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Bio-CNG production potential from locally available biomass

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ABSTRACT

Today Mumbai is facing problem of waste accumulation in different areas and limitation of waste disposal sites. These wastes are dumped in the form of big heaps. The degradation of these waste starts after few days. The process of degradation is aerobic at outer layer and anaerobic at inner layers. Due to these reactions, putresible gases are come out and causes a health hazard. The Bio-CNG plant gives the best solution for this problem. It uses the vegetable waste as raw material and converts it into a high calorific value fuel. Hence it minimizes the waste accumulation and also solves the problem of energy crisis at the same time. In this study 6kg waste is digested under controlled environment condition n a mesophilic temperature range (30°C-45°C) for 26 days to obtain Biogas. The Biogas so obtained contains CH_4, CO_2, H_2S, and Moisture content. The presence of CO_2, H_2S, and Moisture content in Biogas is considered as impurities as it reduces the calorific value of fuel and hence removed using three scrubber units to obtain the composition of natural gas.These three scrubber units contained Sodalime, Silicagel, and Tri-ethelene glycol to remove CO_2, H_2S and moisture content respectively. The Bio-CNG obtained above contains more than 85% of CH_4 which has high calorific fuel value. These Bio-CNG can be used as automobile fuel, for cooking as well as for power generation. It can also consider as alternative fuel option against the limited stock of conventional fuels like coal, petroleum etc in future.

Keywords: *Biogas, Bio-CNG, Scrubbers, Mesophilic Temperature, CO_2, H_2S.*

1. INTRODUCTION

Bio-CNG is a compressed gas which is produced by purification of bio gas. This bio gas is produced by biomass digested in a digestor. Bio-gas has several impurities so it cannot be used for other application except cooking. So in bio-cng plant gas purification units are assembled to remove unwanted gases from bio-gas. Biogas contains CO_2, H_2S, and moisture as a major impurity. These gases when present in considerable amount can cause corrosion. They can also reduce calorific value of Biomass resources such as cattle dung, agriculture wastes, and other organic wastes have been one of the main energy sources for the mankind since the dawn of civilization. There is a vast scope to convert these energy sources into biogas. Biogas production is a clean low carbon technology for efficient management and conversion of fermentable organic wastes into clean cheap & versatile fuel and bio/organic manure. It has the potential for leveraging sustainable livelihood development as well as tackling local and global land, air and water pollution. Biogas obtained by anaerobic digestion of cattle dung and other loose & leafy organic matters/ biomass wastes can be used as an energy source for various applications namely, cooking, heating, space cooling/ refrigeration, electricity generation and gaseous fuel for the vehicular application.

2. MATERIAL AND METHOD

Methodology

Bio-CNG plant consists of the following unit:-
1) Biogas Digestor
2) Scrubber unit for CO2 and H2S
3) Dehydration unit
4) Collection unit

Biogas digestor unit

Bio-CNG unit specification depends on composition depend on the composition of Biogas. Initially, 6kg of bio mass has digested. The digestor is made of thermoplastic material. At the left side of the digester, a perforated column is fitted .the size of perforation is 6mm and the capacity of digestor is 6.5KG. A 1Psi pressure gauge is fitted along with a two-way brass nozzle. This gauge is used to measure the pressure inside the digestor and when pressure increase from 1psi, gas released. One stirrer is fitted at the bottom for mixing of biomass.it is made of steel.

Fig 1.1 Biogas Digestor Unit

Fig 1.2 CO2 Scrubber unit

Fig 1.3 H2S Scrubber unit

Fig 1.4 Dehydration unit

Scrubber Unit

It consists of two scrubbers:
a) CO_2 scrubber
b) H_2S scrubber

a) CO_2 Scrubber:

It is a cylindrical container of 1litre capacity. This scrubber unit is made of polymer and packed with the packed bed made of sodalime pallets and perforated steel scrubber. Steel scrubber packed at top and bottom is made of steel and have some fine perforation. Sodalime pallet used here is of pink colour and can changed colour after saturation with CO2 and turns white. Two nozzles of brass are used at inlet and outlet. At inlet, this scrubber is connected to bio gas digestor and outlet it is connected to H2S scrubber using rubber pipe.

b) H_2S Scrubber:-

It is a cylindrical container of 1litre capacity made of polymer. This scrubber unit is packed with single media bed made of silica gel granules. Silica gel is white granules used for H2S removal. It has also dehydration property so it can remove moisture present in the biogas. Two nozzles of brass are used at inlet and outlet. At inlet, it is connected to CO2 scrubber and at outlet, it is connected to dehydration unit.

Dehydration unit

It is a cylindrical container of 1litre capacity made of polymer. This dehydration unit is packed with perforated iron ring submerged in Tri ethylene glycol. This unit is set to remove moisture from biogas. Two nozzles of brass are used at inlet and outlet. At inlet, this unit is connected to H2S scrubber and at outlet, it is connected to CNG collector bag using rubber pipes.

3. RESULT AND DISCUSSION

Table 1.1 composition of biogas on digestor

Gases	% Amount
CH4	58
CO2	37
H2S	100ppm
Moisture Content	3

Table 1.2 composition on the co2 scrubber

Gases	% Amount
CH4	63.28
CO2	18
H2S	78ppm
Moisture Content	2.99

Table 1.3 composition on the H2S scrubber

Gases	% Amount
CH4	81.45
CO2	16
H2S	42
Moisture content	1.41

Table 1.4 Composition of Bio-CNG

Gases	% Amount
CH4	88.96
CO2	10.6
H2S	42`
Moisture Content	0.98

Discussion of Result obtained on Bio-digestor unit:-

Methane digestor used in this process is contained with a perforated column which is welded at the top. So there is no leakage at the digestor outlet. But temperature and PH are not that much in control so there is less percentage of methane obtained**.**

Result obtained on CO_2 Scrubber unit:-

As CO_2 scrubber, packed with sodalime pallets and perforated kitchen steel scrubber, CO2 can be removed satisfactorily but some nozzles. Methane composition is slightly less due to the absence of nitrate removing unit. Some H2S is also removed in this unit. Some losses occur due unprofessional gas packing at outlet

Result obtained after passing from H2S Scrubber:-

Silica gel scrubber is used for H2S removal. Silica gel has also dehydrating properties. Which can remove moisture from biogas. But unprofessional packing and changing climatic condition leads to some less methane obtained after this scrubber.

Result obtained after passing from Dehydration unit:-

As a moderately dry biomass is used for the process. So water content is lower than normal. Ethelene glycol unit is used for removal of water. As due point is not located properly and some leakage at the outlet valve occure so methane % obtained is less from the expectation. Some CO2 may take part in hydrolysis reaction and get reduced.

4. CONCLUSION

- To implement this bio-cng plant can provide a good option. This plant consist of four basic units. These units produce biogas and at the same time, it purifies it and then collected in CNG cylinders.
- The first unit of this bio-cng plant consists of bio-gas plant which digests the composite biomass into bio-gas under anaerobic condition. The bio-gas produced in the digestor consist of mehane, CO_2, H2S & moisture. The presence of CO2, H2S, and moisture cause the low calorific value of biogas fuel. They also cause corrosion to pipe fittings used in the process of energy generation.
- To remove these impurity from bio-gas and increase calorific value of bio-fuel a purification unit is installed. This unit consist of two scrubber unit for CO2 & H2S removal and one dehydration unit for moisture removal.
- The two scrubber unit consists of packed bed and steel scrubbers at top and bottom. The first scrubber unit is packed with sodalime pallets and steel scrubbers at the top and the bottom. This unit is used for CO2 removal from bio-gas. The second scrubber unit consist of silica jel granuals and steel scrubbers at the top and the bottom. This unit removes H2S from bio-gas.
- The dehydration unit consist of a absorbent packed between fine mesh steel scrubber. The absorbent used here is tri ethelene glycol. This unit removes moisture` from bio-gas.
- After passing through these purification unit biogas composition mainly consist of methane which has high calorific value as a fuel.

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