GREEN RURAL ENERGY HUB: INTELLIGENT BIOGAS AUTOMATION FOR VILLAGERS

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Keywords:

Collision Tolerant, Mechanical Gimbal, Inspection, drone cage, unmanned sewage inspection.

Introduction:

Biogas production from canteen waste is an eco-friendly method to manage organic waste while generating renewable energy. Food scraps and biodegradable materials are collected and placed in a sealed digester, where microorganisms break them down in an oxygen-free environment to produce methane-rich biogas. This gas can be used for cooking and heating, reducing reliance on conventional fuels. The leftover digestate serves as a nutrient-rich organic fertilizer, improving soil quality and reducing the need for chemical fertilizers. This system lowers waste disposal costs, reduces greenhouse gas emissions, and supports a circular economy by converting waste into useful resources. It can be scaled for both small and large operations, making it especially beneficial for rural and small-scale hotel businesses.

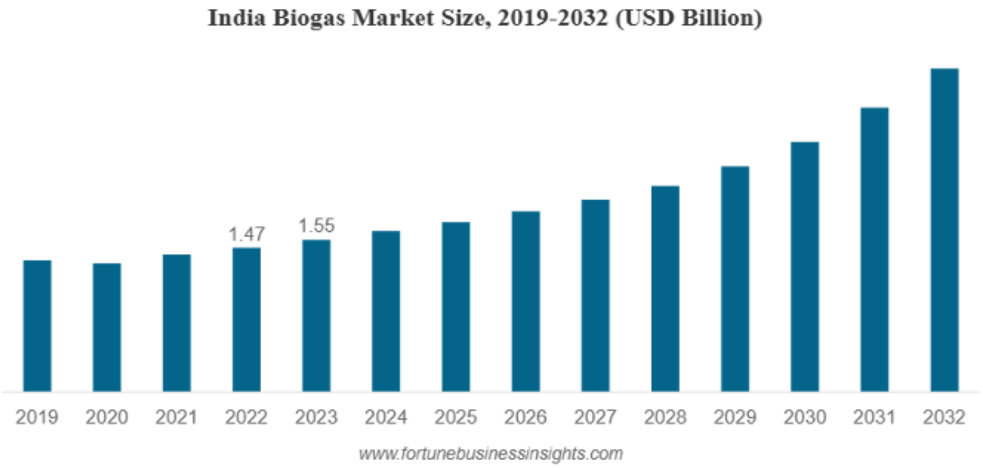

Figure 1: Market survey

Objectives:

1. To Fabricate a biogas plant that is easy to install, operate, and maintain.
2. To Develop a cost-effective biogas plant that uses locally available cow dung and other organic waste.

3. To Encourage the use of renewable energy by utilizing biogas as a clean and sustainable fuel, minimizing the carbon footprint and environmental impact of this business.
4. To provide an efficient and environmentally friendly method for managing organic waste.

Methodology:

The fabrication of an eco-friendly biogas plant involves systematic stages to ensure efficient, safe, and sustainable operation.

1. **Problem Identification:** Ensuring consistent and quality organic waste (feedstock) is crucial, as poor management reduces biogas efficiency.
2. **Literature Survey:** Recent advancements highlight improved designs, materials, and smart systems, though challenges in sustainability and feedstock management remain.
3. **3D Modelling:** Helps design efficient, cost-effective plants using advanced tools, enabling better visualization and optimization.
4. **Fabrication:** Involves constructing the plant using eco-friendly materials, energy-efficient designs, and proper waste management techniques.
5. **Testing:** Includes structural checks, gas production efficiency, environmental monitoring, and system performance evaluation to ensure reliability and safety.
6. **Result Discussion:** Larger-scale systems provide greater benefits, especially for rural and small hotel businesses, improving waste management and energy generation.

Result and Conclusion:

From the testing, it is noted that the amount of bio gas generated in the duration of 15days is 3Kg. This can be utilized for 4-5days in a week and can be regenerated again by repeating the process. By increasing the quantity of ingredients, the output(gas) also can be increased. So that continuous generation is also possible. It is suitable for short-term storage but not ideal for large-scale or long-term use due to limitations in material strength and pressure tolerance. For larger volumes, more robust and durable storage systems are recommended.

The eco-friendly biogas digester is a cost-effective and sustainable solution for small-scale rural businesses. It converts organic waste into biogas, reducing dependence on LPG, lowering costs, and promoting proper waste management. The system supports environmental conservation, reduces greenhouse gas emissions, and provides renewable energy for households, farms, and local enterprises, making it a practical solution for sustainable development.

References:

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Future Scope:

The future scope of this project includes:

1. **Scaling Up:** Expand the system for larger applications like hostels, hotels, and community kitchens to increase biogas production.
2. **Automation:** Integrate sensors and microcontrollers (e.g., Arduino/Raspberry Pi) for real-time monitoring of temperature, pH, and gas levels.
3. **Better Storage:** Develop advanced gas storage solutions like gas holders or CBG cylinders for safer and efficient storage.
4. **Commercial Use:** Promote commercialization to support rural entrepreneurs and reduce dependence on LPG.
5. **Environmental Improvement:** Enhance efficiency and further reduce greenhouse gas emissions for better sustainability.