Enhancement of Efficiency of Biogas Digester in Cold Season

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***Abstract:-*To provide biogas energy for cold cities is become essential thing worldwide. This study analyses the viable and potent method of biomethanation. Reduced production of bio methane, on account of high temperature in cold climates cities (Jammu & Kashmir and north Indian cities) is a major problem which is replaced by changing of material (stainless steel) of feed stock passage amalgamated with solar heating.**

Keywords:-*Thermophilic, anaerobic digestion, psychrophilic, biomethanation, Mesophilic, retention time*

I. INTRODUCTION

Biomass is organic material like manure, sugar cane, dead plants, human waste etc. It is considered as a best renewable energy source. Biogas is a mixture of different gasses primarily methane (CH_4), carbon di oxide (CO_2), small amount of hydrogen sulfide (H_2S) etc. It can be acquired from organic materials like manure, sugar cane, wood, chips, dead plants, leaves. It is a renewable energy source.

The role of bio methane is becoming essential in the development of India. Biomethanation is an activity in which organic matter converts into methane by anaerobic digestion. This type of digestion is completed in the lack of oxygen and in it organic matter is decomposed. It is conducted in a closed space under controlled conditions of temperature, pH etc. The result comes in the formation of methane and carbon di oxide gas.

This biomethanation process occurs in a system which is known as digester. It is usually at 35^{o}C. This process takes about 19-20 days. The retention time depends on the temperature. If the temperature is higher than the retention time is lower. If we talk about north India like Jammu& Kashmir, retention time is higher than south Indian cities because of lower temperature conditions. So it is a major problem in cold countries, cities and tropical cities to operate the anaerobic digesters, consequently biomethanation process is reduced.

This paper analyses the formation of biogas in the cities which have long winter season like Jammu &Kashmir. This paper also deals with increasing the capacity of bio methane production during cold season by replacing of material of passage.

Usually anaerobic digester bags are constructed to operate under two conditions. It may be thermophilic (44-60^{o}C) or mesophilic (21-45^{o}C) condition. Anaerobic digestion has not been explored at psychrophilic temperature (<20^{o}C).

The main purpose of this research paper is to increase the efficiency of biogas digester in cold climate season and the second objective is to increase the temperature by changing the material of feed passage.

II. TEMPERATURE VARIATIONS AT DIFFERENT PARTS OF INDIA

Data has been estimated according to the temperature [2]. If we differentiate between Jammu & Kashmir and Tamilnadu, we can easily find that the gas production percentage is higher in summer than winter season in both states. In Jammu&Kashmir digester temperature remains in mesophilic ranges for seven months and other five months remains in the psychrophilic condition. As a result, it leads to reduce the bio methane production by 24-27% [1].

Table 1: Temperature Variation for Jammu & Kashmir

Months	Maximum(°C)	Minimum(°C)
January	28.8	20.4
February	30.7	21.6
March	33.2	23.5
April	35.6	26.2
may	38.0	27.7
June	37.4	27.4
July	35.3	26.0
August	34.5	25.6
September	34.0	25.3
October	31.9	24.4
November	29.5	22.7
December	28.4	21.5

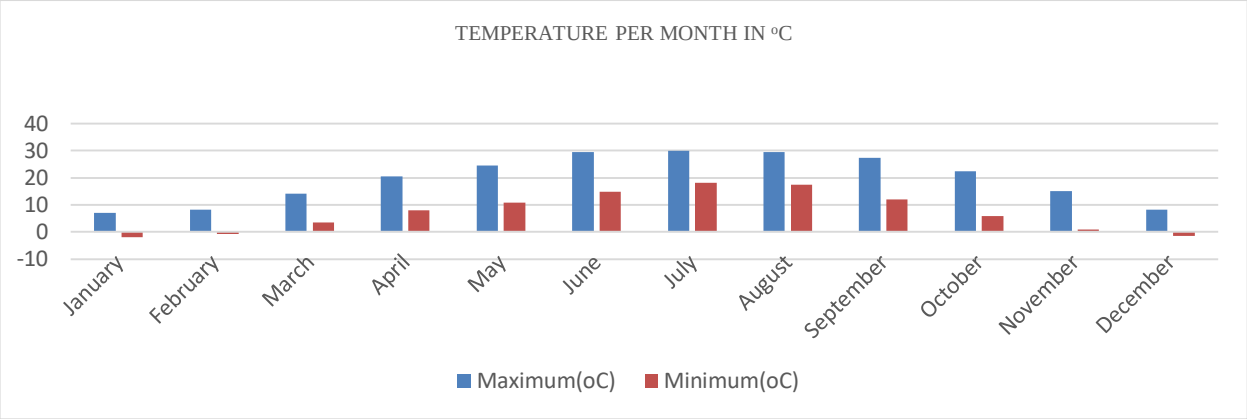


Figure 1: Maximum and Minimum Temperature in Jammu & Kashmir

Months	Maximum(°C)	Minimum(°C)
January	7.1	-2.1
February	8.3	-0.8
March	14.2	3.5
April	20.4	7.8
May	24.6	10.7
June	29.5	14.7
July	30.2	18.2
August	29.7	17.6
September	27.3	12.2
October	22.3	5.9
November	15.2	1.0
December	8.1	-1.4

Table 2: Temperature Variation forTamilnadu

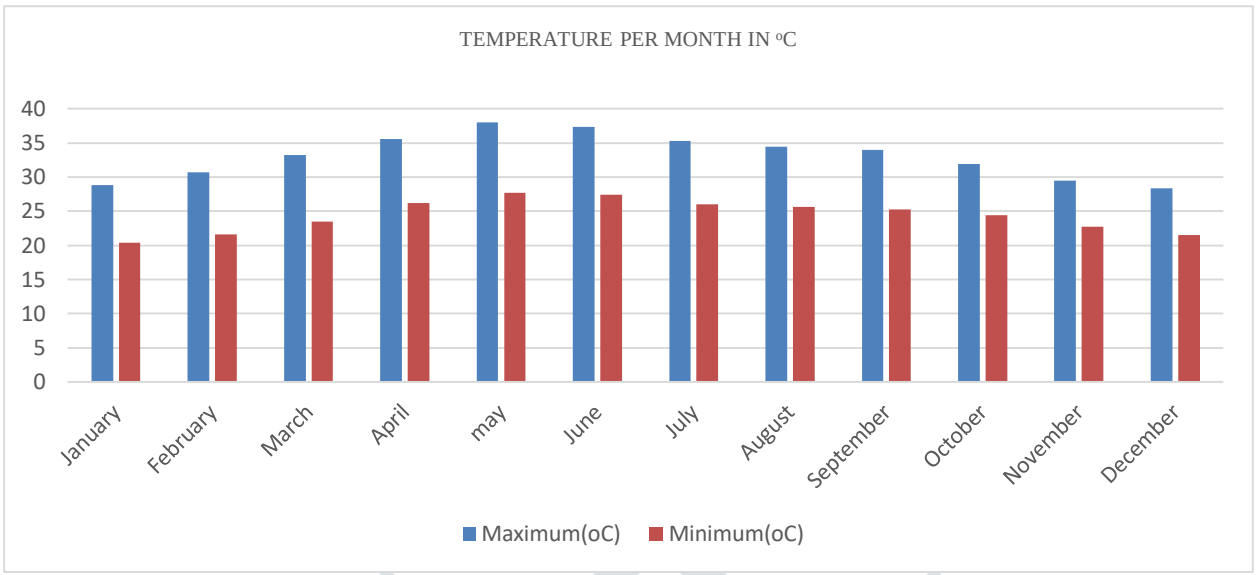


Figure 2: Maximum and Minimum Temperature in Tamil Nadu

III. METHODOLOGY

Existing system of biomethanation:-

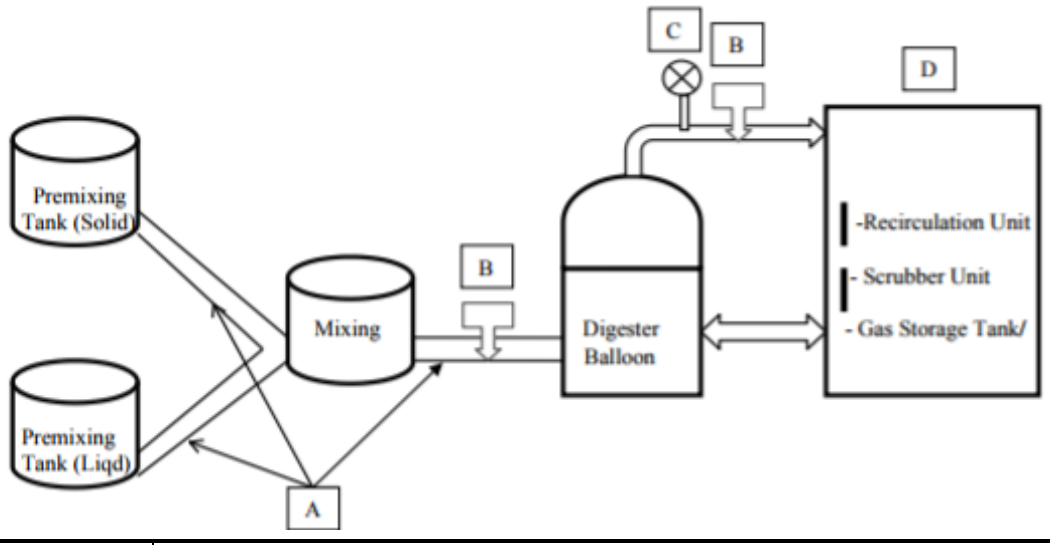
Biomethanation working process occurs in mainly five units:-

(1) Unit for mixing
(2) Unit for digestion
(3) Unit for recirculation
(4) Unit of scrubbing
(5) Unit for storage

Different types of phenomenon and activities occur in these five processes. Various types of feed such a municipal waste, human waste, manure, cow blended manually with liquid. As a liquid wat then blender is referred to biogas digester t The continuously working is done by the d fermentation feed is blended in order to form a completely homogenous medium. Then recirculation tank gets the combining process in the digester. Finally, methane is obtained and then this gas is referred to gas storage tank through the unit of scrubber. Scrubbing unit filters impurities.

A- Passage of concrete
B- valve
C- Pressure indicator
D- unit for recirculation, scrubbing and gas storage

Fig. 3 existing system of biomethanation process



Proposed system of

biomethanation:-

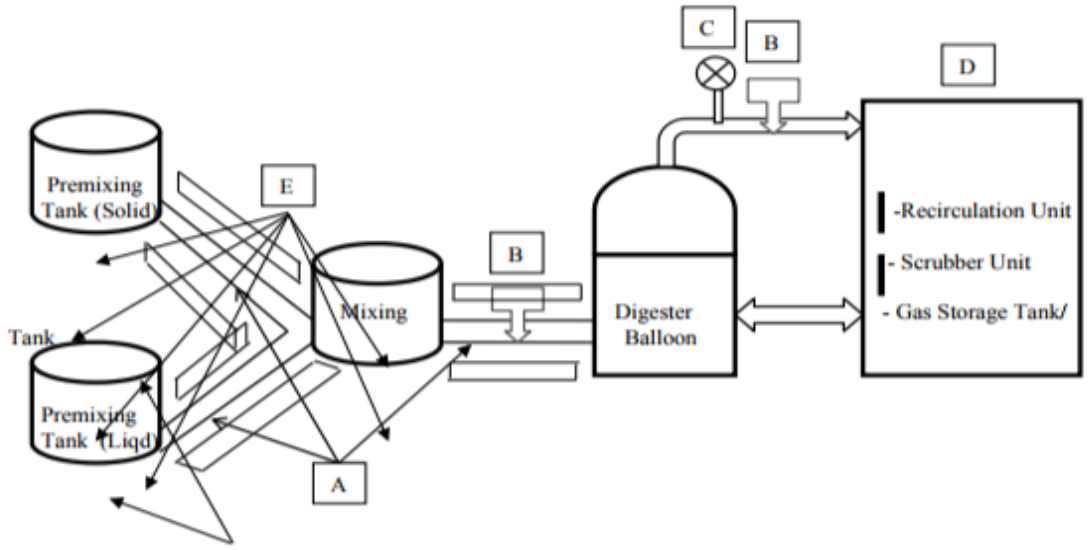
Enhancement of production of bio methane (Increasing the temperature of digestion):-

In this system we used a technique which can be increased the efficiency of biomethanation process under psychrophilic condition.

Usually concrete is used to make the digester. The way from premixing tanks (both liquid and solid) to mixing tank is also fabricated with concrete. When the feed stock passes through this path ther
atmospheric temperat
higher and bio methar

A- Stainless steel passage
B- valve
C- Pressure indicator
D- Unit for recirculation, scrubbing and gas storage
E- Panels of glass reflector

Fig. 4 Proposed system for biomethanation process



In this proposed system of biomethanation process, we used stainless steel path on the place of concrete path with the panels of plain reflector glass. These reflector glass panels have been placed parallel in the digester passage. We are using stainless steel because its thermal conductivity is higher than concrete and tensile strength is also high. Thermal conductivity of concrete and stainless steel is 0.4-0.7 W/mK & 40-46 W/mK. Now the glass reflector panels are able to heat to the passage of stainless steel. This transmits the same heat to the feed stock flowing inside due to its higher thermal conductivity. Thus the retention time is reduced inside the digester and finally and enhances the production of bio methane.

Table3:- Properties of materials used

SN no.	Material	Thermal conductivity	Corrosive resistance	Tensile strength
1.	Concrete	0.4-0.7	Average	2.2-4.2 MPa
2.	Aluminium	205-210	low	40-70 MPa
3.	Stainless steel	40-46	high	505-510 MPa

Table 3 shows the thermal conductivity, corrosive resistance and tensile strength of concrete, aluminium and stainless steel. From the above table, we can easily find stainless steel is better than the other two materials because its tensile strength is too high and it is much more corrosive resistance than others. Although thermal conductivity of aluminum is greater than others but it is low corrosive resistance compare to stainless steel. That's why we used stainless steel.

Passive heating might be another option to increase the temperature of digester. In this process, a black coating is coated in the digester in order to adsorb the heat, thus this increases the temperature of digester and decreases the retention time

Consequently the production of bio methane increases.

IV. RESULT

The study on the psychrophilic condition was concluded and the lower temperature in feed stock passage was increased thus the efficiency of production of bio methane was incremented. Temperature variation of two different states was studied. In cold climate state like Jammu & Kashmir, feed stock passage material of biomethanation process was replaced in order to enhance our efficiency of this production.

Efficiency of biomethanation process was increased about 10-15% much more from the existing system and retention time is reduced and this is 14-15 days.

V. CONCLUSION

The previous system of production of bio methane was examined and found, decreased production of bio methane in cold areas. Now, we have a proposed system in which the efficiency of biomethanation process can be increased replacing with stainless steel on the place of concrete of the passage in the digester.

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