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Biogas Plant at LDRP-ITR, Gandhinagar

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Abstract

According to the 2011 survey of India, 33.6 million (28.5%) Indian households used LPG as cooking fuel in 2011. An annual increase in usage of 2-3% could result in currently recoverable reserves lasting significantly less, perhaps as few as 80 to 100 year. Biogas plant is an anaerobic digester that produces biogas and fertilizer from organic matter like animal waste, human waste, sewage slurry, vegetable waste and other. A biogas plant in the LDRP-ITR is one of the green technology applications as it not only produces renewable gases but also minimizes the sewage waste. Propound design of biogas plant for capacity of 141.34m3 is presented in this paper with literature survey.

Keywords

Biogas Plant, Biogas, Digester, Human Waste, Kitchen Waste

Introduction

Biogas energy is renewable energy. Biogas refers to a gas produced by anaerobic fermentation of organic matters like kitchen waste, human waste and other in absence of oxygen in airtight container called biogas digester. During the process, as an airtight tank transfer biomass into methane producing renewable energy that can be used for heating, cooking, electricity and other. The process of biogas depends on fermentation. Fermentation is the process in which chemical breakdown of a substance by bacteria, yeast, or other microorganism and also depends on temperature.

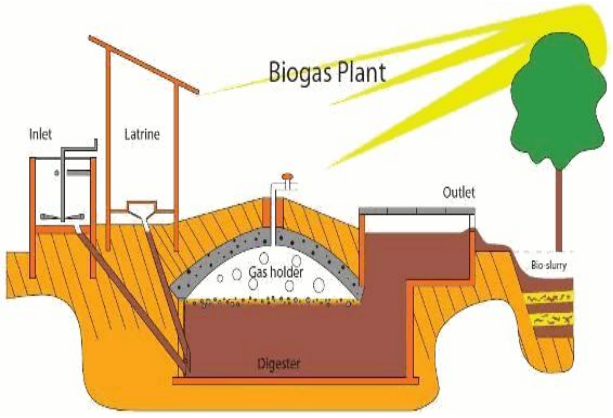

Figure 1: Components of Biogas Plant

S. No.	Compound	Chemical Formula	Percentage (%)
1	Methane	CH4	50-70
2	Carbon dioxide	CO2	30-50
3	Nitrogen	N2	0-2
4	Hydrogen Sulphide	H2S	0-1
5	Water vapour	H2O	0-1
6	Hydrogen	H2	0-1

Table 1: Typical composition of BIOGAS

S. No.	Types of Animals	Production of Solid Waste in Kg per Day	Production of Biogas from this Solid Waste in Kg per Day
1	Cow	15	2.1
2	Buffalo	10	2.8
3	Chicken	0.15	0.0032
4	Sheep	5	1.05
5	Goat	2	0.077
6	Men	0.5	0.04
7	Child	0.2	0.01

Table 2: Production of Biogas from different animals per Day

Biogas is about 20% lighter than air and has an ignition temperature in the range of 650-750 °C. It is odourless and colourless that burns with a blue flame similar to that of liquid petroleum gas.

Need For Study

Land and water pollution is increasing at a high pace nowadays, that causes degradation of natural resources and creates illness. Also, the population increases day by day that uses the conventional energy resources which depletes gradually. Currently in LDRP-ITR hostel, student's strength is 1100. Every day 121.37kg LPG gas is consumed, that costs around Rs. 8623.94 per day. From review of various research papers, it is concluded that one person can produce a 0.5kg solid waste per day. So, as per strength of the hostel 550kg of solid waste can be produced. It is found from research articles that 1 kg of human solid waste can produce from 0.02 to 0.05kg of biogas according to surrounding condition. So from the 550kg solid waste, around 16.5kg of biogas can be produced that can save Rs. 1172.40 per day.

Objective of Study

1. Main objective is to use the solid waste of hostel in effective manner by producing biogas from it that can fulfil daily requirement of hostel.

2. The other objective is to fulfil our social duty by producing biogas from solid waste that can reduce the use of conventional energy sources and helps in reducing the pollution.

Literature Survey

1. N. Stalin, et al (2007) modified three stage methane fermentation system was developed to digest animal manure effectively. The digester having an effective volume of 200 litres is constructed with central tube filled with burnt bricks. The burnt brick in the central portion of the digester increase the microbial concentration by immobilizing the bacteria on the surface of the burnt bricks. The size of brick material is not more than 3 to 5 mm size. The carrier materials used in the digester are 5%, 10%, 15% and 20% of the total volume of the digester and also for each percentage 3.5kg of cow dung and 3.5kg of water (1:1) is well mixed and added daily. The reading was taken between biogas generations various times for each percentage of carrier material from the total volume for microbial growth gave more gas generation. Operational temperature was from 30°C to 50°C. The study examines the effect of microbe growth, temperature, on biogas generation and hydraulic retention time.

2. Tom Bond, et al. (2011) Studied technologies which recover biogas do so by harnessing anaerobic degradation pathways controlled by a suite of microorganisms. The biogas released acts as an environmentally sustainable energy source, while providing a method for disposal of various wastes. Biogas contains 50–70% methane and 30–50% carbon dioxide, as well as small amounts of other gases and typically has a calorific value of 21–24 MJ/m3.Various appliances can be fuelled by biogas, with stoves offering an application appropriate for deployment in developing countries. Widespread dissemination of biogas digesters in developing countries stems from the 1970s and there are now around four and 27 million biogas plants in India and China respectively. These are typically small systems in rural areas fed by animal manure. However, in many other countries technology spread has foundered and/or up to 50% of plants are non-functional. This is linked to inadequate emphasis on maintenance and repair of existing facilities. Beyond this, there remains potential for domestic plants to utilise currently underexploited biogas substrates such as kitchen waste, weeds and crop residues. Thus there is a need for research into reactors and processes which enable efficient anaerobic biodegradation of these resources.

3. In Nyazura Adventist High School, they built a biogas plant for generating electricity and also for cooking purpose. After the development, they concluded that the total energy requirement for the school is 2710 kWh per day and the total energy from biogas of the feed stocks was 450 kWh/day. Therefore, the biogas would contribute to 16% of the total energy needs of the school. The total energy for lighting was 135 kWh/per day. It can be concluded that lighting for the whole school takes only 30% of electricity that is generated from the biogas. Therefore, the other 60% of

electricity from biogas would be enough for all electricity requirements in the following; computer laboratory, classrooms, administration block, school library, boys and girls laboratories. The remainder 10% of electricity from biogas would add to the cooking needs supported by the electricity from the grid. The calculated annuity, the dynamic payback period and the net present value (NPV) are high. So the project is favourable, profitable and worth undertaking [1].

4. Dissemination of biogas technology in Pakistan started in 1974 with a comprehensive government programmed and till the end of 2006 some 6000 plants have been installed across the country. The general outcome of study suggested that the existing biogas plants are functioning at a satisfactory level through there are lots of rooms for further improvement. The functional conditions of 34% plants were satisfactorily, 45% plants were functioning partly and the remaining 21% plants were not functioning at all during the time of field investigation. This data clearly illustrate that there are rooms for further improvements. In terms of saving of conventional fuel sources, one biogas plant on average have contributed cutback of 3.08 kg of firewood, 0.11 kg of LPG, 3 kg of dung cakes/balls and 1.82 kg of agricultural residues per household per day. Such savings have resulted in monetary gain of Rs.7976.60 per household per year, which is a substantial amount [2].

5. The Project is targeted at benefitting the community of Sitapur by means of producing electricity from human and animal wastes and agricultural biomass. One of the direct impacts of the project would be improved living conditions in terms of clean surroundings devoid of stagnating sewage water and less incidents of diseases such as diarrhea, typhoid, cholera etc. The main hope is to service an estimated 200 households with electricity for a period of 7 hours, from 4pm to 11pm. It is expected that with availability of electricity, there will occur a number positive outcomes such as improved grades of the children of Sitapur, more leisure time for the family in evening, increased agricultural productivity, increasing the likelihood of women to engage in productive activities etc [3].

Propound Design

Total number of student in LDRP-ITR hostel=1100
Total discharge = 1100 × 0.5 = 550kg/day
Total solid of fresh discharge=550×0.2=110kg
8% concentration of total solid is required
I.e. 8kg of solid is required to make 100kg influent
110 kg of solid is required to make = (110×100)/8 = 1375kg
Total influent required-Total discharge = 1375 – 550 = 825kg
So that 825kg water to be added to make the discharge 8% concentration of total solid.
Working volume of digester
= Total influent required ×HRT (Hydraulic Retention Time)
= 1375×50
= 96250kg

1000kg = 1m3
96250kg = 96.250m3
Approx = 98 m3

Volume of cylinder = πd2h/4
98 = πd2h/4
98×4/π = d2h
d2h = 124.84m3 = Influent storage
Gas storage = 1100×0.5×0.03
= 16.5m
Total Volume of storage tank = Volume of influent + Gas storage
= 124.84 + 16.5
= 141.34m3
Here, the total volume = 141.34. Two biogas plants are suggested.
Total volume of storage for both Biogas plant = 70.67m3
Required height = 4.42m, and required diameter = 4.0m

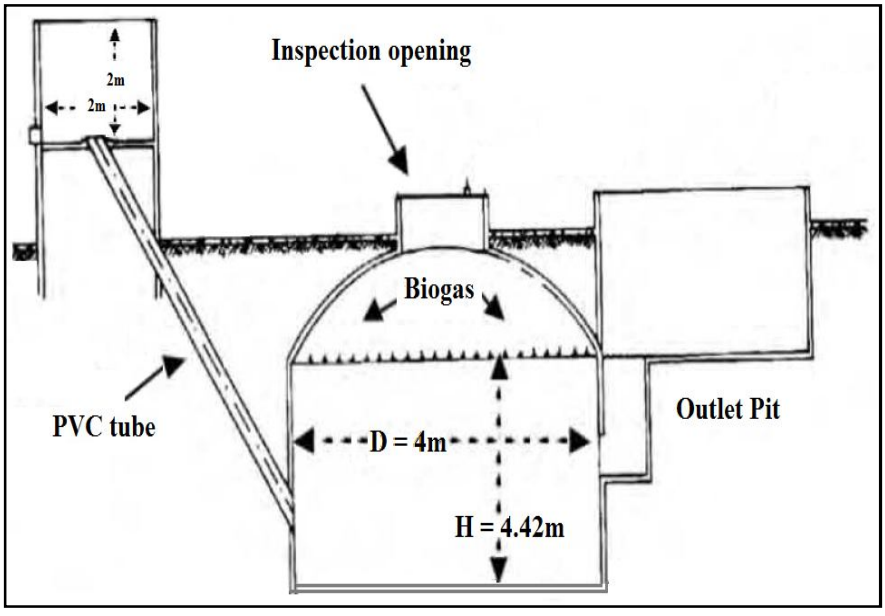

Figure 2: Propound Design of Biogas plant at LDRP – ITR, Gandhinagar

Conclusion

1. We will require storage tank having volume of 141.34m3.
2. By installing this project, we can save around Rs.1172.40 per day.

Future Scope

Waste generally comprises of both solid as well as liquid components but the proportion may vary. In the similar way LDRP - ITR hostel too releases the waste which comprises more component of liquid waste as compare to the solid. So it is require flushing out the liquid waste before the installation of biogas plant.

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