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# Paddy straw based biogas generation technology for rural areas of Punjab

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**Abstract**
The main objective of this research is to introduce the developed technology for utilizing the paddy straw for biogas generation. This technology is an alternative of LPG cylinder, which is used by major population of India. This technology is a part of paddy straw management policy. This paper present the paddy straw as a useful renewable energy source. It also represents the practical to utilize the paddy straw as a cooking gas. The design and data of paddy straw based biogas plant are discussed in this paper. The biogas generation by paddy straw utilization is due to anaerobic digestion in the absence of oxygen. The feeding material is paddy straw mixed with cattle dung. Total capacity is 1600 kg paddy straw and 400 kg cattle dung. This is batch type system. Size of plant is 10 feet diameter x 10 feet depth.

**Keywords:** Paddy straw, concrete based biogas plant, mild steel biogas plant, biogas generation, LPG cylinder

## 1. Introduction
Paddy is cultivated in about 43.95 million hectares producing about 106.54 million tonnes of rice and approximately 160 million tonnes of straw with a ratio of 1:1.5 for rice grain produced to straw produced. Punjab produced 11.27 million tonnes of rice, which is 10.6 per cent of all India's total production for the year 2013-14 and produced a total of 16.90 million tonnes of paddy straw [1]. Paddy straw is also a form of biomass. Any biomass available on earth is a big source of bioenergy. If this source of paddy straw gets converted into biogas and electricity generation, than it plays a big role to overcome the fuel problem. Paddy straw is available in rural areas and villages; over 62% population of India is dependent on LPG cylinders and paddy straw after anaerobic digestion is an alternative to the LPG cylinders. The biochemical composition of rice straw is 30-45% cellulose, 20-25% hemicellulose, 15-20% lignin and number of minor organic compounds. Paddy straw husk used as a valued added raw material for different purposes. It possesses various properties that make them suitable for bioethanol production [2]. The ash of rice husk has properties of bricks and is used in road constructions and other useful purposes [3, 4]. The carriage of digested material is not difficult as it can be carried in baskets for loading in tractor trolley.

### Project overview
In this research, paddy straw (PS) is used to produce biogas for cooking. The main focus is to make this crop residue useful for maximum population. It covers the rural areas, because paddy straw is available mostly in villages. There are two designs of biogas plants available after testing for a long interval of time to consume the PS for biogas production. A batch system of biogas plant is developed. Biogas produced by anaerobic digestion in the absence of oxygen in a leakage proof system. This plant produced biogas for a family size of 7-8 regularly for an interval of three months. An average of 3-4 LPG cylinders were produced by this plant monthly. This quantity is enough for a family. The storage quantity of plant is 1600 kg paddy straw. The capacity of plant is 4 meter cubic daily biogas production.

## 2. Methods &Materials
There are two types of plants developed for biogas production:
I) Concrete based Paddy straw biogas plant.
II) Mild- steel biogas plant.

The details are discussed in this section.

**2.1 Concrete based Paddy straw biogas plant**

Attempts have been made at "Department of Renewable Energy Engineering, Punjab Agricultural University, Ludhiana, to construct masonry structure as digester. The details of plant are given in Fig.1. The life of structure is more than 20 years. The advantage of masonry structure is that the whole structure is underground, on which cold would have little effect in winter. The process of Dry Fermentation is a batch process, once the digester is loaded and activated, it would produce biogas for a period of 3-4 months.

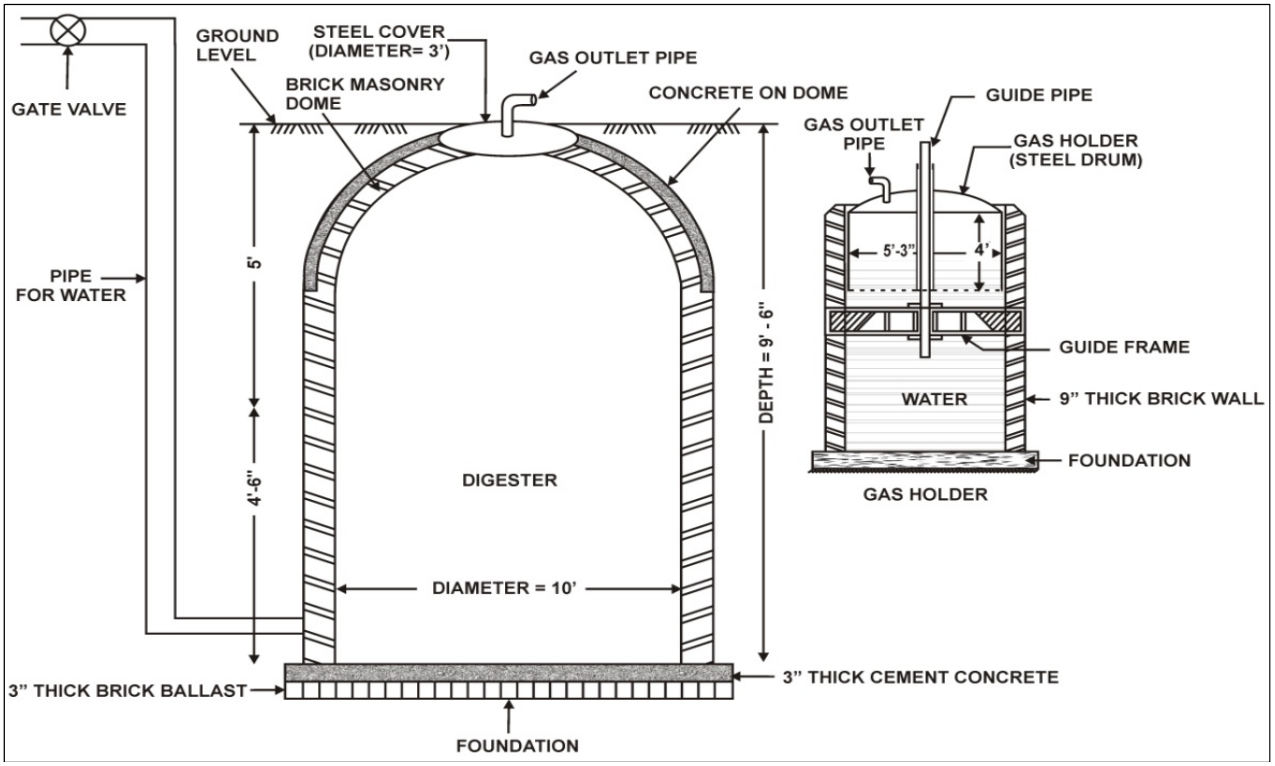


**Fig 1:** Dimensions of Dry Fermentation Biogas Plant

This digester has been constructed and made completely air tight unlike conventional biogas plant digester in which gas holder was only water tight. In the conventional biogas plants, the digestion is taking place in presence of large amount of water and the gas bubbles are free to move only in vertical upward direction, but in present case, the quantity of water is very little and thus, the gas bubbles are free to move in all directions. In case the digester is not air tight, no storage of gas is possible.

Quantity of paddy straw = 1.60 MT
Quantity of cattle dung = 0. 40 MT

Water added in the plant through a pipe connected at bottom to saturate the paddy straw. Gas production starts after about 7-10 days. Gas supplied to the burner from steel gas holder is connected to the digester. Gas production is in the range of 4-5 $m^3$/day i.e. 3-4 cylinders of LPG/ month. Gas production continues for about 3 months. Plant is reloaded after 3 months by emptying it. Digested material collected from the plant is rich organic humus which can be used in the field as organic manure. Approximate cost for the construction of the plant is 1.20 lakh.

**2.2 Mild-steel biogas plant**

In this research a big size digester is developed having dimensions 10 feet diameter x10 feet height. It is made up of mild steel. The digester is fixed on tripod stand. This stand is made up of 4 inch 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 16000 kg paddy straw and 400 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 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 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.

## 3. Results and discussions

**Table 1:** In this section the biogas production and total LPG cylinders produced by the plants are shown. In table 1.

| Paddy straw plant | Daily Biogas Production | Total LPG Cylinders per month |
|---|---|---|
| Concrete based paddy straw plant | 4 -5 cubic meter | 3-4 cylinders |
| Mild steel paddy straw plant | 4-5 cubic meter | 3-4 cylinders |

**3.1 Results for Concrete Paddy straw Biogas Plants**: This plant was installed underground. This plant is tested for 5-6 years and currently producing the biogas continuously. The storage capacity of paddy straw is 1600kg. Once filled, it produced biogas continuously for 3-4 months. The average daily production is 4-5 cubic meter. Total 3-4 cylinders were produced monthly by this plant and it generate biogas for 4 months. Therefore 15 LPG cylinders produced by it.

**3.2 Results for Mild Steel Paddy straw Biogas Plants:** This plant is installed on the ground. It is directly in contact with sunlight. This plant is tested for 1 year and currently producing the biogas continuously. The storage capacity of paddy straw is 1600kg. Once filled, it produced biogas continuously for 3-4 months. The average daily production is 4-5 cubic meter. Total 3-4 cylinders were produced monthly by this plant and it generate biogas for 4 months. Therefore 15 LPG cylinders produced by it.

## 4. Conclusion

- This project is beneficial in paddy straw management.
- This is an alternative of LPG cylinder.
- Million tonnes of paddy straw can be utilized for power generation and biogas generation.

## 5. Future Scope

- By increasing the size of plant, the volume of the biogas can be increased.
- A common plant can be installed for fulfilling the needs of whole village.

## 6. References


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