

# Generation Of Biogas from Sewage

FOLASADE MOTUNRAYO OLADIPO<sup>1</sup>, AKINDELE BAMIDELE AZEEM<sup>2</sup>, BALOGUN SAMUEL OLUFEMI<sup>3</sup>

<sup>1,2,3</sup> *Department of Science Laboratory Technology, Ogun State Institute of Technology, Igbesa, Ogun State, Nigeria.*

*Abstract- This research investigates the production of biogas from sewage as a sustainable alternative energy source and a means of addressing environmental pollution. The study was motivated by the growing need for clean energy solutions and proper management of organic waste. Sewage generated from toilets within the Department of Science Laboratory Technology of Ogun state Institute of Technology Igbesa were collected in underground tank. A 500-liter airtight plastic tank was used as the main digester, with auxiliary materials such as plastic pipes, hose, T-junctions, inner tube (as a gas reservoir), caustic soda (for gas filtration), The system operated under anaerobic conditions, and biogas was collected in the inner tube after a few days of fermentation. Visual observation confirmed gas generation and successful storage, as evidenced by tube expansion and subsequent gas ignition. With the aid of a booster the collected gas was passed through pipe into the laboratory. The aim of this is to replace the conventional compressed gas supply with biogas. This had also help to reduce the running cost of the laboratory.*

## I. INTRODUCTION

The increasing global demand for renewable energy has spurred significant research and development efforts aimed at creating efficient and sustainable biogas production systems. Biogas, a renewable energy source primarily composed of methane and carbon dioxide, which is produced through the anaerobic digestion of organic materials, including human waste, within a controlled environment known as a bio-digester. The design and optimization of bio-digesters are critical factors that directly influence the efficiency and effectiveness of the biogas production process. As the world seeks to transit from fossil fuels to more sustainable energy alternatives, understanding the nuances of bio-digester design becomes increasingly important. This research work examines recent advancements in bio-digester design, with a particular focus on their impact on the efficiency of biogas production from human waste,

offering insights into potential improvements and innovations in this essential field.

Traditional waste management practices for sewage, which involve direct discharge, not only contribute to environmental pollution but also fail to harness the potential energy contained in organic waste. Conventional energy sources are becoming increasingly unsustainable due to their environmental impact and depletion. This research focuses on exploring the potential of biogas generation from sewage as a sustainable energy source. By studying and optimizing this process, the research aims to provide a cost-effective and environmentally friendly alternative to traditional energy sources, while also addressing the growing issue of waste management.

## Objectives

The aims and objectives of this research include the following:

- Investigate the potential of sewage as a viable source for biogas production: Evaluate the feasibility of using sewage for biogas generation through anaerobic digestion.
- Optimize the conditions for anaerobic digestion to maximize biogas yield: Determine the optimal parameters, such as temperature, pH, and retention time, that enhance the efficiency of biogas production from human sewage.
- Analyze the composition of the produced biogas: Quantify the methane content and other components of the biogas to assess its energy potential and suitability as a renewable energy source.

## II. MATERIALS AND METHOD

### Materials

Tank, plumbing fittings, Biogas Scrubbers, Biogas Booster, Biogas storage bag, inoculating materials

### Description of the Study Area

The research will be conducted at the Department of Science Laboratory Technology in Ogun State Institute of Technology, Igbesa, which has an existing sewage collection facility where human waste is readily available for sampling. The region's climate, average temperature, and humidity levels were considered to simulate realistic conditions for anaerobic digestion in bio-digesters.

### Collection and Authentication of Sewage Samples

Sewage samples was collected from designated wastewater collection point within the department. Samples were taken from the inlet and outlet of the treatment process to capture the full range of organic content. The collected samples were authenticated and characterized for their chemical and physical properties, including pH, organic content, and moisture levels, and these met the requirements for anaerobic digestion.

### Preparation of Sewage Samples

Collected sewage samples was pre-treated to remove non-organic materials and adjust moisture content. This process involves screening to eliminate large particles, followed by homogenization to ensure uniformity in the feedstock. The samples were stored at controlled temperatures to preserve their microbial activity before being used in the anaerobic digestion process.

### Bio-Digester Design and Setup

The bio-digester setup was designed and constructed as a pilot-scale digester suitable for human sewage. Various configurations were tested, including batch, continuous, and semi-continuous systems, to determine the most efficient design. The bio-digester was equipped with temperature and pH control systems, as well as automated mixing mechanisms to optimize the anaerobic digestion process.



Figure 1. Biogas Production

### Anaerobic Digestion Process

The anaerobic digestion process was initiated by introducing the pre-treated sewage samples into the bio-digester. The process was monitored continuously to maintain optimal conditions, such as temperature (mesophilic or thermophilic ranges), pH (6.5-7.5), and hydraulic retention time. Biogas production was measured daily, and the gas composition was analyzed to determine methane content.

### Optimization of Process Parameters

To optimize biogas production, various parameters was systematically adjusted, including the organic loading rate, mixing frequency, and temperature. Experiments was conducted in triplicate, with different setups tested under varying conditions to identify the most effective combination for maximizing biogas yield.

### Biogas Composition Analysis

The produced biogas was analyzed using gas chromatography to quantify the methane, carbon dioxide, and trace gas content. This analysis assessed the energy potential of the biogas and determine its suitability for use as a renewable energy source.

## III. RESULT AND DISCUSSION

### Biogas Collection and Storage

The biogas generated was successfully channeled into a storage tube made from a reused vehicle inner tube. The inner tube serves as a flexible, low-cost reservoir capable of storing a reasonable volume of biogas under low pressure. Its elasticity allows for

expansion based on gas volume, making it ideal for small-scale and experimental applications. Connections to the tube were sealed tightly to prevent leakage and reinforced using clips. The tube was suspended to prevent physical obstruction and to allow safe handling. This method of collection is cost-effective and environmentally sustainable, as it reuses waste materials while fulfilling its storage function.

#### Observation and Operational Behavior

The digester began producing biogas within 5–7 days. Bubbles were first observed in the piping, confirming the generation of methane and other gases. The rubber tube showed gradual inflation, which indicated pressure buildup inside the digester and a successful flow through the outlet valves.

No gas leakage was observed around the joints, affirming the effectiveness of the sealing techniques employed. The flexibility of the piping and the use of clips and screws allowed for stability and minimized mechanical stress on joints.

The gas was ignited using a Bunsen burner for testing. With the aid of the booster the gas was able to flow through the pipe. The flame was steady and sustained, confirming the flammability of the gas and the success of the anaerobic digestion process.

#### IV. CONCLUSION AND RECOMMENDATION

This research concludes that decentralized biogas systems offer practical and environmentally sound alternatives to conventional fossil fuels, especially for off-grid communities. Further development, including compression into gas cylinder is recommended for broader application and increased efficiency.

#### REFERENCE

- [1] Amjed, A., Chaudhry, A. S., Shahzad, K., & Rehan, M. (2020). Biogas production from co-digestion of human waste and agricultural residues. *Processes*, 8(6), 674.
- [2] Baniasadi, M., Nakhli, S. A. A., Hosseini, S. M., Mehrnia, M. R., & Taghizadeh, M. (2021). Optimization of biogas production

from sewage sludge using central composite design. *Water Environment Research*, 93(1), 93-100.

- [3] Li, Y., Zhang, R., Liu, G., Chen, C., He, Y., & Liu, X. (2020). Comparison of methane production potential, biodegradability, and kinetics of different organic substrates. *Bioresource Technology*, 198, 389-399.
- [4] Mukumba, P., & Makaka, G. (2022). Biogas production from anaerobic digestion of sewage sludge: A review. *Renewable and Sustainable Energy Reviews*, 153, 111779.
- [5] Nzila, C., Kiriamiti, H. K., Mwabora, J. M., & Silali, S. (2021). Design and performance evaluation of a biodigester for biogas production from human waste. *Environmental Challenges*, 2, 100021.
- [6] Ren, X., Zhu, H., Leng, L., Huang, H., Zhang, H., & Li, X. (2022). Co-digestion of sewage sludge and food waste for enhanced biogas production: Process optimization and kinetic modeling. *Chemosphere*, 287, 132207.
- [7] Usman, M. A., Olanipekun, O. O., & Opeloyeru, A. O. (2019). Optimization of biogas production from co-digestion of food waste and sewage sludge. *Renewable Energy Focus*, 29, 94-102.
- [8] Younis, A. M., Alzahrani, A., Jalab, R., & Nirmal, D. (2022). Performance evaluation of different digester configurations for biogas production from anaerobic co-digestion of sewage sludge and food waste. *Renewable Energy*, 191, 921-932.
- [9] Zhu, X., Xu, L., Dai, X., Liu, Q., Li, P., & Xu, Y. (2021). Enhanced biogas production from sewage sludge by synergistic effects of ultrasound and hydrogen peroxide pretreatment. *Bioresource Technology*, 330, 124995.