Making Biogas SMART using Internet of Things (IOT)

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Abstract - The present paper deals with the current scenario of the need of increasing the productivity and monitoring of biogas energy.

Drawing energy from the fermentation of waste products such as manure, food and sewage, biogas offers a route towards a 'circular economy' in the use of products beyond the end of their service life.

Thus, monitoring and controlling bio gas plants remotely by the help of IOT, becomes very important as quality, production and usage of biogas can be monitored.

Sustainable agriculture development and increasing the rate of renewable energy sources have become an economic issue under the present economic conditions, the private sector cannot solve its complexity the problem of environment protection and energy from its own sources. Thus, using biogas energy sector with strategic policy and programme it will help us in our future saving as well as to maintain the quality of environment.

Keywords – Biogas, Monitoring, IoT, ICT, LPG, pH

I. INTRODUCTION

Despite the rapid uptake of LPG for cooking, approximately 500 million people in India remain without access to clean cooking fuel. These households are using biomass or kerosene for cooking, both of which cause harmful indoor air pollution. People in rural areas use firewood, crop residue and dung cakes for their cooking purpose. The hazardous smoke emitted by this results in millions of lives annually.

Apart from being a major health hazard, these fuels lead to major deforestation and environmental damage by emitting greenhouse gases. On the other hand, LPG gas provided by the government is not yet available in some rural parts and is expensive for most rural population.

There are around 536 million cattle in India owned by 80 million families and around 50 percent of that have sufficient space and animal manure to generate biogas as an affordable solution for their cooking needs.

In India, the estimate for the production of biogas is about 20,757 lakh cubic meters in 2014-15. This is equivalent to 6.6 crore domestic LPG cylinders. This is equivalent to 5% of the total LPG consumption in the country today. Even after implementation of rigorous programmes of biogas such as National Biogas and Manure Management Programme (NBMMP) and etc. the government has achieved limited impact due to lack of awareness of the end user, no after sales support and difficulties in repair and maintenance of biogas plants. Due to lack of technical and market failures, bio gas is still waiting to be resurrected. To resurrect bio gas apart from offering superior technology which is cost effective, there is a need to provide ground and service support too.

Information and Communication Technology (ICT) consumes energy, but is also a means of conserving energy. ICT can play a critical role in supporting the necessary paradigm shifts within the energy sector towards more sustainable energy generation.

Thus, IOT can be used to connect all dumb physical devices and can be commanded as per the situation. IOT can be used to monitor the production, quality and bill calculation.

II. FACTORS ON WHICH PRODUCTION OF BIOGAS DEPENDS:

1. Sub layer composition
2. Temperature inside the digester
3. Retention time
4. Working pressure of the digester
5. Fermentation medium pH
6. Volatile fatty acids (VFA).

III. PROPOSAL

The present paper deals with 3 proposals: -

1. Monitoring and control of pH.
2. Monitoring and control of water level.
3. Monitoring and bill calculation of consumption of biogas.

1. MONITORING AND CONTROL OF pH.

The production of biogas can be increased by maintaining a pH in the range of 6.8 to 7.3 this can be done by real time pH monitoring and control. Real time monitoring of the mixture quality relies on the type of the sensors deployed and measurements of parameters involved in the processes. In general, pH and temperature are the main parameters to be controlled through the phosphate, ammonium and heavy metal ions in water.

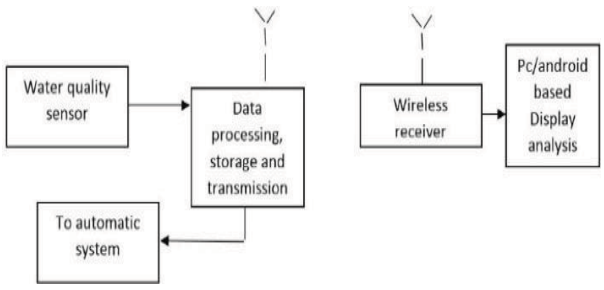

Fig 1: - Block diagram of real time pH monitoring and control system.

The system shown in figure 1 consists of a water quality sensor, data processing and storage and transmission system,

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connected to automatic system for the control of the parameters to be sensed. Here a wireless communication system is developed for the monitoring and control purpose that is controlled through the android application or personal computer is used for the same as well to store the logs.

a) SOFTWARE IMPLEMENTATION

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION
1	Microcontroller	Arduino Mega ESP8266
2	Temperature Sensor	Waterproof LM35
3	pH Sensor	pH Sensor Module v1.1
4	Valve	Solenoid valve

Table 1:- Hardware required for Real time monitoring and control of pH.

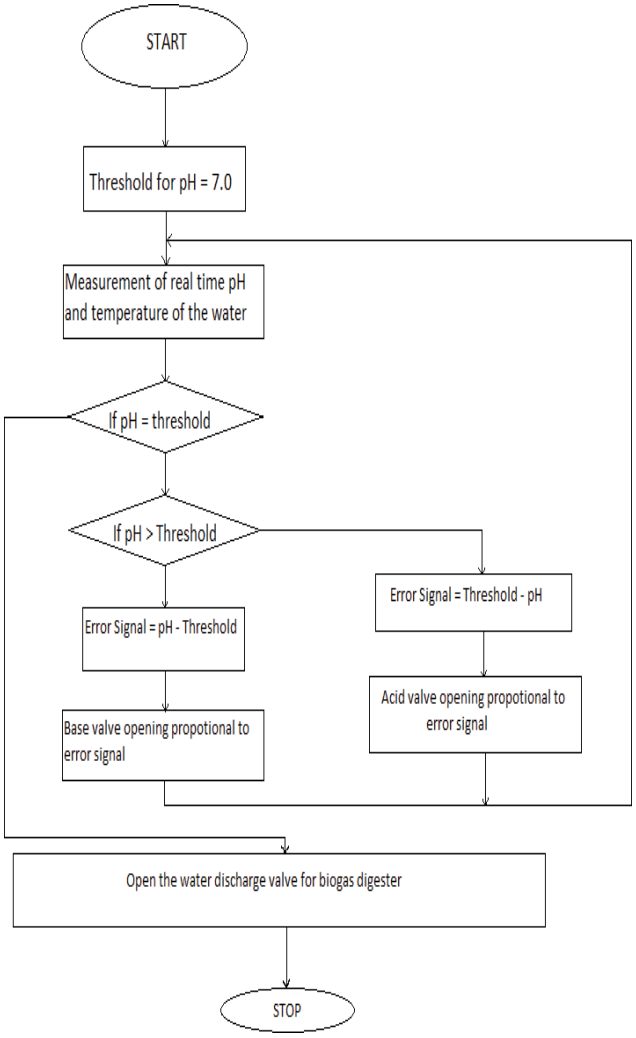

Fig 2:- Real time monitoring and control process flow chart

b) SYSTEM ARCHITECTURE

Figure 3 represents the system architecture for the real time monitoring and control of pH and temperature for the production of biogas. It consists of an Arduino mega with Wi-Fi shield and the three solenoid operated valves operates and control the dosing of the water, acid and base as per the signal generated by the controller after comparing the real time pH value with the prescribed threshold value i.e.(6.8 to 7.3). When it achieves the prescribed value mixture will be discharged for production of biogas. This system monitoring and control can be performed by computer or android base application.

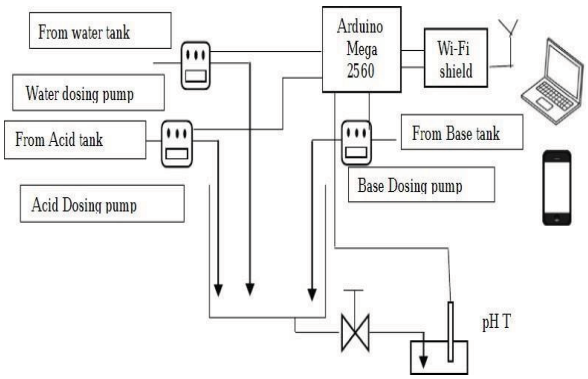

Fig 3: -System Architecture RTMC (real time monitoring and control) of Mixture and temperature.

2. MONITORING AND CONTROL OF WATER LEVEL

The production of biogas can be increased by controlling the water being mixed in the bio gas mixture as the required water is 3 times the manure used.

Water is becoming a luxury these days and keeping tab on water consumption is a necessity now. This can be done by using an IOT based water level monitoring system.

In this monitoring system firstly the total height of the tank is measured and then the height of the manure mixed is measured and according to that 3 times water is being added to the manure.

a) SOFTWARE IMPLEMENTATION

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION
1	Ultrasonic Sensor	US-100
2	Microcontroller	Arduino Mega ESP8266

Table 2:- Hardware required for real time monitoring and control of water level

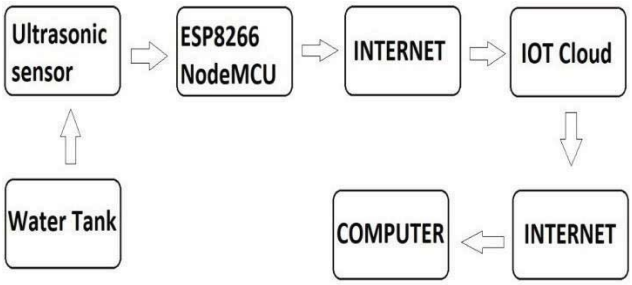

Fig 4:- Real time monitoring and control process for level of water

3. MONITORING AND BILL CALCULATION OF CONSUMPTION OF BIOGAS

The basic idea is to monitor the consumption of biogas by a user, with the help of IOT.

For this we will use an analog gas flow meter for calibration, step up pump and an IOT module. Step up pump is used to pull the biogas from the digester to the biogas burner. An IOT module is placed near to biogas burner which will measure the consumption of biogas and sends a text message with authentication code to the android application which acts as a SMS gateway through a GSM module and will also update the database.

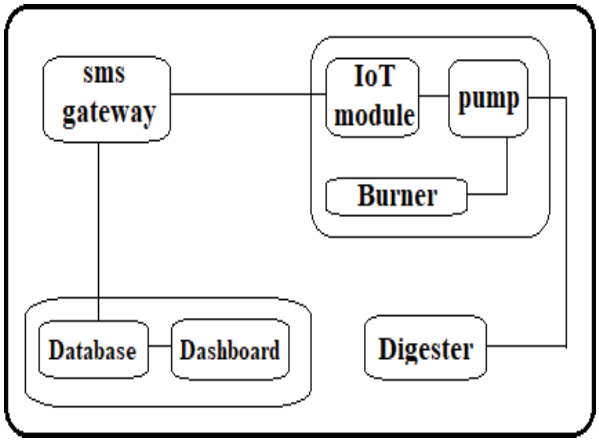

Fig 5:- Overall system Architecture for monitoring consumption of biogas

The android application will also be used to calculate the biogas consumption monthly bill. The calculation will be based on the web database made from the usage of biogas by the user.

The IOT module will also be used to lock the consumption by the administrator remotely if the user fails to pay the bill.

a) IOT MODULE (LOGIC BEHIND CALCULATION OF BIOGAS CONSUMPTION)

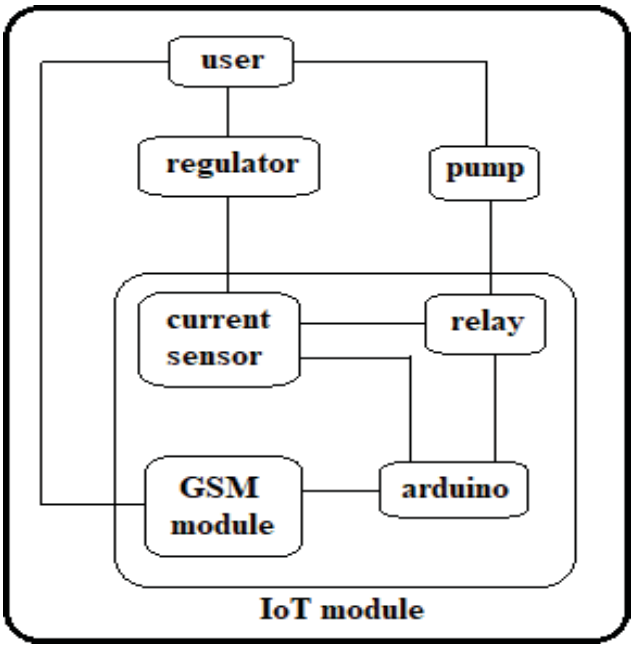

Fig. 6. Architecture of IoT module

The step-up pump used helps in increasing the pressure of the biogas from the digester at the burner. The amount of gas is calculated per unit time as the gas running is at a constant speed. Analog gas flow meter is used to correlate the values of the gas pumped. During measurement of the consumption the start and end time is noted and the total duration is calculated. The IOT module.

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION
1	Microcontroller	Arduino Mega ESP8266
2	Current Sensor	ACS712
3	GSM Module	SIM800A

Table 3:- Hardware required for monitoring consumption of Biogas

IV. TOTAL ESTIMATED COST

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION	COST
1	Microcontroller	Arduino Mega ESP8266	850
2	Temperature Sensor	Waterproof LM35	70
3	pH Sensor	pH Sensor Module v1.1	2700
4	Valve	Electric Solenoid valve (12V)	725

Table 4:- Cost of monitoring and control of pH.

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION	COST
1	Microcontroller	Arduino Mega ESP8266	850
2	Ultrasonic Sensor	US – 100	350

Table 5:- Cost of monitoring and control of water level.

Sl. No.	NAME OF THE COMPONENT	MAKE AND SPECIFICATION	COST
1	Microcontroller	Arduino Mega ESP8266	850
2	Current Sensor	ACS712 (30A)	70
3	GSM module	SIM800A	2700

Table 6:- Cost of monitoring consumption of Biogas

Therefore, the total estimated cost excluding the pipe lines, burner, step up pump and etc is 7545 rupees which is very minimal. This is a one-time investment and can be regained within some months.

V. KNOWN ISSUES

Though biogas seems an obvious choice for a world that needs to cut down both waste and carbon emissions, it is not a perfect method.

Currently, there are no new technologies to simplify and improve the process of biogas generation, meaning that it is not a completely efficient system. Large-scale production for a wider population is not yet possible, and investment into the sector is not particularly popular with governments, which are instead putting money into the more developed alternatives of wind and solar.

In addition, biogas still contains impurities even after refinement and compression. This means it can damage vehicles if used as a bio-fuel, as it can corrode the metal parts of the engine and increase the need for and cost of maintenance.

Moreover, government initiatives aren't enough to popularize usage of biogas.

Finally, biogas production is not suitable for every location. As larger production relies on an abundant supply of waste manure or crop materials, it is impractical in urban areas.

VI. ADVANTAGES

"There are so many advantages to a biogas system," Murphy said, "from waste treatment, production of bio- fertilizer, generation of a renewable energy suitable for transport, heating or electricity, improved water quality and provision of jobs in rural communities. It is the full package."

The future of the biogas facility is a bio-factory where value is created from previously wasted materials; this ensures sustainability of the environment and potential for financial gain for the local community. The biogas plant is the hub in the future circular economy.

Biogas as compared to LPG is more eco-friendly. LPG as fuel will generate Carbon Dioxide – a pollutant. Although natural gas (consisting primarily of methane) generates fewer CO_2 emissions than propane when burned, methane is a direct greenhouse gas when released into the air. While combustion of biogas, like natural gas, produces carbon dioxide (CO_2), a greenhouse gas, the carbon in biogas comes from plant matter that fixed this carbon from atmospheric CO_2.

Further, any consumption of fossil fuels replaced by biogas will lower CO_2 emissions.

Biogas is safer than CNG and 3 times more safer than LPG Cylinder. LPG is very dangerous as LPG behaves like liquid yet acts like gas.

If the proposed idea is set up in a housing society, it will be a profitable business as initial cost of building a biogas plant and maintaining the biogas plant can easily be reimbursed within few months as people will use biogas as an alternative to LPG which is costlier. It will be a one- time investment but a long-time running business.

In a country like India where the supply of LPG is 80% of Indian households (as of March 2018), the rest 20% are the rural parts of the India. The proposed idea can be used by the government to set up biogas plants to supply cooking gas to rural Indian households. This will stop them to use wood and coal as a fuel to cook, which is hazardous to their health and to the environment.

In a country like India where burning of crop residue (stubble) is a common method by famers to save money and time which causes immense air pollution (as caused in October and November in Delhi), this proposed idea can be a good alternative as crop residue can be used in the production of biogas. This proposed idea will help farmers to motivate to use the crop residue in biogas plant which will be helpful as a side income for them moreover the slurry formed at the end of biogas production can be used as fertilizer for the soil which will also help the farmers to save their cost of fertilizers. The proposed idea can also be set up at dump yards where the waste of whole city is being thrown.

VII. CONCLUSION

The architecture proposed here is a scalable solution to increase the productivity and to monitor the usage of biogas. This can be used as a successful encouragement to the rural masses to embrace the renewable energy solutions like biogas using IOT. For farmers it will be a suitable idea to use their crop residues for biogas production rather then burning it, which causes pollution. Moreover, it will also reduce greenhouse gas and hence will reduce air pollution.

VIII. REFERENCES

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