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Paddy straw based energy generating biogas plant made up of mild steel

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Abstract

The main objective of this research is to produce biogas from paddy straw collected from the field. The biogas produced by dry fermentation in the absence of oxygen. A new design of leakage proof digester is made up of mild steel is developed. This digester is placed on the ground, so that it remains in the contact of sunlight directly. For production of biogas high temperature and leakage proof system is favorable. Sunlight increases the fermentation and provides high temperature. The size of digester is 6feet diameter x 6.6 feet height. The capacity of digester is 460 kg paddy straw chopped husks mixed with 150 kg cattle dung. This composition of paddy straw and cattle dung produced biogas for regular three months. In this research the production of biogas is measured and this biogas produced is equivalent to 3 LPG cylinders.

Keywords: Mild steel digester (6feet diameter x 6.6 feet height), biogas

Introduction

Biogas is the major source of energy. Biogas is a good source of renewable energy having natural composition methane (50-65%), carbon-dioxide (30-40%), hydrogen (1-5%), nitrogen (1%), hydrogen sulphide (0.1%) and water vapors (0.1%). Calorific value is about 5000kCAL per m³. Cattle dung, live stocks and now these days paddy straw is also a source of producing biogas. Biogas digester is any structure that converts organic material into energy in the absence of oxygen^[1]. Paddy straw after harvesting is available all over the fields of Punjab. It can be utilized for power generation as well as cooking gas. Various projects such as ethanol generation and electricity generation are based on paddy straw. This crop residue has various applications and it can be a major energy source. As nature provide everything for producing energy. This paddy straw management is not a problem as well as it's an energy source. The ash of rice husk has properties of bricks and is used in road constructions and other useful purposes^[2]. The Paddy straw burning is the major problem for country^[3]. These paddy straw husks in the field regular produce pollution in the environment^[4]. There are various ways to control this. By collecting the paddy straw waste from the fields and put them in a leakage proof digester, cooking gas can be easily obtained. There are many machines developed to resolve this problem such paddy straw chopper, multures. Happy seeder is also a good option to overcome this problem. Some industries are using paddy straw as a packing material in boxes for safety of products.

There are many other designs for producing biogas for example deen-bandhu biogas plant, PAU Janta model biogas plant. There are some other plastic tanks which are used as a biogas plant. Cattle dung is used as a feeding material in these plants. Daily feeding is required for these plants. There are some plants developed by "Punjab Agricultural University" based on paddy straw. Various designs are available such as concrete based paddy straw plant which is installed under the ground. Another design is mild steel based paddy straw plant installed on the ground. This flow chart gives the overview of working of paddy straw plant and production of biogas.

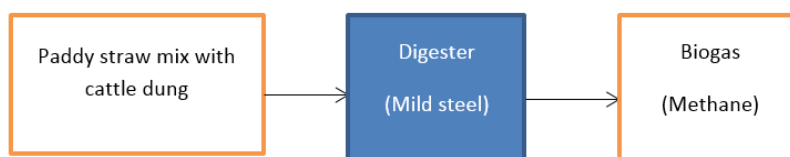


Fig 1: Flow diagram indicating working of paddy straw plant

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Methods & Materials

In this research a big size digester is developed having dimensions 6feet diameter x 6.6 feet height. It is made up of mild steel. The digester is fixed on tripod stand. This stand is made up of 4inch girders and has strength to hold the weight of structure. Proper welding is done on the various joints of plant so that it remains a rigid body structure. This design is totally leakage proof and is designed in that way that no bursting or any accidental chance can occur. This digester is developed to produce biogas further used as cooking gas and for lightning purpose. It has total capacity of 460 kg paddy straw and 150 kg cattle dung to increase fermentation inside the digester. The material is filled from the top of digester. Single laborer filled the plant. On the top a 3 feet diameter sized mild steel cover is available. After filling the cover gets bolted. This cover has two rings. First ring is fixed with upper mild steel sheet and other ring is flexible. A seal of high temperature resistant is placed between the two rings to avoid leakage of biogas during the dry fermentation process. After filling it takes 7-8 days to complete dry fermentation process and then it start producing biogas. This is continuous process. It continuously produces gas for three months. After three months the paddy straw gets converted into solid bio-digested slurry. This solid bio-digested slurry is used as compost. The design of paddy straw based dry fermentation biogas plant is shown in figure. 1. The paddy straw used as feeding material is well chopped by a toka machine. The paddy straw is collected from the fields of Punjab agricultural university. The well chopped paddy straw is shown in fig. 2. The daily biogas is measured with the help of gas flow meter. This meter provides readings in cubic meters. Temperature is measured by an ordinary thermometer. The weight of material is measured by weighing machine. The data is collected on daily basis. The biogas is stored in gas holder. The digester shown in figure. 2 is a type of batch system plant.



Fig 2: Paddy straw based biogas plant made up of mild steel.



Fig 3: Well chopped paddy straw used as feeding material

Results & Discussions

The biogas plant was commissioned with 460 kg of paddy straw of 150 kg cattle dung and water up to saturation of paddy straw. The daily biogas generation in this plant is given in Table 1.

Table 1: Daily biogas production for the period from 09.05.2017 to 08.2017

Date	Gas Production / day (m ³)	Temperature	Date	Gas Production / day (m ³)	Temperature
09.05.2017	-	-	28.06.2017	1.478	31 °C
10.05.2017	1.49	-	29.06.2017	1.159	27 °C
11.05.2017	1.294	-	30.06.2017	1.023	33 °C
15.05.2017	2.286	41 °C	04.07.2017	4.577	30 °C
16.05.2017	0.033	38 °C	07.07.2017	3.341	32 °C
18.05.2017	1.189	-	17.07.2017	9.905	31 °C
19.05.2017	0.471	40 °C	25.07.2017	5.473	32 °C
22.05.2017	2.597	30 °C	02.08.2017	4.094	31 °C
23.05.2017	-0.473	-	03.08.2017	0.41	31 °C
24.05.2017	3.002	38 °C	04.08.2017	0.455	35 °C
26.05.2017	3.49	40 °C	07.08.2017	1.094	34 °C
30.05.2017	9.763	34 °C	08.08.2017	0.561	34 °C
31.05.2017	3.228	27 °C			
01.06.2017	2.853	35 °C			
02.06.2017	1.99	35 °C			
05.06.2017	5.731	39 °C			
06.06.2017	2.026	40 °C			
07.06.2017	1.466	38 °C			
12.06.2017	6.597	34 °C			
13.06.2017	1.409	36 °C			
14.06.2017	1.311	35 °C			
15.06.2017	1.369	35 °C			
16.06.2017	1.351	31 °C			
17.06.2017	4.359	37 °C			
20.06.2017	1.323	32 °C			
21.06.2017	1.273	28 °C			
22.06.2017	1.275	31 °C			
23.06.2017	1.35	32 °C			
27.06.2017	6.075	37 °C			

Results

- This data indicates the production of biogas from the digester. The biogas produced at the average rate of 2 cubic meters daily. Total biogas produced by the mild steel digester is 103.756 m³ which is equivalent to 3.14 LPG cylinders. 44.6 kg of LPG is produced by the paddy straw mild steel plant.
- No structural problem is observed during the whole process. Single person can easily operate as well as handle the plant.
- The bio fertilizer produced is of good quality and used in farms.
- No corrosion is observed after unloading the paddy straw from the mild steel digester.

Conclusions

Summer season is very favorable for this digester. In winter season insulation is required. By constructing dry fermentation paddy straw based biogas plants with alternate construction material like M.S. sheet / fiber in place of brick masonry, the cost of the plant can be reduced and also the operation of the plant is easy with these efforts, this technology has to be feasible at the individual level.

Future Scope

- The research can be extended up to 100m³ by increasing the size of digester.
- Production of biogas depends upon the size of plant and quantity of paddy straw loaded in the plant.

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