PRODUCTION OF BIOGAS FROM COW DUNG AND DETERMINATION OF CALORIFIC VALUE

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Abstract - *In the present scenario of dwindling petroleum resources and global warming, exploring other avenues for eco-friendly fuels became essential. Biogas which is a clean and environmental friendly fuel emerged as one of the potential alternative fuels. Raw biogas contains about 60-70% methane (CH4), 30-40% carbon dioxide (CO2), traces of hydrogen sulphide (H2S) and fractions of water vapours. But its wide spread use is hampered by the associated problems like low energy density due to the presence of impurities, generation at low pressures and the absence of means for storing and transporting. In this context this work intends to design and establish a facility at the site of biogas production in the campus for purifying, compressing, bottling and making it transportable. To remove this impurities steel wool, water and silica gel was used. The steel wool is to react with the hydrogen sulphide, the water is to reduce the percentage of carbon dioxide and the silica gel is to reduce the presence of water vapour in the purified biogas. in order to evaluate the impact of biogas purification on heating value, purified and raw biogas was used to heat 15^{o}c rise of water and took 2.26 and 2.5 minutes respectively.*

Key Words: **gas production, purification, increase calorific value.**

1. INTRODUCTION

Biogas is generated when bacteria degrade biological material in the absence of oxygen; in a process known as anaerobic digestion. Since biogas is a mixture of methane (CH4), carbon dioxide (CO2), hydrogen sulphide and traces of water vapour. It is a renewable fuel produced from waste treatment. Biogas is a gas produced from organic materials Such as animal manure, human excreta, kitchen remains, crops straws and leaves after decomposition and fermentation under air tight (no oxygen) condition. Main products of the anaerobic digestion are biogas and slurry. After extraction of biogas (energy), the slurry comes out of the digester as a by-product of the anaerobic digestion system. The main constituents of biogas are the CH4 and CO2 gas. The biogas burns very well when the CH4 content is more than 50% and therefore biogas can be used as a substitute for kerosene, charcoal and fire wood for cooking and lighting. This saves time and money and above all it conserves the natural resources from cutting trees to get firewood.

Substances	Symbol	Percentage
Methane	CH_4	50-70%
Carbon dioxide	CO_2	30-40%
Hydrogen	H_2	5-10%
Nitrogen	N_2	1-2%
Water vapour	H_2O	0.3%
Hydrogen sulphide	H_2S	traces

Table.1 Composition of biogas

In the above table, we can see that the combustible components of biogas are CH4 and H2. Other gases are useless, toxic or harmful and have no energy contribution in biogas. Also, among these two gases only CH4 is present in a significant amount and hence, is considered in most cases involving biogas. Production of biogas could be a continuous process. The utilization of biogas as an efficient energy source depends strongly on its methane concentration. Therefore, biogas purification is essential in order to have more energy per unit volume of compressed biogas and to get rid of the corrosive effect of H2S. This can be done by compressing the gas into the cylinders, which is possible only after removing carbon dioxide (CO2), hydrogen sulfide (H2S) and water vapor. Biogas purification increases the concentration of methane in biogas, in order to have fuel of higher calorific value. This can be achieved by decreasing the concentration of carbon dioxide. Elimination of carbon dioxide from the biogas helps to increase its calorific value as well as to eliminate the greenhouse gas.

MATERIALS AND METHODS

The procedures followed in this experiment involves: Designing and establishing of biogas purification, and Executing test, namely – to test the calorific value of biogas(using Junkers gas calorimeter)before purification and after purification, water boiling test

2. Production of biogas

2.1 Raw materials

The wastes used in the study were cow dung. The cow dung collected from the cattle forming. This design was to combined feedstock with high caloric content and anaerobic microbes. The fresh cow dung was mixed with water thoroughly by hand. The cow dung served also as inoculum's as it contended required microorganisms for anaerobic digestion. The waste samples were weighed and poured into digester based on the experimental design after the digester was kept for that day and gas production was checked the next day.

2.2 Experimental procedures

In the study biogas production was done in batch system, in which the slurry was added once in the digester for the whole duration of the process. In the experiment 20 kg of cow dung is used for decomposition (15 to 20 days) and after daily we augmented 500 grams of cow dung with slurry for external source. The digester was provided with suitable arrangements for feeding, gas collection and draining residues. The slurry was allowed to ferment anaerobically for 15 to 20 days under mesophilic temperature of 26 – 35^{0}c.

2.3 Digester description

A biogas chamber of 20kgs slurry capacity was constructed and used for this experiment. The biogas digester was built to maintain the anaerobic condition. The inlet pipe is inserted into digester at ¾ level. The outlet is placed at the ¼ level from the top of digester as like as manometer head.

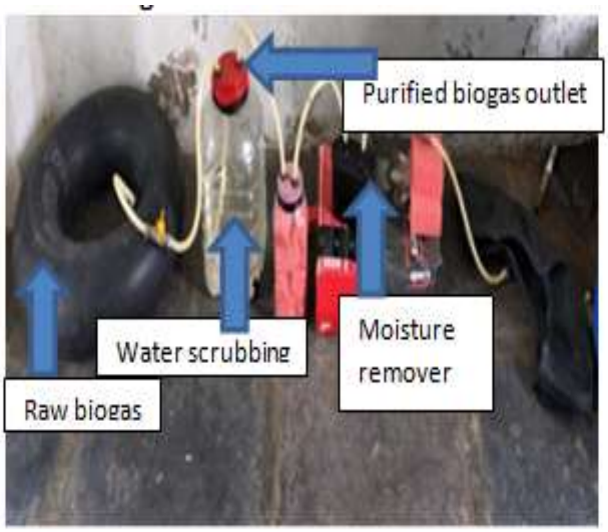
Fig .1 gas production plant

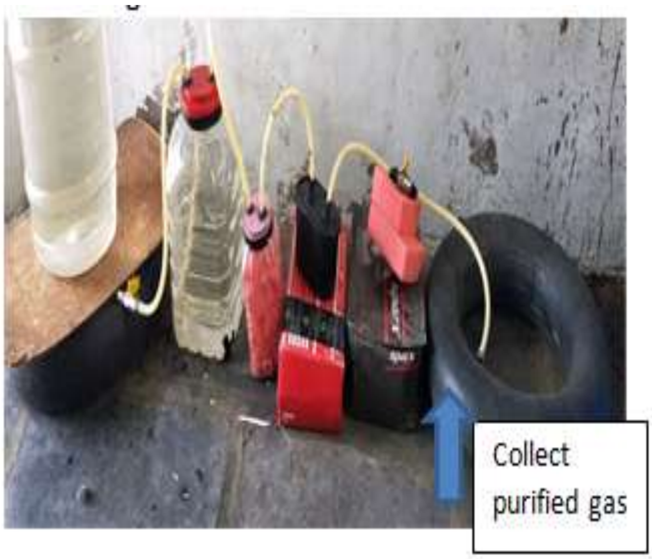
3. BIOGAS PURIFICATION

The biogas scrubbing system consists of three units, the hydrogen sulphide (H_2S) removing unit, Carbon dioxide (CO_2) removing unit, and moisture trapping unit. The three units are interconnected with plastic hoses. In the purification process of biogas which was conducted; steel wool, pure water and an adsorbent material (silica gel) were used. The steel wool is to react with the hydrogen sulphide, the water is to reduce the percentage of carbon dioxide and the silica gel is to reduce the presence of water vapor in the purified biogas. The experiment was done by taking the raw biogas with pressure builds up in the digester head and forced through the steel wool on its way to the biogas scrubber unit to remove hydrogen sulphide. After the hydrogen sulphide was removed by the steel wool, the raw biogas passes into the water scrubbing unit for further purification. When carbon dioxide dissolved in water carbonic acid (H2CO3) is formed. It is a weak acid.

$H_2O + CO_2 \rightarrow H_2CO_3$

Fig.2 BEFORE PURIFICATION Fig.3 AFTER PURIFICATION





Liquid leaving the scrubbing unit will thus contain increased concentration of carbon dioxide, while the gas leaving the scrubbing unit will have an increased concentration of methane. The purified biogas that was collected at the top of the scrubber unit has some water vapors. Water vapor is the leading corrosion risk factor. To reach water contents as low as in the purified biogas, silica gel was used in this experimental set up. Silica gel is a material that has a capability of absorbing moisture.

4. TO TEST THE CALORIFIC VALUE OF BIO GAS BY USING JUNKERS GAS CALORIMETER

4.1 OPERATION

This Gas Calorimeter works on the Junker's principle of burning of a known volume of gas and imparting the heat with maximum efficiency to steadily flowing water and finding out of the rise in temperature of a measured volume of water. The formula, **Calorific Value of Gas X Volume of Gas = Volume of water X Rise in Temperature**, is then used to determine the Calorific Value of the Gas (assuming that heat capacity of water is unity).

4.2 EQUIPMENT

This equipment consists of the Calorimeter with Powder Coated Stainless Steel exterior with burner (with choice of two nozzles) on a tripod stand, a Gas Flow Meter) and a pressure governor. Requisite tubing & measuring jars as well as thermometers (0.1oC graduation) for reading inlet & outlet water temperatures are also provided along with a detailed instruction manual.

Fig.4 junkers gas calorimeter

4.3 CALORIMETER

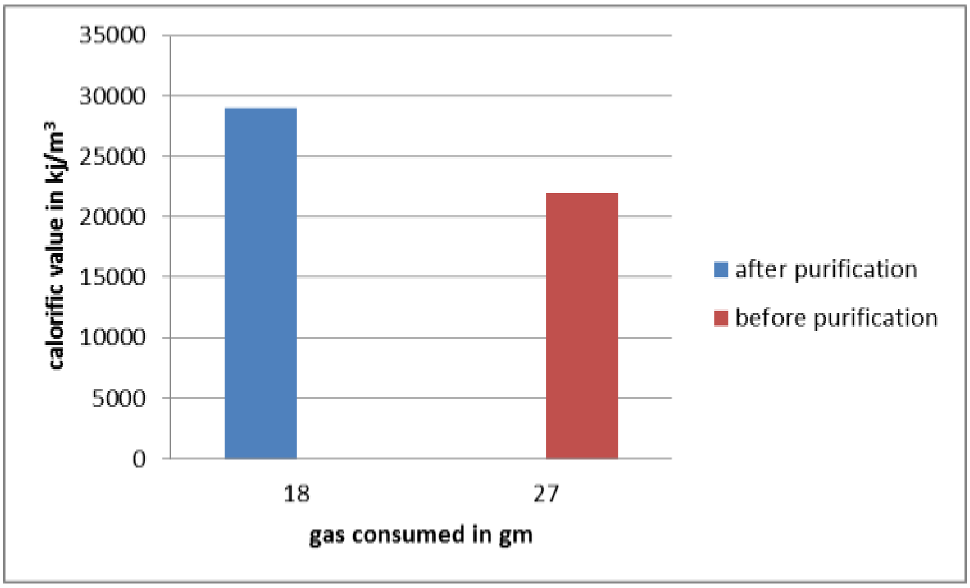
This Calorimeter covers a wide range between 120 BTU (1000 to 26000 K Cal/m3). The Calorimeter is fixed on a tripod stand having leveling screws to keep the Calorimeter in perfectly vertical position. The Calorimeter mainly consists of a gas combustion chamber, heat Exchanger and water flow system. Heat exchanger is designed for maximum efficiency of heat transfer and is fabricated out of heavily tinned copper sheet. A constant water head maintenance device provided in the feed water pipe along with the inlet water flow regulator is fixed to the outer housing of the Calorimeter. The outer housing is of powder coated stainless steel. This constant water level attachment has an over flow device through which excess water drains out. Water from this constant head device enters the bottom of the heat exchanger through inlet water flow regulator and raised along the annular space, comes up to the filtering position at the top and gets collected at the swinging funnel attachment.

4.4 Following results were obtained when a biogas was tested in a Junkers gas calorimeter:-

S.NO	PARAMETERS	WITH MOISTURE	WITH OUT MOISTURE
1	Volume of gas used in **kg**	0.027	0.018
2	Raise in temperature in ^{0}c	15	15
3	Mass of water heated in **kg**	3.45	2.95
4	Time taken in sec	150	136
5	Specific heat of water in **kj/kg**	4.18	4.18
6	Calorific value in **kj/m^3**	20799	28423
7	In terms of **kwh/m^3**	5.77	7.895

Table.2 comparison of values with and without moisture

5. Results and discussion



As we observed that after the purification of biogas the calorific value was increased at high level.in before purification of gas to heat the water rise in temperature at 15^0c in that the time taken in 150sec and 0.027kg of gas is used. At the same way after purification of gas to heat the water rise in same temperature in that the time taken in 136sec and 0.018kg of gas is used. The calorific value is 20799kj/m^3 and 28423kj/m^3 before and after purification respectively.

5.1 Effect of purification on heating value

In order to clarify the impact of purification on the heating value and cooking time of the purified biogas, purified and raw biogas were used to heat 15^0c rise in temperature. Due to unavailability of gas analyzer, calorific value of raw biogas and purified biogas were compared by heating 15^0c rise in temperature of water.

Energy source	Time(min) for 15^0c rise in temperature
Raw biogas	2.5
Purified biogas	2.26

Table.3 time for increase 15^0c rise in water temperature

The reduced heating time required by the purified biogas means the calorific heating value of the purified biogas was more than that of raw biogas. This is because only methane contributes to the combustion property where as the other mixture is useless, toxic or harmful. Therefore it is very necessary to remove CO2 from raw biogas in order to increase its calorific value.

6. Conclusions

- The study investigated biogas production of animal dung using locally made anaerobic digester.
- With the increasing demand of energy, biogas demand also increases. In future biogas replace the fossil fuels as a source of energy.
- Traces of impurities are present in biogas. Removal of these impurities (such as water vapour, CO_2 and H_2S) is essential prior to using as fuel for various applications. We have established the setup required for the purification.
- It is proved that the concentration of calorific value available in the purified biogas was higher than that of raw biogas. The approximate calorific value for **purified** and **raw biogas** was **20799kj/m^3** and **28423kj/m^3** respectively.
- Based on the results purification of biogas is essential to use as a fuel in engines and generate electricity etc.., it increases the calorific value of biogas by reducing the moisture, CO_2 and H_2S.

7. Recommendations

- Biogas is no more just the renewable energy source of rural population but it is also an abundant and appropriate source of energy for urban population, having potential to replace fossil Fuel. Hence research and proper interest must be given towards advanced use of biogas.
- Purification must be carried out at higher calorific value to prove it as an appropriate alternative source of energy.

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9. References

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