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Bio Gas Production from Municipal Solid Waste

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ABSTRACT

Wherever there is human habituation, municipal solid waste is produced, which consist mainly of household food waste, agricultural waste, human and animal waste. For each year the amount of produced municipal solid waste is increasing dramatically. Breakdown of organic materials in the absence of oxygen produces methane. The process is known as anaerobic digestion and performed through the biological activity of microorganisms. The rest product contains also a high amount of nutrients that can be used as a natural fertilizer. The objective of this experiment is potential of biogas (methane) production from municipal solid waste. The digester operated used in this experiment is plastic barrel; the experiment was performed with mixtures of cafeteria waste. The mixture with different combination of fava bean, bread, vegetables, fruits, fishes and meat wastes was an-aerobically digested in reactors. The results of this experiment indicate that there is potential of bio-gas production from the municipal solid waste.
Keywords: Bio gas, Anaerobic Digestion, AD, Digester.

I. INTRODUCTION

Municipal Solid wastes are solid or semi-solid materials produced by various activities of the society, which have lost their value to the first user or useless or unwanted materials. Which originate from household, commercial, industrial activities .Improper disposal of solid wastes pollutes all the vital components of the living environment (i.e., air, land and water) at local and global levels.

There has been a significant increase in municipal solid waste (MSW) generation in Sudan in the last years. This is largely because of rise in population, rapid urbanization, industrialization and changes in life style across the country led to massive increase in waste. In most cities and towns in Sudan, urban waste is disposed of in an unregulated and unscientific manner in open dumps on the outskirt area.

Energy recovery from MSW is already contributing to reducing global and local pollution of environment. Energy recovery from MSW can reduce emissions of greenhouse gas and other gaseous that causes both local and global effects, has a great potential for assisting in meeting the Kyoto obligations, and can significantly contribute to sustainable development.

II. METHODS AND MATERIAL

Experimental work

The digester was a Plastic barrel, with a capacity of 128 litres and it was selected because its large entrance which make entering cafeteria waste in digester more easy, and its big surface cover can be used to fix both suction valve and pressure gauge, suction valve would be used to pull air from inside the digester and directed the bio gas out for burning without opening the digester, and a pressure gauge to measure the the biogas pressure inside the digester, to install the suction valve and a pressure gauge two holes had been punctured on the surface of cover with diameter equal to outer diameter of pressure gauge pipe and suction valve, each pipe contain screw and two nuts, which installed in the suction valve and a pressure gauge on the surface cover and tow piece of rubbers, the first putted between the upper nut and cover surface and the other one between the cover surface and lower nut, all nuts fixed in pipe screw tightly, for both suction valve and pressure gauge , and then the

total surface of upper nut and rubber had been painted with silicon to prevent biogas leakage. The barrel base has circular shape and circular dimensions change with height, it reaches its maximum circular diameter at height of 55 cm from the base of barrel which is 80 cm in height.
the configuration of the batch experiment is shown in Fig. 1.

The material of the digester is plastic because it does not affected with acidic materials, which produced from an aerobic digestion process of organic matter by bacteria, because the acid materials leads to an increase in pH, and this acidic is a bacteria waste, in this experiment there is no daily add organic material to overcome these acidic substances produced from the fermentation process.

The digester closed tightly to sure that there is no leakage in the digester normal air compressor used to pump an air in the digester but un fortunately there was a leakage at the clearance between the cover and the end of the barrel, and to fix this leakage iron frame had been made which was as square at the base and set of four iron metal had been welded with the base square and punctured the end of these metal 8 mm and also a upper square punctured also in four different places fit with the four metal until they are installed four metals and upper square with screws and nuts. The barrel had been putted in that a cage, but this did not prevent the leakage, the problem leakage led to change the digester to another one which can prevent the leakage.

The new digester is also plastic cylindrical barrel, with a diameter 40 cm and the height of the cylindrical part is 70 cm, has half cubic based at diameter of the top circular to a height of 20 cm and the entrance of barrel in the slope of the cube and the other half is flat surface. And this barrel has a small entrance, which can be useful in preventing leakage, and this entrance had screw, and there are four small holes in this barrel in upper half of the cube and another hole around 4 cm diameter found in the bottom also long slit in the near the entrance, and the first problem in this barrel was no cover, but another cover had been used to covered the barrel and this cover wrap with thin tape to close the barrel tightly.

The Holes in the upper half-cubic closed by screws with nuts and pieces of rubber. and the hole in the bottom closed by a piece of Teflon, then all holes painted with silicon to make sure there is no leakage from the digester, also slit exists near the entrance bridge had been painted with silicon. Two holes had been punctured in the upper flat surface each had diameter half an inch to fix the intake valve and a pressure gauge on these holes. Piece of rubber had been putted between upper surface and upper nut and other piece of rubber between lower surface and lower nut then the nuts fix tightly in the screw then covered all the surface of the upper nut and the rubber with silicon to prevent leakage.
From defects of this barrel that transparent, this does not help in the process of the heat absorbing from outside environment.

Then cafeteria waste had been brought in cartons, which is an eating and juice waste, and the substrate was shredded it into smaller pieces and homogenized, after that mixed together in order to prevent reactor clogging.

Mass waste had been measured five kg separately with blocks equipment so the total mass waste within the digester became 50 kg, then the waste inside the Digester mixed carefully. And digester closed tightly and the clearance between the barrel and cover painted with silicon to prevent the leakage. Then by using the vacuum gauge the air pulled out from inside the digester to generate negative pressure which was 8 below zero so that the volume inside the digester became free of air and be in an aerobic condition. Then the digester put in an open area where direct sunlight and wind movement were available that transfer heat from the surrounding environment to the digester.

Anaerobic Digestion Experimental Set-up

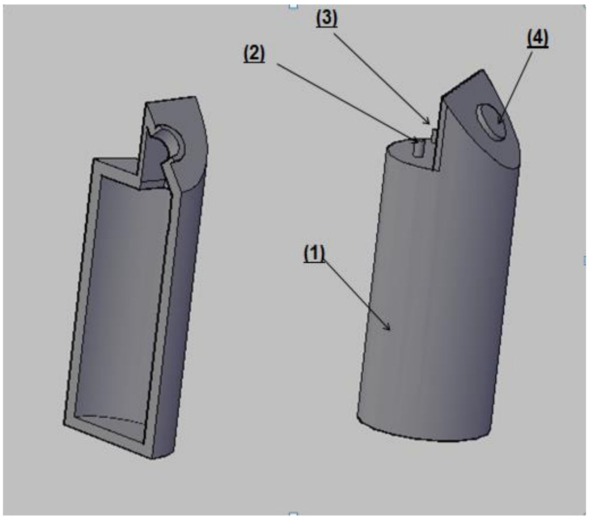

Fig. 1

(1) Digester.
(2) Suction valve.
(3) Indicator pressure gauge.
(4) Inlet and outlet of municipal solid waste (MSW).

III. RESULTS AND DISCUSSION

Because of there is no required equipment which is able to measure the pressure inside the digester daily where the pressure change is a small relative to the large volume that contains bio-gas, which is 60 liters, as the pressure gauges available in the market with a large range as five-bar as minimum range and higher than that, either the experiment need to measure pressure range is a small for example one bar and the highest two-bar, so pressure inside the digester could not be measure.

By assuming that the biogas is an ideal gas. The daily volume of the biogas can be known, and so by measuring the pressure in the head space of digester, the ambient temperature, the temperature of the digester and total volume which contains biogas and then converting to volume by application of the ideal gas law Daily pressure differences were converted into biogas volume as:

$V_{biogas} = (P_2 - P_1) \,.\, T_a .\, V_r / (P_a \,.\, T_r)$

Where:
V_{biogas} = volume of daily biogas production (mL)
P_1 = post-release headspace pressure of the previous day (kPa)
P_2 = headspace pressure before biogas release (kPa)
P_a = ambient pressure (kPa)
T_a = ambient temperature (K)
T_r = temperature of the digester (K)
V_r = head space volume (mL).

By knowing the volume of the biogas which produced in digester and the density of the gas which is equal to 1.2 kilograms per cubic meter so the daily amount of biogas well be known, and it is equal to the product of the volume and density of the biogas.

And because there is no a bio-gas analysis instrument, which can determine the proportion of net methane gas in the biogas produced in the digester because there are other gases produce from an aerobic digestion such as carbon dioxide and sulphur dioxide.

On the fifth day of starting the fermentation process the suction valve opened for burning the gas produced and make sure there is biogas generated inside the digester or not, but did not happen burning and that due to the pressure inside the digester not be above atmospheric pressure to push the biogas out of the digester, and on the seventeenth day of the fermentation process the digester opened again and at this time burning happened for 90 seconds which shows that there is a biogas generated inside the digester, but the quantity and quality of biogas yield and pure methane could not be determined.

IV. CONCLUSION

Biogas digester which made from plastic is used for biogas production because it is less prone to corrosion, light in weight. But it is drawback to the solar radiation. In this experiment it has been observed that is able to produce renewable energy (biogas) from municipal solid waste in Sudan because in Sudan the temperature is above 25°C around the year. When the Percentage Total Solids (PTS) of cafeteria waste in an anaerobic digestion process increases, there is a corresponding geometric increase for biogas produced. Must be sure there is no leakage in the digester; because it is biggest problem facing the experiment. Generating extensive data tables of biogas yield and system stabilization periods for various feedstock materials used individually and in mixtures. And more powerful pretreatment to release the maximum amount of biogas. Determine the minimum retention time requirements in the digester for different types of wastes. Use another type of digester be more durable, less prone to corrosion and more heat absorbing capacity.