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Design, Development and Testing of Screw Press Machine for Paddy Straw under Ground Digester

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A B S T R A C T

The main objective of this research is to develop a machine for removing solid bio-digested slurry from the underground digester. In this research, a concrete digester having depth 10feet x 10 diameter was constructed and installed under the ground for biogas production. The storage capacity of this digester is 2000 kg .The application of this digester is biogas production and an alternative of LPG cylinder. The biomass used is chopped paddy straw, which gets converted into solid bio-digested slurry after an interval of three months. The main problem was removal of this solid bio-digested. To overcome this, a machine was developed according to dimensions of digester and tested. A screw press machine of length 11 feet and 4 inches diameter is designed and fabricated in that way, so that it can be handled by a single person.

Introduction

Paddy straw management is the focus area of government. Several projects and policies are adopted to overcome this problem of burning caused by paddy straw in North India. Paddy straw digester is the developed technique to produce biogas by utilizing paddy straw waste collected from the field. The paddy straw with cow dung loaded in the digester initially. After 7-8 days it starts producing biogas in the absence of oxygen by anaerobic digestion. This project is very beneficial for domestic purpose as well as power generation. The digester produces biogas at the rate of 6 cubic meters daily, which is sufficient for family size 7 to 8 members. After it stop producing biogas, the paddy straw gets converted into solid bio-digested slurry. This solid slurry further used as manure in the farm fields.

Fabrication depends up on the designs. Due to automation mechanical industry as well as agriculture industry is also adopting new concepts to increase the production by time reduction. Every new project is different so

obviously the requirements become special. For new and special requirements the machines are not available in the market. Only for standard work the machine are easily available in market. In this research project the major requirement is removal of material from the depth. There are various techniques for lifting i.e. hydraulics, conveyer system and screw press. For this project the screw press technology becomes feasible in the end.

Statement of the problem

The paddy straw digester is fabricated underground. The digester after filling with 1600 kg paddy straw and 400 kg cow dung start producing biogas for three months. After three months it gets converted into solid bio-digested slurry. There is no standard size machine available in market which can be used for removal of this solid slurry. So the major problem is removal of material. Without it, project is not considered completed. This is the reason for developing machine for this digester.

Significance of the project

The government of India is planning for introducing the plant at domestic level. This is the alternative of LPG cylinders. Biogas is the natural source of energy as well as cheapest to others. Paddy straw is also the major problem, after harvesting majority of farmers burns their field and this raises the problem of air pollution and other diseases caused by smoke. The planning of government is to utilize the paddy straw waste in the form of cooking gas as well as power generation.

At present, all crop residues like paddy straw, potato tendrils, vegetable plants and tree leaves are being burnt in the fields just to make the fields clean for the next crops in short time. These crop wastes can be valuable fuel for kitchen the kitchen/ power generation [1]. Although at present, some of the crop residues are being used for power generation using thermal method which not only create atmospheric pollution but also produce a huge amount of ash for which disposal becomes a headache. Research work indicates that open field burning of crop residue is a common practice in many countries [2]. Such crop residues may be digested by anaerobic means for the production of methane gas as a fuel for the kitchen as well as for power generation. The latest method of anaerobic digestion i.e. dry fermentation of organic wastes can be carried out which require little labor and produce a large amount of methane for a period of 3-4 months.

The digested material so produced from such anaerobic digestion is good quality manure, ready for use in fields. Rice husk used as a valued added raw material for different purposes. It possesses various properties that make them suitable for bio-ethanol production [2]. The ash of rice husk has properties of bricks [3]. The rice husks are used in road constructions and other useful purposes [4]. The carriage of digested material is not difficult as it can be carried in baskets for loading in tractor trolley.

Materials and Methods

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 Figure 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 complete project drawing is shown in Figure 1.

In this section the design, fabrication and testing of machine is discussed.

Design of machine

Design is the base of machine. The removal of solid bio-digested slurry (SBDS) was very difficult task. The major requirement of the project was to develop a handy machine according to dimensions of underground digester. There is only one way for filling and removal of material, so the machine was designed 11 feet long and 4 inch spiral blades welded were welded all around it.

A single phase electric motor was bolted on the top which rotate the shaft and lift the material from the depth and throws it outside on the ground. 11 feet long shaft was covered with CRC pipe as well as the motor was covered with safety cover. The design of machine is shown in the Figure 2. The weight of total machine is 27 kg.

Digester

The machine was developed according to dimensions of digester and the dimensions of the digester were 10feet depth x 10 feet depth. The structure is concrete based having 9 inch brick walling. A 3 feet mild steel manhole is provided on the top, the only way to enter the machine in digester. There is no other point provided for entering, because leakage proof system is the requirement of digester for continuous biogas production.

The storage capacity of the digester is 2000kg i.e.1600 kg paddy straw and 400 kg cow dung. Once material filled in this digester, it provides biogas continuously for three months. After three months period, new material is required for working of plant and the need of machine becomes a requirement.

The developed machine working in the digester is shown in Figure 3. From the top of the plant it is inserted by a laborer. After it get started, the blades welded on the shaft starts rotating and removes the solid bio-digested slurry.

Testing

After completion of interval of three months, the digester stops producing biogas. Paddy straw mix with cow dung gets converted into solid bio-digested slurry. The screw press machine attached with electric motor was inserted in the digester. The performance of the machine, time taken and design was tested in the field of Punjab Agricultural University.

Results and Discussion

This section shows the results taken during the testing of machine. The major requirement of project is removal of solid bio-digested slurry from plant. This machine is tested in the digester.

The weight removed, time taken, by the machine is noted during the testing. The data taken is shown in table 1. The results for design and fabrication is also discussed in this section of screw press. The fabrication of machine is shown in figure during working in Figure 4.

Results for screw press machine tested in digester

The machine is tested and find feasible for solid slurry removal. The material removed by this machine according to its size is very appreciable. The machines are tested for 18 hours in three days and remove 780kg of weight. The machine is handled by a single person and it was found that the machine can easily be rotated in any direction. The data is noted after 15- 20 minutes according to measuring the weight.

Table.1

S.No.	Solid Bio-digested slurry removal in kilograms	Time Taken in Minutes
1	7kg	15 min
2	9kg	18 min
3	10kg	20 min
4	20kg	35 min
5	15kg	25 min
6	14kg	25 min
7	9kg	15 min
8	10kg	15 min
9	20 kg	35 min
10	12kg	20 min
11	10kg	18 min
12	14kg	22 min
13	12kg	20 min
14	14kg	20 min
15	17kg	28 min
16	12kg	18 min
17	11kg	18 min
18	10kg	16 min
19	9kg	14 min
20	12kg	15 min
21	11kg	15 min
22	10kg	13 min
23	9kg	15 min
24	8kg	12 min
25	7kg	10 min
26	6kg	10 min
27	7kg	10 min
28	11kg	20 min
29	12kg	18 min
30	11kg	20 min
31	14kg	20 min
32	17kg	28 min
33	12kg	18 min
34	11kg	18 min
35	10kg	16 min
36	9kg	14 min
37	12kg	15 min
38	11kg	15 min
39	10kg	13 min
40	9kg	15 min
41	8kg	12 min
42	7kg	10 min
43	6kg	10 min
44	7kg	10 min
45	11kg	20 min
46	12kg	18 min
47	11kg	20 min

Fig.1 Dimensions of Dry Fermentation Biogas Plant

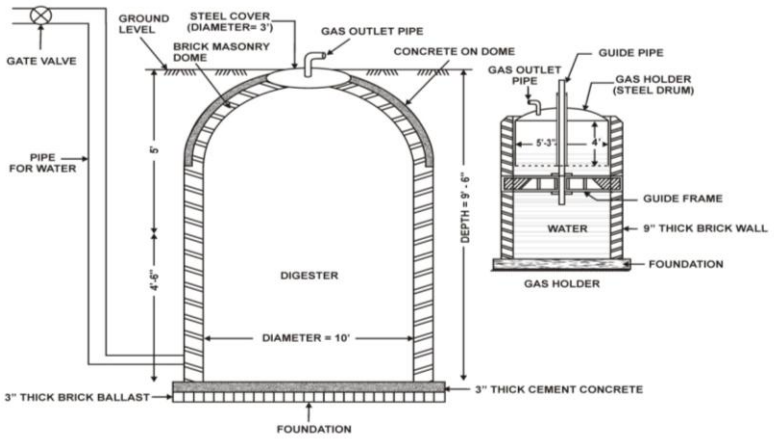

Fig.2 Design of screw press machine

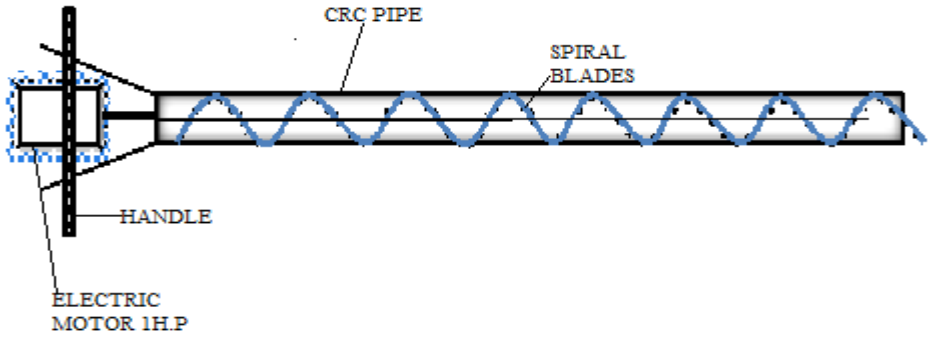

Fig.3 Screw press machine working in paddy straw digester

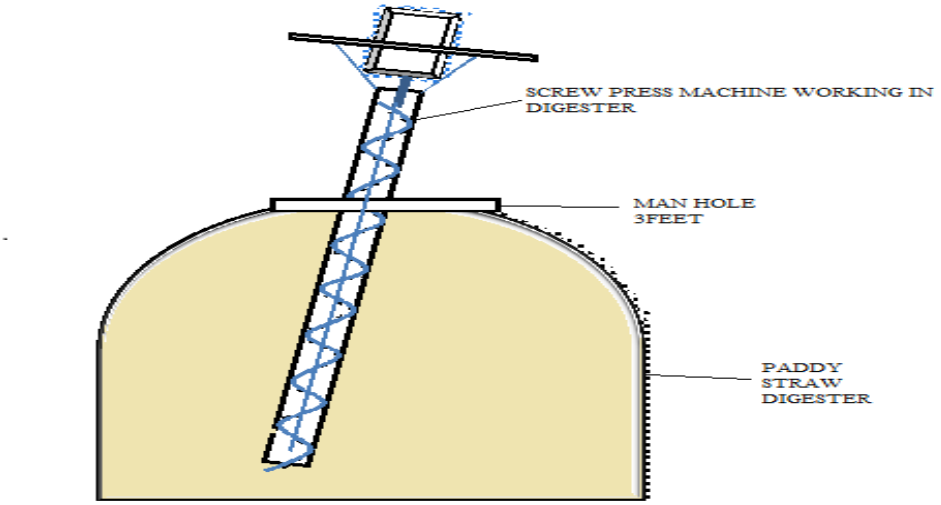

Fig.4 Screw press machine

Results for design of screw press machine

This machine removed the physical load of labor.
No chattering was observed during operating of machine.
The welding was firm and no breakage observed.
The electric motor is firmly fixed and bolted on the top and finds no shaking of chattering.
No accidental chances observed
CRC pipe and blades inside it worked smoothly, no wear and tear observed.
Easily transferrable due to its light weight.
After work, the electric motor can be used for other works.

Economics

The cost of the machine including labor cost is just Rs.14,000. The rate of electric motor is also included in this. The project is for domestic usage, so the requirement is also cheap. This is very cheap concept and affordable by consumer

In conclusion, a cheapest machine is the major requirement. The machine can easily handle by a person, which reduces the labor as well as physical load. The machine fulfills the demands of project and makes it feasible for domestic use.

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