Gobardhan Biogas Monitoring System

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Abstract: -

The Biogas Monitoring System aims to address the issues of inefficient monitoring and safety concerns in biogas production processes, especially for small-scale producers. Existing monitoring systems are often costly, complicated, and inaccessible, making them less suitable for small biogas plants. These plants face problems such as gas leakage and improper control of temperature and humidity, which not only reduce production efficiency but also pose significant health risks. To solve these problems, this project focuses on creating a low-cost, easy-to-use monitoring system. The system integrates sensors to track gas composition, temperature, and humidity in real time, providing continuous monitoring of the biogas environment. Using an Arduino-based platform, the system offers an affordable alternative to existing high-cost solutions, making it accessible for small-scale producers. The system's sensors detect harmful gases, monitor methane levels, and track environmental conditions that are crucial for efficient biogas production. The methodology involves real-time data collection, which is processed and displayed on an LCD screen for easy interpretation by operators. The system has been tested under different biogas compositions and environmental conditions, with results showing accurate performance in real-time monitoring. By identifying issues early, such as hazardous gas levels or unfavorable environmental conditions, the system helps to enhance both safety and productivity in biogas plants. Additionally, the use of a simple algorithm ensures that the system remains user-friendly, without requiring technical expertise. The biogas monitoring project thus offers a scalable, cost-effective solution to improve the efficiency and safety in biogas monitoring.

1. INTRODUCTION

The increasing demand for renewable energy has sparked interest in biogas production, an eco-friendly energy source derived from organic waste through anaerobic digestion. To ensure efficient biogas production, it is essential to monitor key parameters such as gas composition, temperature, and humidity within the digester. An Arduino-based Biogas Monitoring System offers a cost-effective, customizable solution for real-time tracking of these critical variables, ensuring optimal performance

and safety in both small-scale and industrial biogas plants. This system integrates sensors to continuously monitor gas levels and environmental conditions. One sensor detects harmful gases such as carbon dioxide and ammonia, which may indicate inefficiencies or safety concerns. Another sensor focuses on methane detection, the primary component of biogas, while another sensor tracks temperature and humidity, which are crucial for maintaining ideal conditions for microbial activity in the digester. Data from these sensors is processed by an Arduino microcontroller and displayed on an LCD screen, allowing operators to monitor the digester in real time. The system is designed to be user-friendly and scalable, providing flexibility for further customization and integration of additional sensors or automated control mechanisms. Operators can quickly respond to any fluctuations in parameters, ensuring efficient and safe biogas production. The Arduino platform's adaptability makes this system an ideal solution for improving the sustainability and efficiency of biogas plants, contributing to the broader adoption of renewable energy technologies.

A. Advantages

1. Improve yield of Biogas.
2. Effective Digestion.
3. Low cost kit.
4. Real Time Detection.

B. Problem statement

To design a system that optimize the production and utilization of biogas by continuously tracking key parameters in the biogas production process using a sensor network and internet of things technology.

C. Aim and Objective

Aim

The aim of a biogas monitoring system is to continuously track, analyze, and optimize the production and composition of biogas to ensure efficient and sustainable operation. By keeping a close eye on key parameters such as gas composition— including methane (CH_4), carbon dioxide (CO_2), and hydrogen sulfide (H_2S)— the system helps maintain a stable and productive process. It also monitors temperature within the digester, pressure levels to prevent leaks or system failures, and the overall flow rate of biogas being produced. Additionally, maintaining the right pH levels is crucial for microbial activity, ensuring that the digestion process remains effective. By providing real-time insights, a biogas monitoring system plays a vital role in improving efficiency, safety, and overall plant performance.

Objectives

A biogas monitoring system plays a crucial role in optimizing production by ensuring that conditions inside the digester are ideal for maximum methane yield. By continuously tracking factors like temperature, pH levels, and gas composition, it helps maintain an efficient and stable process. Safety is another key aspect, as the system detects potential hazards such as gas leaks or pressure build-ups, preventing accidents like explosions or equipment failures. Additionally, it enhances overall efficiency by reducing energy waste and improving plant performance. Environmental compliance is also a major focus, ensuring that emissions and waste management align with regulations to minimize the plant's environmental impact. With real-time monitoring and control, operators can remotely access data, analyze trends, and make informed decisions to keep the system running smoothly and sustainably.

2. Literature Survey

1)" Development of PLC grounded monitoring and control of pressure in Biogas Power Plant Digester," E. Mudaheranwa, A. Rwigema, E. Ntagwirumugara, G. Masengo paper, published in IEEE's ic ABCD, presents a monitoring and control system for biogas factory digesters using Programmable Logic regulators(PLCs). The system utilizes detectors to cover pressure, temperature, and gas composition, and employs PLCs to control faucets, pumps, and admonitions to maintain optimal operating conditions. The authors demonstrate the system's capability to help overpressure, insure safe operation, and optimize biogas product. The paper highlights the eventuality of PLC-grounded systems to ameliorate the effectiveness, safety, and trustability of biogas power shops, making it a precious donation to the field of renewable energy and artificial robotization.[1]

2)" Biogas Management using IoT," Dr. S.R. Patil et al.'s paper, published in IJRASET, presents a new approach to biogas operation using Internet of effects(IoT) technology. The authors propose a system that utilizes detectors and IoT bias to cover biogas product, composition, and application in real- time, enabling effective operation and optimization of biogas shops. The system also includes features similar as automated data collection, pall- grounded data analysis, and cautions for anomalies or conservation requirements. The paper highlights the eventuality of IoT- grounded biogas operation to ameliorate energy effectiveness, reduce emigrations, and enhance overall sustainability of biogas product, making it a precious donation to the field of renewable energy. [2]

3)" Research and Application of the Intelligent Biogas Monitoring System Grounded on LoRa Technology," Mei Xu and Chunmei Wang's paper, published in IEEE's AIAM, presents a new intelligent biogas monitoring system exercising LoRa(Long Range) technology. The system employs LoRa- grounded detectors to collect data on biogas parameters similar as temperature, pressure, and composition, and transmits the data wirelessly to a pall platform for real- time monitoring and analysis. The authors demonstrate the system's capability to ameliorate biogas product effectiveness, reduce labor costs, and enhance safety through early discovery of anomalies. The paper highlights the eventuality of LoRa technology in enabling dependable, long- distance communication for intelligent biogas monitoring, making it a precious donation to the field of renewable energy and IoT operations.[3]

4)" Development of IoT grounded Monitoring of Biogas Plant," Rushikesh Ravindra Pansari, Dr. S.R. Patil, and Dr. M.S. Khan's paper, published in the International Journal of Scientific & Engineering Research, presents the design and development of an IoT- grounded monitoring system for biogas shops. The system utilizes detectors to cover parameters similar as temperature, pH, and gas composition, and transmits the data to a pall platform via Wi- Fi or GSM modules. The authors demonstrate the system's capability to give real- time monitoring, automated data logging, and cautions for abnormal conditions, enabling effective operation and conservation of biogas shops. The paper highlights the eventuality of IoT technology to enhance the productivity, safety, and sustainability of biogas product, making it a precious donation to the field of renewable energy and artificial robotization.[4]

3. MODULE DESCRIPTION

Exploration methodology refers to the ways or tactics used to collect, elect, process, and dissect information about a content. A exploration composition's methodology section allows the anthology to objectively estimate the study's overall validity and responsibility. The proposed methodology incorporates both qualitative and quantitative perspectives. The following modules will be included in the system

1. Biogas Company Module

The purpose of Biogas Company Management Module is to give a centralized platform for biogas companies to manage multiple biogas shops effectively. This module enables company directors to oversee factory operations, assign detector accoutrements , and maintain up- to- date records of each installation. By offering functionalities similar as factory enrollment , assignment of covering

accoutrements , and access to detailed detector logs, the module facilitates streamlined operation and ensures that the biogas product installations are operating safely and efficiently. also, it allows the company to give factory-specific suggestions and guidelines, icing that conservation and functional procedures are harmonious and acclimatized to the unique conditions of each factory.

2. Biogas Plant Module

The purpose of Biogas Plant Monitoring Module is to equip individual biogas factory drivers with real- time monitoring and functional perceptivity. This module focuses on furnishing easy access to current detector readings and literal data, helping factory staff track gas attention and environmental conditions for safety and effectiveness. The module enables factory drivers to cover critical detector data and follow company- handed suggestions to maintain optimal biogas product. It's designed to insure that factory operations are continuously informed by over- to- date data, thereby reducing pitfalls and enhancing the overall productivity and safety of the biogas generation process.

4. PROPOSED SYSTEM

The Biogas Monitoring System is designed to optimize the production and utilization of biogas by continuously tracking key parameters in the biogas production process. This system plays a crucial role in ensuring efficient gas generation, safety, and environmental sustainability. By integrating various sensors and real-time monitoring capabilities, the system provides operators with valuable data to enhance biogas production efficiency and detect potential issues at an early stage. The Biogas Monitoring System using Arduino incorporates advanced sensing technologies to measure critical parameters such as gas levels, pressure, temperature, and methane content. The system utilizes MQ-135 and MQ-5 gas sensors to detect carbon dioxide and methane levels, respectively, while a DHT11 sensor measures temperature and humidity. These parameters are crucial in maintaining optimal digester conditions, ensuring maximum microbial activity, and enhancing biogas yield. The MQ-135 sensor is particularly beneficial for detecting harmful gases such as ammonia and carbon dioxide, which can negatively impact the efficiency of biogas production. The MQ-5 sensor focuses on methane detection, allowing operators to monitor the primary component of biogas effectively. The DHT11 sensor helps regulate the temperature and humidity levels within the digester, ensuring a stable environment conducive to microbial fermentation. An Arduino microcontroller serves as the central processing unit, collecting data from all connected sensors and processing it for real-time analysis. The acquired data is displayed on an LCD screen, providing operators with instant insights into the digester's conditions. This feature enhances operational efficiency by allowing quick decision-making based on accurate, real-time readings. To further enhance functionality, the system can be programed to trigger alerts or activate control mechanisms when critical thresholds are exceeded. For example, if methane levels drop below a specified range, the system can prompt corrective actions such as adjusting feedstock input or temperature conditions. Similarly, if carbon dioxide levels become excessively high, operators can take immediate measures to prevent system inefficiencies or safety hazards. One of the key advantages of the Arduino-based Biogas Monitoring System is its flexibility and scalability. The platform allows for future upgrades and additional sensor integration to accommodate more complex monitoring needs. This makes the system suitable for both small-scale biogas plants and larger industrial setups that require continuous monitoring and data logging for process optimization. By enabling real-time monitoring and continuous data collection, this system significantly enhances the efficiency, safety, and sustainability of biogas production. The data-driven approach helps operators optimize digester performance, minimize gas losses, and improve overall plant efficiency. Additionally, the ability to detect anomalies early reduces maintenance costs and ensures long-term operational reliability. The Biogas Monitoring System using Arduino provides a cost-effective and efficient solution for monitoring and optimizing biogas production. By leveraging modern sensor technology and real-time data analysis, the system ensures enhanced biogas yield, safer operations, and greater sustainability. The integration of this monitoring solution benefits both small-scale and large-scale biogas production units, supporting the global transition to renewable energy sources.

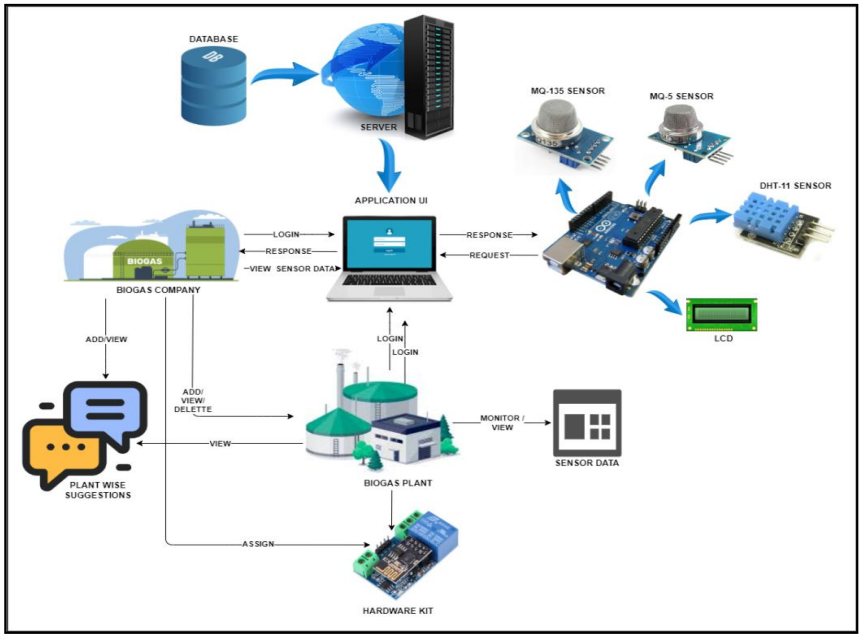


Fig. Proposed System

5. Activity Diagram

The Application Login process begins when the user enters their credentials, which the system. If successful, the user proceeds to the Main Menu, where they can choose options like adding a new biogas plant, viewing existing plants, monitoring hardware kit data, or displaying data on an LCD. The Add Biogas Plant option allows users to input information about a new plant, which the system then adds to the database. For View Biogas Plant, users can select an existing plant, and the system displays its details, including hardware kits. In the Monitor and View Hardware Kit Data section, users can select a hardware kit to view real-time sensor data. The system also offers the ability to Display Data on LCD, where collected data is shown on an LCD screen. Finally, the Logout option ends the session. Throughout this process, the system continuously collects, processes, and displays data, offering the user a streamlined interface to manage and monitor biogas plant operations.

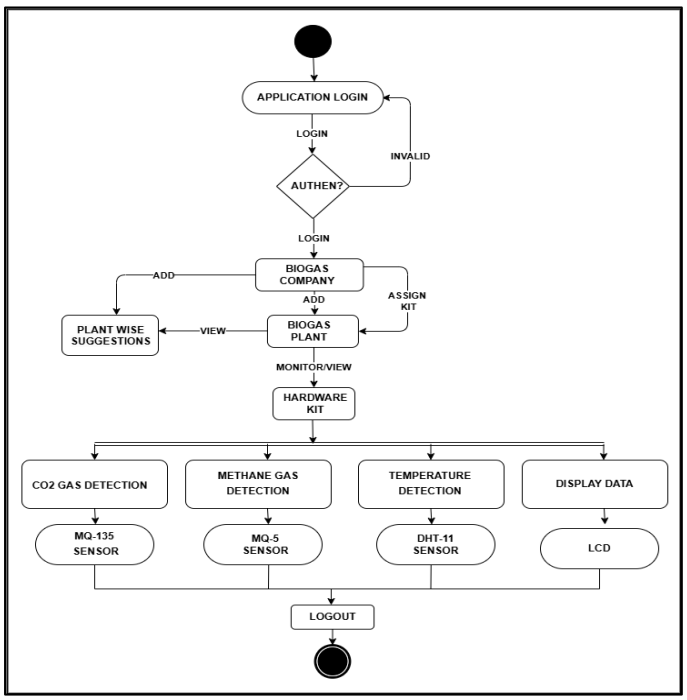
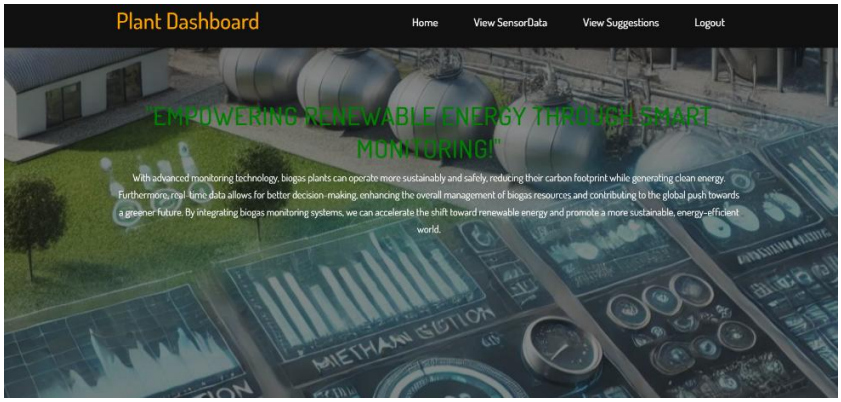


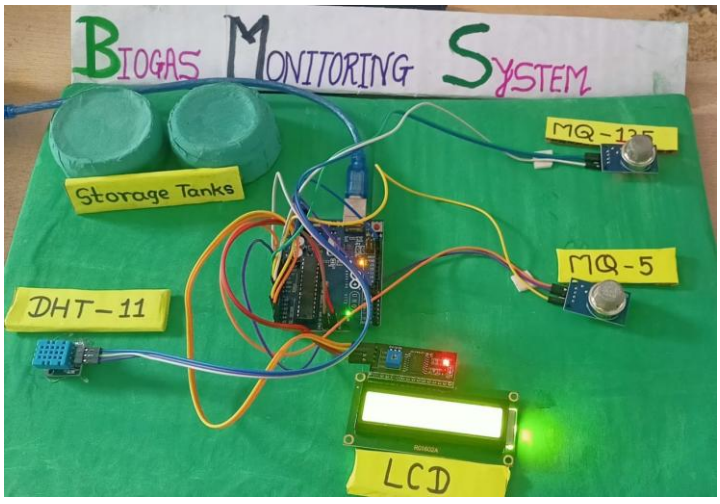
Fig. Activity Diagram

Output: -

Company Module



Plant Module



Hardware Kit

6. CONCLUSIONS

In conclusion, the bio-gas monitoring system offers a reliable, efficient, and cost-effective solution for real-time monitoring and analysis of bio-gas quality and composition. By utilizing advanced sensors and automation technology, the system provides accurate and reliable data, enabling operators to

optimize bio-gas production, ensure safe handling and storage, and maximize energy generation. The system's ability to provide real-time alerts and warnings enhances operational safety and reduces environmental impact. With its user-friendly interface and adaptability to various applications, the bio-gas monitoring system is poised to revolutionize the bio-gas industry, making it a crucial tool for sustainable energy production and a cleaner environment.

7. REFERENCES

1) E. Mudaheranwa, A. Rwigema, E. Ntagwirumugara, G. Masengo, "Development of PLC based monitoring and control of pressure in Biogas Power Plant Digester" and Publisher: IEEE's icABCD in 2019

2) Dr. S.R. Patil et al., "Biogas Management using IoT" and Publisher: IJRASET in Volume 8 Issue VIII Aug 2020.

3) Mei Xu and Chunmei Wang, "Research and Application of the Intelligent Biogas Monitoring System Based on LoRa Technology" and Publisher: IEEE's AIAM in 9 Jan 2020.

4) Rushikesh Ravindra Pansari, Dr. S.R. Patil, Dr. M.S. Khan "Development of IoT based Monitoring of Biogas Plant", International Journal of Scientific & Engineering Research Volume 11, Issue 8, August-2020 ISSN 2229-5518.