of bearing sleeves and unit for increasing the strength properties of bearing sleeves”, was awarded with Silver Medal of the IV International Warsaw Invention Show IWIS in 2010.

7) Surface Engineering and Tribology

The Laboratory is concerned mainly with materials and machine parts research as well as biomaterials and implants material research.

Materials and machine parts research

The Laboratory carries out its materials land machine parts research Rusing the following control and measuring devices:

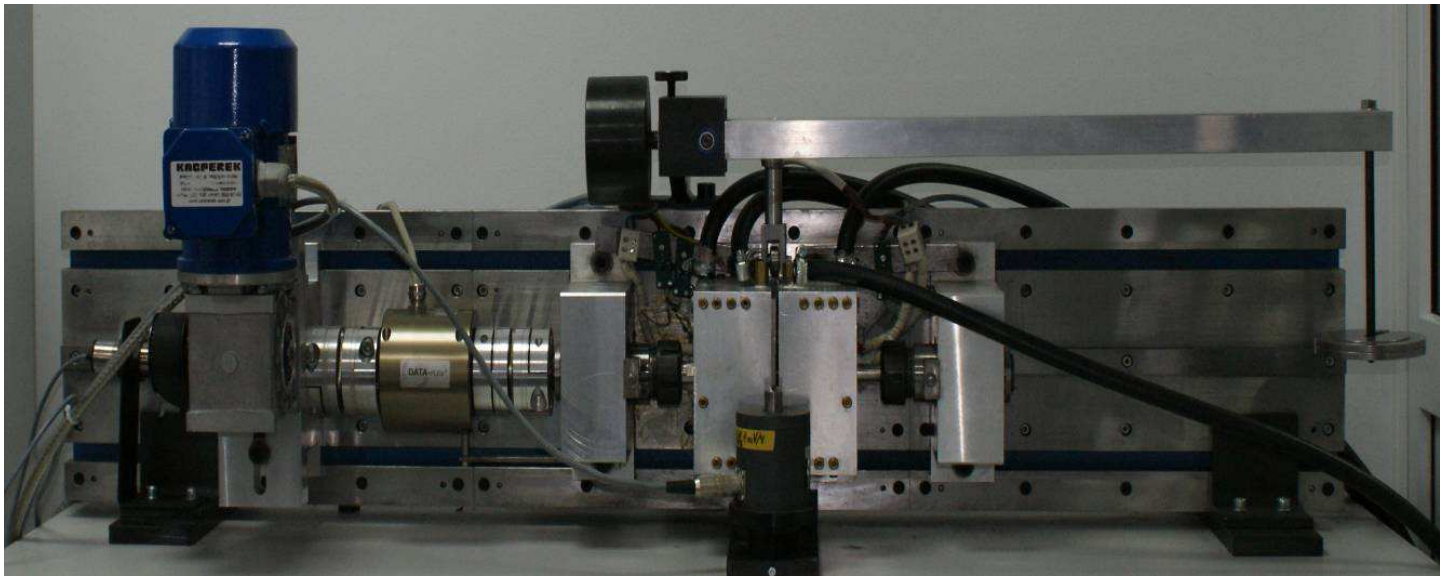
- **Tribological tester T-10**

Tribological ball-on-disc tester type. The device is used for assessing the tribological features of new materials used for gliding elements of machines, mainly thin sheaths.

Using the T-10 device you can precisely examine the resistance for wear and the coefficient of friction of any material association working in gliding motion, depending on the speed of gliding, surface pressing and other factors.

- **Tribological tester TWT-500N**

Own construction tribological tester used for research of dry friction of machine parts. This tribological tester is used for research in temperatures from room temperature to 600 ^{0}C.



Samples

- **Tribological tester T-05**

Device T-05 is used for research of tribological features of lubricants i.e. solid lubricants, oils, plastic lubricants as well as resistance to wear of materials used for gliding elements of machines.

What should also be mentioned are:

- **Device for hardness tests in elevated temperatures in Rockwell scale BT-G01**

It allows for hardness measurements in HRA, HRB and HRC scale in temperatures up to 500 °C. The sample surface is protected from oxidation by protective gas blow in test chamber.

- **Device for hardness and microhardness tests in elevated temperatures in Vickers scale BT-G02**

It allows for hardness measurements in Vickers scale, with various loads, in temperature up to 500°C. The use of special clamps allows for small samples testing.

- **Device for small dimension samples compressing in elevated temperature HC-V01**

Device allows for performing compression tests and flow curves determining for small samples, even Ø2x3mm, in temperature up to 500°C.

Manufacturing of sulfide graphene-like nanoparticles using the „Rolling Cleavage Technology".

8) Research on biomaterials and materials used for implants

Increased lifetime of humans resulting from the ability to make use of a number of technical devices as well as progress in the diagnostics and curing of illnesses generates the demand for various types of implants. Such fields as orthopedics, traumatology, dentistry, cardiosurgery, laryngology, ophthalmology, etc. Using different types of implants, so called "surrogate organs" such as joints endoprostheses, coronary stents used widely in cardiosurgery or spine implants has become the challenge of contemporary civilization..

In order for the implant to meet the requirements it needs to be constructed in a specific way and needs to be made of a suitable biomaterial. Due to this fact regardless of the progress in implant construction constant research is being conducted in order to improve the chemical composition and biomaterials specificity.

The group of implants used in the human osteo-skeletal system where tribological processes play a role are composed of:

- hip-joint endoprostheses mainly the „ball-socket" locomotor system,
- knee-joint endoprostheses: the runner-polyethylene insert system,
- joints endoprostheses: brachial, cubital, crurotalar,
- intervertebral spinal disc implants,
- teeth implants.

In the group of elements exposed to heavy wear surgical instruments should also be named.

INOP has:

- workplace for friction and wear research of biomaterials (testers named above i.e. T-05, T-10, etc.),
- workplace (simulators) for friction and wear research on implants.

The Metal Forming Institute in Poznan designed and constructed some of the simulators for tribological research on implants i.e.:

- simulator for research on hip-joint endoprostheses made in two different versions of attachment,
- simulator for research on knee-joint endoprostheses,
- simulator for research on intervertebral spinal discs.

Each of the simulators has an automatic registration system for the researched parameters.

Main aims of tribological research on implants run on simulators are:

• determination of the friction resistance in the researched motion node of the implant for different material associations,
• determination of the intensity of wear of the researched materials of the friction couple (for example ball and socket).
• collection and research on the products resulting from wear (their quantity, size, chemical composition).
• research on other destructive processes such as: biocorosion, material fatigue, quantity of metalic ions impacting the metal, the so called metalosis effect, etc.,
• possibility of assessing the durability of an implant.
Main advantage of the Simulator run tests is the fact that they are conducted on prototypes of real implants (for example endoprostheses of joint, spinal implants, etc.)before they are introduced to the medical practice.

Simulators

a) Simulator of the hip-joint endoprosthesis: i) arrangement compliant with the human biological system, ii) reverse arrangement

b) Example of a simulator used for research on hip-joint endoprosthesis

c) Example of a simulator used for research on implants of intervertebral spinal disc

POLISH WELDING CENTRE OF EXCELLENCE

(Instytut Spawalnictwa)

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http://www.is.gliwice.pl/en/indexen.php

Instytut Spawalnictwa (The Institute of Welding) is engaged in development and transfer of knowledge in the field of joining advanced structural materials in order to ensure innovation and competitiveness of producers of welded structures. Established in 1945, Instytut Spawalnictwa is a leading and key welding research centre in Poland. In its long-standing activity the Institute has been solving problems in welding technology, coordinated numerous R&D projects and strengthened close links with industry and research centres.

Instytut Spawalnictwa is the only organisation of its type in Poland and has the status of the Centre of Excellence and functions as:

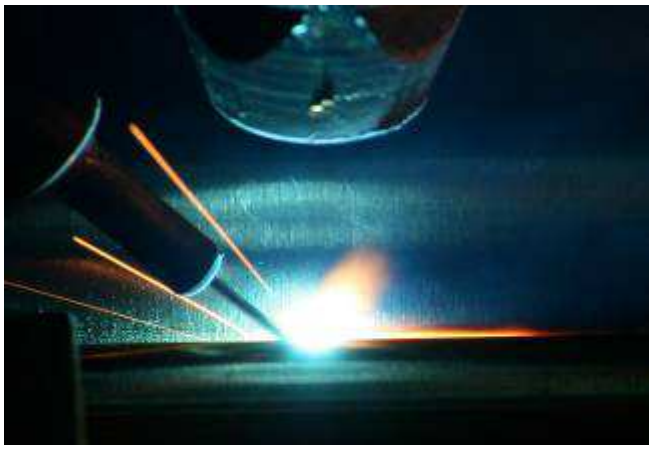
- ANB – Authorised National Body – in European Federation of Welding, Joining and Cutting (EWF) and International Welding Institute (IIW), authorised for qualification of welding personnel,
- ANBCC – Authorises National Body – in EWF – authorised for certification of enterprises according to PN-EN ISO 3834 standards,
- Accredited in Polish Centre for Accreditation (PCA) organisation for certification of welding products and processes, Factory Production Control systems, welding and NDT personnel and quality management systems,
- Notified Body in the European Union in the scope of 2006/95/WE, 97/23/We and 87/404/WE Directives.

Institute has the certified quality management system in accordance with PN-EN ISO 9001:2009 standard.

Applied and development research constitutes the basis of the Institute's activities. Instytut Spawalnictwa in Poland deals with processes of joining of structural materials with the use of advanced technologies of welding, brazing and thermal cutting as well as allied technologies.

Areas of activity:

- development and applied research into welding and allied technologies
- weldability of steels and non-ferrous metals
- mechanical, structural and non-destructive testing
- environmental engineering
- expert opinions, advisory service
- testing for CE marking, certification and approvals
- transfer of innovation into industry
- education and supervision of welding education in Poland
- certification of welding personnel, quality management systems and products, welding processes and Factory Production Control systems
- testing and qualification of welding technologies
- qualification of industrial enterprises, supervision of structures manufacture
- standardization
- scientific, technical and economic information
- collaboration with Polish and foreign organisations
- professional publications, seminars, conferences



SCIENCE FOR INDUSTRY

Instytut's team of technologists highly experienced in conducting research and development works as well as collaborating with industry, offers a wide range of research and expertise services including assistance in transfer of innovative technologies into industrial practice. The offer includes collaboration and consulting services in solving problems such as reduction of costs, quality and competitiveness improvement of product and manufacture of welded structures.

The offer includes the following services:

Consultancy and technical assistance in development and transfer of new technologies into industry

On the basis of technological audits and information about currently applied technologies, Instytut researchers offer assistance in the planning of technology development and improvement of welding work quality and selection of innovation technologies.

Development and implementation of welded technologies

Development of welding technologies includes conditions for preparation of joints, selection of parameters, consumables and equipment, conditions for joints examination, heat treatment etc. Research/test results are available in the form of reports and/or WPS/BPS. Implementation includes vocational guidance as well as authors' supervision over new technology acquisition and pre-production batch manufacturing.

Qualification of welding technologies

Acting as a third party, Instytut Spawalnictwa qualifies technologies of welding, surfacing and brazing in accordance with PN-ISO EN and PN-EN standards as well as other standards and regulations specified by the Customer. Instytut issues documents of technology qualification in the form of WPQR, WPAR, PQR and BPAR stating that the technology fulfils specified requirements.

Weldability of materials and testing of welded structures

Instytut Spawalnictwa conducts research works devoted to weldability of metals and welded structures. Structural, mechanical and non-destructive testing, stress analysis and fatigue testing is performed in order to provide assistance for designers and producers of welding consumables and structures.

Environmental Engineering

The specialists offers a wide range of research and services in work safety, health protection and ecology in welding processes. The offer includes investigation of dust and gas emission, noise and electromagnetic fields, microclimate of work environment, optical radiation, and welding consumables and processes in respect of pollutants emission.

Training of personnel in implementation of new technologies

Apart from a wide range of training dedicated to welding personnel, Instytut Spawalnictwa offers specialist training adapted to conditions and requirements specified by enterprises.

The scope of collaboration includes the following technologies:

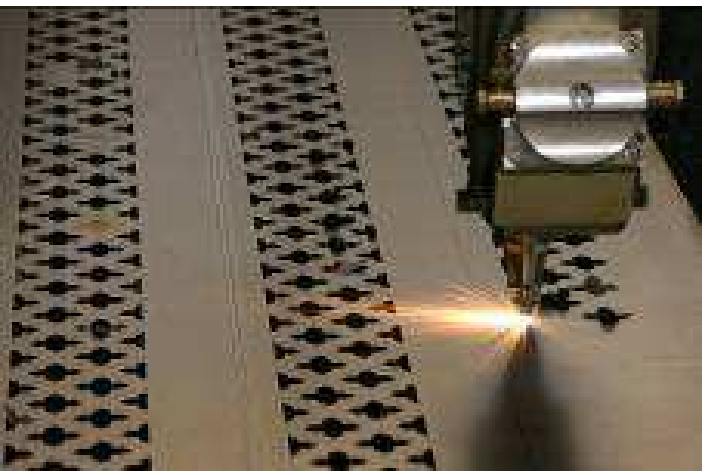
- laser welding and cutting
- plasma welding and cutting
- arc welding
- preventive surfacing and rebuilding
- brazing, soldering and braze welding
- resistance and friction welding
- robotic and mechanised welding

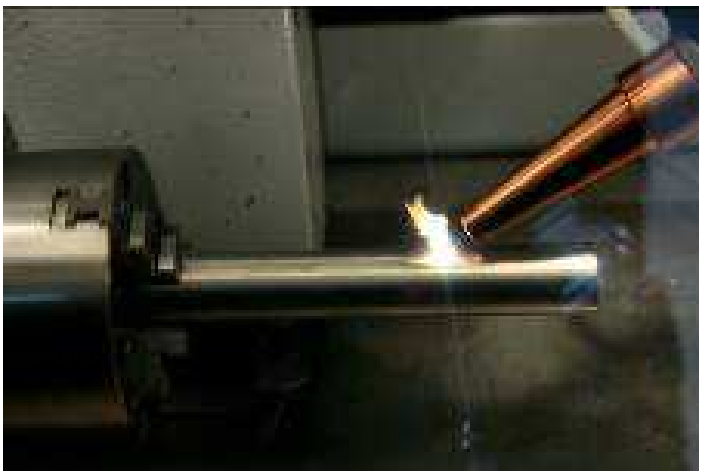
Laser Welding and Cutting

Instytut offers research/testing, technology and consultation services in the range of laser welding and cutting processes aiming at improvement of quality, repetitiveness and reduction of costs of welded products. Works are conducted by means of numerically controlled and robotised laser welding and cutting stations with CO_2 and YAG lasers processing centres for welding and cutting of two and three-dimensional elements. The laser stations reproduce the real industrial conditions.

Laser welding enables:

- joining of materials without edge preparation and necessity to use welding consumables
- obtaining very narrow welds with restricted heat affected zone and minimum distortions in welded joints i.e. welding “ready-made” products
- welding of elements of diversified thickness
- simplification of the structure and manufacture of products by applying advantages of laser welding





Laser cutting enables:

- ensuring high quality and repeatability of cut-out elements
- elimination of additional machining of edges
- cutting of coated plates, pipes and stamped elements, etc.
- saving materials due to optimum layout of elements

Plasma Welding and Cutting

In the range of plasma welding the offer includes:

- development of welding technologies for 0.1 ÷ 2 mm thick materials made of unalloyed and alloyed and galvanised (without damaging of zinc coating) steels used in electronics, medicine, precision engineering, food and automotive industries, etc.
- implementation of welding systems with welding technologies
- pre-production or prototypes batches

Great stability, high level of concentration and ionisation as well as high power density of plasma arc ensure very good quality and appearance of joints.

In the range of plasma cutting the offer includes:

- cutting with the use of water shielding resulting in reduction of stresses and distortions
- technical advice in cutting technology and organisation of work stations

Arc Welding

Instytut offers extensive collaboration in welding of steels, aluminium, titanium, copper and other metals with MIG/MAG, TIG, A-TIG, SAW and MMA processes as well as hybrid laser + MIG/MAG welding process.

The collaboration includes:

- development of welding technologies
- advice on process and consumable selection
- process development aimed at improvement of applied technologies
- manufacture of pre-production and prototype elements welded with different methods

Preventive Surfacing and Rebuilding

The offer of Instytut covers:

- MIG/MAG, SAW and MMA surfacing
- plasma and gas surfacing of elements made of unalloyed, alloyed and non-weathering steels, cast steels and some cast irons; the surfacing is conducted with metallic powders such as nickel, cobalt, iron or copper-based alloys
- assistance in development of surfacing technologies on the basis of analysis of abrasive wear of elements of equipment and machinery
- development, manufacture and implementation of specialised iron and nickel-based tubular cored electrodes for surfacing meeting specified exploitation requirements

Brazing, Soldering and Braze Welding

The offer of technological collaboration in the range of **soldering and brazing** includes:

- flame brazing with the use of conventional and volatile fluxes (manufacture of feeders of volatile flux)
- induction brazing of tools and machine parts
- oven brazing in vacuum and argon blanket soldering of parts of machines, tools, heat exchangers and other metal devices

Instytut offers specialised filler metals, fluxes and pastes for brazing and soldering as well as assistance during their implementation.

MIG/MAG braze welding is an alternative to arc welding and brazing of plates covered with anticorrosion coating and sheets of alloyed and unalloyed steels. This method enables obtaining high quality joints with retaining original anticorrosion properties of the base material.
Instytut offers development and implementation of the technology of robotised and semi-robotised MIG/MAG braze welding of galvanised and alloyed steels.

Resistance and Friction Welding

Instytut offers support in problemshooting and development of technologies enabling the manufacture of products with the use of:

- spot resistance, projection and butt welding
- friction welding including friction stir welding (FSW)
- ultrasonic welding
- braze welding

A relatively new FSW method enables:

- joining aluminium sheets and plates, depending on equipment size, of thickness up to 50 mm in single run, without shielding gases and edge bevelling
- welding dissimilar materials such as aluminium to copper
- welding of non-ferrous metals which cannot be welded using other processes
- reducing costs of welding

Cost reduction is the result of simplified preparation of plates for welding, absence of consumables, limited necessity of application of protection measures (indispensable in arc welding of aluminium and its alloys).

Robotic and Mechanised Welding Processes

Within the range of robotic and mechanised welding Instytut offers:

- economic analysis of profitability of implementation of robotised stations for specified applications
- development of assumptions of the best possible configuration of welding station and assistance in selection equipment suppliers
- development of technology of robotised welding or braze welding
- support in implementation of robotised welding technologies

THE RESEARCH AND DEVELOPMENT CENTRE FOR BUILDING INSULATION INDUSTRY

(Centralny Ośrodek Badawczo Rozwojowy Przemysłu Izolacji Budowlanej)

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e-mail: sekretar@cobrpib.katowice.pl
http://www.cobrpib.katowice.pl/ang/angindex.htm

We are interested in cooperation in range:

1/ Technology offer

Title:

Flame retardancy of bitumen materials for roof waterproofing

Short description:

Technology allows to obtain bitumen materials for roof waterproofing with increased resistance to fire in relation to traditional products. During production of bitumen layer for preparing reinforced flexible sheets for waterproofing or during production of bitumen compounds, solutions and dispersions some additives are added, which decrease a spreading of fire during its action.

2/ R&D offer

Cooperation:

Research of the heat transfer in materials or products for thermal insulation in range of temperature from -160 ºC to 700 ºC.

WOOD TECHNOLOGY INSTITUTE

(Instytut Technologii Drewna)

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http://www.itd.poznan.pl/en/

The Wood Technology Institute (in Polish: Instytut Technologii Drewna, ITD) is the only research and development unit in Poland which, since 1952, has been comprehensively dealing with issues concerning wood processing, its application, and the creation of new composites based on wood as a raw material. The mission of the Institute is to conduct research aimed at achieving the sustainable development of the wood industry, maintaining the high competitiveness of the Polish wood sector, developing innovative materials, technologies, and machining techniques, as well as improving education and awareness in a knowledge-based society.

The Wood Technology Institute's activity involves research, certification, normalization, information dissemination, and training for the forestry-wood sector companies.

The institute co-operates with numerous national and foreign entities and companies within and outside the forestry-wood sector (e.g. ministries, the State Forests, regional and local authorities, various associations and industry chambers, national courts, technology platforms, wood companies).

Research activity encompasses the following areas:

- structure, quality, properties, and protection of wood, wood products and wood materials,
- production processes in the wood and furniture industries,
- biotechnology,
- wood industry organization and economics,
- markets in roundwood, sawnwood, wood-based panels, furniture and other wood products,
- product quality,
- environmental protection and safety at work.

The Institute is an **EU Notified Body (No. 1583)** and acts as an **Independent Controller (No. TPC-19)** of composite wood product manufacture within the area of formaldehyde release, conferred by the California Air Resources Board (CARB).

The Institute has in its structure a **Testing Laboratory of Wood, Wood-Based Materials, Packaging, Furniture, Constructions and Woodworking Machines** which performs tests according to requirements of national, European, and international standards, and is divided in eleven sections (A: Anatomical and Taxonomical Testing, B: Physical Testing, C: Chemical Testing, D: Furniture Testing, E: Packaging and Construction Testing, F: Environmental Protection and Safety Testing, G: Wood Preservation and Conservation Testing, H: Surface Testing, K: Inflammability Testing, L: Woodworking Machines and Machine Tools Testing, and M: Solid Biofuels Testing). **The laboratory is accredited by the Polish Centre for Accreditation (PCA).**

The Institute also has a **Certification Centre for Wood Industry Products** which is authorized to issue product certificates (on average it issues 50 certificates a year) and a **Quality Policy Department**.

In its activity he Institute follows the principles of a **Quality Management System** acc. to **ISO 9001:2008** standard.

Since 2005 the Institute has been **coordinator of the Polish Forest-Based Sector Technology Platform**, which is a national support group of the European Forest-Based Sector Technology Platform (FTP). The Institute also has **office of the Polish National SME Services Network**.

The Institute co-operates with the following **Technical Committees of the European Committee for Standardization** (CEN/TC 38 Durability of wood and derived materials, CEN/TC 175 Round and sawn timber, CEN/TC 142 Woodworking machines – Safety, CEN/TC 112 Wood-based panels, and CEN/TC 207 Furniture) and **ISO Technical Committees** (ISO/TC 136 Furniture, ISO/TC 218 Timber, ISO/TC 89 Wood-based panels, and ISO/TC 39/SC4 Woodworking machines).

The Institute has **numerous patents and pending patent applications**, for example: “A method of reducing the content and emission of formaldehyde in boards from lignocellulosic particles bonded with amine resins”, “A method of testing initial adhesion of plywood glues and a sample for testing of initial adhesion of plywood glues”, “An adhesive and method of bonding flat surfaces and a method of spatial objects production”, “Agents for surface and deep protection of wood against moisture and a method of surface protection of wood against moisture”.

TECHNOLOGY FOR COMPOSITE PANELS MADE OF UNCONVENTIONAL LIGNOCELLULOSIC RAW MATERIALS

This offer encompasses sale of technology and its adjustment to raw materials and regional conditions, including:

- the manner of grinding and obtainment of chips (flakes and fibrous chips),
- the choice of glue resin and glue formula, taking into account pH and buffer capacity of lignocellulosic raw materials,
- the structure and formulas of the panel,
- pressing parameters,
- tests of panel properties.

The developed technology enables the production of furniture panels and indoor equipment panels, interior and exterior load shift panels, and building panels, i.e. structural and insulating panels, with the use of chips obtained from agricultural waste, fast growing plants (from agricultural and forest plantations), and root offshoots. The below table compares chosen properties of panels produced according to the ITD technology with the properties of popular building OSBs.

Panel properties	**Results of panel testing acc. to the ITD technology**	Requirements of the PN-EN 300:2006 standard for OSBs, type		
		2	3	4
Bending strength [N/mm^2] - major axis - minor axis	**33 – 42**	 20 10	 20 10	 28 15
Modulus of elasticity [N/mm^2] - major axis - minor axis	**3950 - 4620**	3500 1400	3500 1400	4800 1900
Internal bond [N/mm^2]	**1.09 – 1.54**	0.32	0.32	0.45
Internal bond after cyclical tests (option 1)	**0.72 – 1.19**	-	0.15	0.17
Tensile strength after boiling test (option 2) [N/mm^2]	**0.12 – 0.26**	-	0.13	0.15
Swell in thickness, 24 h	**5.1 – 6.0**	20	15	12
Swell in thickness after cyclical tests (option 1) [%]	**5.6 – 8.5**	-	-	-
Density [kg/m^3]	**660 - 710**	-		-