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Popular Article

Article: RT1100

Biotica Research Today Vol 4:9 2022

652/653

How to cite this article?
Rathinavel *et al*., 2022. Role of Internet of Things (IoT) in Biogas Systems. Biotica Research Today 4(9):652-653.

Role of Internet of Things (IoT) in Biogas Systems

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Open Access

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Keywords
Biogas, Internet of Things, Methane estimation, Optimization

Abstract

Several advancements in biogas production techniques and plant design have been achieved in recent years. Boom in internet use and automation goals had brought IoT into play in many sectors including agriculture, industry, transport and energy as well. Coupling the IoT with energy sector, specifically the biogas systems made several benefits in the aspects of production, management, safety and environment. Here the paper discusses the importance of IoT in the biogas systems through its technology and applications.

Introduction

Global warming and resource exhaustion are the major challenges discussed in the recent times. Mitigating the methane gas emissions, bioenergy extraction, reduced fossil usage, waste management and pollution control are the talks of solution. In this regard, biogas plants play a major role in processing the bio-wastes to produce biomethane.

Supervisor Control and Data Acquisition (SCADA), for more than 40 years it has helped various biogas plants (similar to industrial plants) in monitoring and managing their applications, processes and boosting the efficiency of operations. Now, i4.0 (Industrial 4.0) comes in the form of IoT along with a wide range of connectivity. Unlike SCADA, IoT is relatively simple in integration, flexible on changes and accessible across various departments of organization. Researchers argue that IoT emerges when SCADA ends, thus extending SCADA with IoT, can of advantages for both systems (Aguida *et al.*, 2021).

The IoT makes the plants to be smart through data acquisition, data processing, prediction, adoption *etc*.

The applications of IoT in biomethanation are process optimization, gas estimation and safety. Each application was discusses as follows.

Process Optimization

The important application of IoT in biogas plants is process optimization to increase the productivity. The biogas plants - in house of anaerobic digestion comprising various phases with activities of microbes demands several environmental criteria.

Tracking the state of micro-organism along its life cycle and managing the environment parameters is the strategy to boost the biogas production. Real time monitoring of parameters such as pH, water level *etc*., can be highly helpful in increasing the gas generation. The hardware component requirements are sensors, micro-controllers, solenoid valves, Arduino boards, pumps, other modules *etc*., for an efficient working

Article History
Received on: 20th September 2022
Revised on: 23rd September 2022
Accepted on: 24th September 2022

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of the IoT system in the biogas production system to boost the productivity. A sample workflow of IoT framework based biogas plant is shown in figure 1. With this user can also get notification regarding the performance of the plant.

A research was conducted by Aguida *et al*. (2021) and they proposed an IoT based framework including systems, control techniques, networking technologies and predictive analytics for plant production optimization. Their framework works with three layers, namely the perception layer (sensors and actuators network), the network layer (IT network), and the application layer (IoT platform and software sensor for predictive analytics).

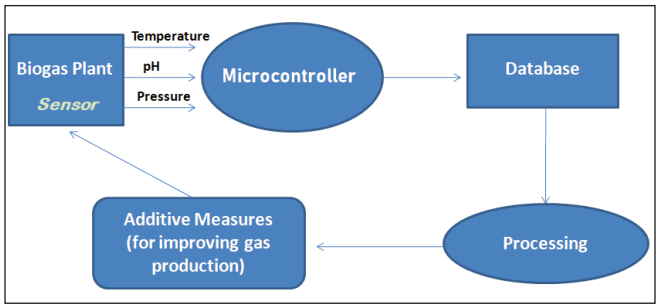

Figure 1: IoT Controlled Biogas Plant Workflow

Gas Estimation

Gas estimation can help to predict the output on the future occasions and facilitate storage planning and further functioning. This estimation can be achieved through IoT coupling with biogas plants through sensors, gas detectors, processors *etc*.

Gas analysers and chemical sensors are available nowadays for estimating the gas composition. But there is a need for a strong system to detect the composition and/or presence of gas in any environment, such as Automated Extraction Monitoring System (AEMS) biogas analyzer.

Logan *et al.* (2019) coupled IoT with pilot scale anaerobic digestion (food waste) plant for monitoring the performance.

Huo *et al.* (2019) discussed a system for monitoring the household biogas appliances, and their results say that the system provides precise information for the effective management of the medium and large sized biogas plants.

Based on IoT, in the city of Mohammedia (Morocco), biogas emissions from the landfills were estimated based on the seasonal changes. This helps to find out the hazards out of the emissions and to mitigate the same as precautions (Mabrouki *et al.*, 2021). The system is used to monitor the gas generated from the landfills and update the same into a remote database system.

Safety

Another important application of IoT in biogas plants are safety, including fire safety and leak tests. The fire smoke alarms along with embedded and cloud based frameworks, wireless and intelligent technologies can be adopted in biogas plants. The system of sensor-wireless communication-mobile application helps the user to extinguish the fire based on the alarm received from a remote location. This ensures the safety of both plant and surroundings without any human surveillance.

Conclusion

Green technologies such as solar, biogas and wind energies can be a good alternate for the future. Hence the technologies such as IoT, plays a major role in boosting the efficiency of the energy system applied. This collaboration can be helpful in various sectors such as agriculture, industry, transport, domestic, and smart applications including green buildings. By the role of IoT in biogas plants, the positive results can be observed in production, monitoring, estimation and safety.

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