Novel Design of Crusher and Digester for Generation of Electricity using Campus food waste

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Abstract— To extract the power from biogas available in Campus after design of crusher and digester plays important role for generation of electricity using waste food. As in the waste food waste is available in different sizes so that is necessary to crush into small particles that will be helpful for bacteria to consume organic matter efficiently. For designing of crusher some calculations are carried out. For digestion process fixed dome type digester is used. There are two methods of digestion process first is aerobic and anaerobic digestion. Anaerobic digestion is more efficient that aerobic. So that anaerobic digestion processes is used. In anaerobic digestion processes the digestion will be takes place in the absence of oxygen. Then this biogas produced is given to generator for electricity generation purpose. After that electricity produced is used in classroom and computer lab in college campus.

Keywords: Fixed Dome Type Digester, Crusher, Biogas Production, Digestate, Anaerobic Digestion, Electricity Generation

I. INTRODUCTION

India has population more than 1028 million and this is growing at an annual rate of 1.58% [1].As the fossil fuels reducing, India will face the energy shortage in future [1] for overcoming this problem the biogas plant is best option. In biogas plant food waste is used as fuel. This system is specially designed one [2]. For converting food waste in to gas anaerobic digestion is a biological process in which microorganisms decompose organic matter into CH_4, CO_2 [3]. Anaerobic digestion converts that food waste into digestate [3].This digestate used for improving quality of soil and produced biogas which have 60%CH4 and 40% CO2 which is considered as sustainable source of energy [3]. In many countries biogas is used for cooking. This gas also used like natural gas and used in power motor vehicles [2]. In our plant we can used this gas for generation of electricity using gas engine. For gas production we can use campus food waste, 10 Kg per day.

II. CRUSHER

The organic food waste is available in various sizes. Hence it is necessary to shredded in the crusher to form fine slurry. This fines lurry helps the bacteria to consume the organic matter efficiently and biogas production in shorter period. Apart from this the fine slurry of food waste is easier to digest as compared to the regular food waste particles.

We carried out the following steps in order to assess the biogas production from waste food [4]. The food waste is collected from college campus. Then this food waste is crushed into crusher. Also 1:1 proportion water is added with food waste for proper crushing purpose as well as maintaining pH of fine slurry.

A. Design of Crusher

1) Single Phase Induction Motor

Single phase induction motor has lower cost as compared to other motors. Also single phase induction motor requires very little maintenance. Single phase induction motor has longer life. So this type of motor is used in crusher.

Below Fig 1 shows the actual construction of crusher:-

Fig. 1: Crusher

2) Rating

- 1HP, 2880 rpm
- One stainless steel pot of 2 kg capacity. In stainless steel pot 4 blades of galvanized plating used.
- Height of crusher = 300mm
- Diameter of crusher =200mm

Food waste generated is crushed into crusher.

III. DIGESTER

Following procedure is carried in digester. In the absence of oxygen anaerobic digestion is a process in which microorganism breakdown biodegradable material. For energy production the methane biogas produced is suitable therefore anaerobic digestion process is considered as a renewable energy sources. The biogas is burned to produce heat and electricity.

This requires specific temperature & is done in between 14 to 40 days depending upon feedstock, number of organisms, temperature and pH value. There are many types of anaerobic digestion, but for food waste mesophilic (35^0C) is the most suitable. Thermophilic digestion allows for faster methane extraction.

Now we can see simple construction of digester. Here the food waste from crusher is feed in digester which is mesophillic and fixed dome and kept for 21 days under the temperature of 35C to 55C. Thenthe biogas is produced which contains 60% of methane, 35% of CO2 and 5% of water and hydrogen sulphide. This gas is supplied to IC engine. And the remaining from digester is given to digestate.

According to gas storage digester is classified into three types-

- Fixed Dome Type
- Floating drum Type
- Bag Type

Firstly we design floating drum type digester as shown in below Fig 2

Floating drum type digester requires water for floating and also manual steering is required. But fixed dome type digester is self-agitated by biogas pressure. The gas pressure of floating drum type digester is around 20 mbar but fixed drum type digester produces gas pressure between 60 and 120 mbar. Also the methane emission of fixed dome type digester is high as compared to floating drum type digester. Hence fixed drum type digester is better as compared to floating drum type digester.

Fig. 2: Floating drum type digester

Below Fig 3 shows the demo model of fixed dome type digester. Compare to floating type and bag type digester fixed dome digester is economical, construction of this type digester is simple. There are no metal parts due to this there is no any rusting problem [5].

Fig. 3: Fixed dome type digester with gas collector

A. Calculation for biogas production-

- 1 kg of kitchen waste produces 0.1 m^3 biogas according to experiment gas production 0.1*10 kg = 1m^3
- Active slurry volume
- V_S = HRT *2* food waste/1000

=21*2*10/1000

=0.42 m^3 [6]

- Capacity of digester 500 liter

D=2.84 m

H=0.0663 m

IV. GENERATION

Biogas which is produced in digester is given to the IC engine generator set. IC engine burn this biogas and produces mechanical output and this mechanical output is given to generator. Generator converts this mechanical energy obtained from IC engine into electrical energy. According to above biogas production rate generation calculations are as follows-

- 1kg of food waste produces 0.1m^3 gas. For 10kg biogas production rate 10*0.1 = 1m^3

1m3*19 = 19 MJ

- MJ to KW conversion = 19/3.6 = 5.277 KW Considering 65% losses = 5.277* (35/100)
- Generation of electricity from 10 kg food waste per day =1.846 KW

V. MATERIAL

Different material with improved protection and lower cost introduced in market in recent years. Different construction material polyvinyl chloride (PVC), polyhylene (Pe) has been used for digester [3].

VI. CONCLUSION

We concluded that it is possible to generate electricity from waste food. We generate 1.846kw electricity from 10 kg food waste per day. In this processes fixed dome type digester is use because it is more efficient than floating drum type digester. So this plant satisfies the India's growing demand.

REFERENCES

[1] Ashwani kumar; Naresh Kaushik', Kapil Kumar' "Renewable energy in India: current status and future potentials"

[2] M.A.othuman Mydin',N.F.Nik Abllah," Development of environmental friendly minibiogas to generate electricity by means of food waste"

[3] Charbel Abou Khalil, Lucien Ibrahim, Elsy Ibrahim, "Clean energy Generation through psychrphillic Anaerobic Digestion of Food and Landspace Wastes"

[4] "Techno-Economic Evalution of biogas production from food waste for electricity generation", Regina Kulugomba', Sohataya Thongsan and Sarayooth Vivudth

[5] "Biogas digesters in India: Review", Jyoti C-K Mishra

[6] "Design of biodigester for biogas production", A Review Robert Huberts

