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Biogas Production Potential Of Pungam Oil Cake

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Abstract : The use of biomass as an energy source is an issue of great importance, as it constitutes part of an alternative solution for the replacement of fossil fuels. Biomass includes energy obtained from fuel wood, charcoal and energy crop like sugarcane, sweet sorghum, oil seeds like jatropha, pungam, etc., besides agricultural and forestry residues. These resources are utilize to produce heat, steam, biogas, ethanol, biodiesel and electricity. In this paper, studies have been made to study the characteristics of pongamia pinnata oil cake, to study the biogas production potential from pongamia pinnata oil cake. These parameters have been analysed in the laboratory by repeated experiments.
Keywords : Biomass, Biogas, Pongamia pinnata.

1. Introduction

Energy is at the forefront of all the issues again. The primary energy demand in India is expected to increase from 537 MTOE (Metric tonnes of oil equivalent) in 2005 to 770 MTOE in 2015 and to 1,299 MTOE by 2030 [1]. This has resulted in finding out alternative fuels for meeting the energy demands of the developing sectors. Therefore, there is a need to explore the possibility of deriving energy from various alternative sources. Food and Agricultural Organization (FAO) reported that bio energy hold out immense potential for generating income and labour opportunities [2]. At present energy from biomass constitutes 15 per cent of the global energy consumption and even up to 90 per cent in some developing country.

1.1 Biogas technology

Biogas technology is based on the phenomenon of decomposition of organic matter in the absence of air to yield a gas, mainly consisting of methane and carbon-dioxide. This gas can be used as a source of energy. The stabilized organic product, after digestion, contains many of the useful substances present in the original wastes and they are often present in a more usable form. Apart from the use of biogas for household cooking and lighting, it is claimed that systems can be built to provide power for small scale productive operations such as pumping of water, village service facilities like clinical refrigerators and small scale industry.

1.2 Feed stock for biogas production

India has a very huge potential of tree-born non-edible oil seeds. The non-traditional seedoils available in the country, which can be exploited for this purpose, are *Madhuca indica*, *Shorea robusta*, *Pongamia glabra*, *Mesuaferra* (Linn), *Mallotus philippines*, *Garcinia indica*, *Jatropha curcas* and *Salvadora* [3]. Out of these seeds, at the most 35 per cent is converted into vegetable oil and the remaining 65 per cent is rejected as toxic de-oiled seed cake. However, this could be a big source of bio-energy production from the generated waste [4].

Table 1. Potential availability of some non-edible oil seeds in the India [5]

Sl. No	Name		Million Metric Tonnes/Year		
	Common Name	Botanical Name	Seed	Oil	Cake
1.	Karanja	*Pongamiapinnata*	0.20	0.055	0.145
2.	Jatropha	*Jatrophacurcas*	0.05	0.015	0.035
3.	Neem	*Azadirechtaindica*	0.50	0.100	0.400
4.	Mahua	*Madhucaindica*	0.50	0.180	0.320

Considering the future scenario of non-edible oil seeds utilization for biodiesel production in the country from *Jatropha curcas* (jatropha) and *Pongamia pinnata* (karanja) there is need for efficient utilization of their cakes.

Several attempts are being made to utilize non-edible seed cake for biogas production [6][7]. Though several Indian Institutes are attempting production of biogas from non-edible oil cake, at present, very little experimental work has been reported to assess the potential of oil cakes as the feed material for biogas production. Thus, this work was carried out as an attempt to fill the gap.

2. Materials And Method

2.1 Collection of pungam oil cake

Pungum cake is proposed for this study with and without cow dung. Pungum cake was collected from Gandhi vegetable market, Tiruchirapalli, Tamilnadu.

2.2 Procedure of bottling of various feed stocks

The collected feed stocks materials were analyzed to know their Total Solids and Volatile Solids content. These waste material were taken for five different sample according to percentage. Total solid content of pungam and cattle dung are 92.44 and 22.13 per cent, respectively. Water was added to obtain Total Solids content of 10 per cent.

The pungam cake with different proportions were mixed with cattle dung as shown inTable 2.

Table 2. Feed material and there proportion for different treatment

Sample name	Proportion (%)		Weight of feed-stocks (kg)		Volume of water (litre)
	CD	PC	Cattle dung (kg)	Pungam cake (kg)	
S1	100	0	0.680	0.000	0.820
S2	25	75	0.170	0.122	1.207
S3	50	50	0.340	0.081	1.077
S4	75	25	0.511	0.040	0.948
S5	0	100	0.000	0.160	1.340

The top of the bottle is sealed by hard rubber cork (Figure 1). A hole is made at the center of cork and one end of the L – shaped glass tube is inserted in to it and the other end of the glass tube is connected to a rubber tube. The rubber tube is clipped at its other end in order to make it airtight as shown in the figure below.

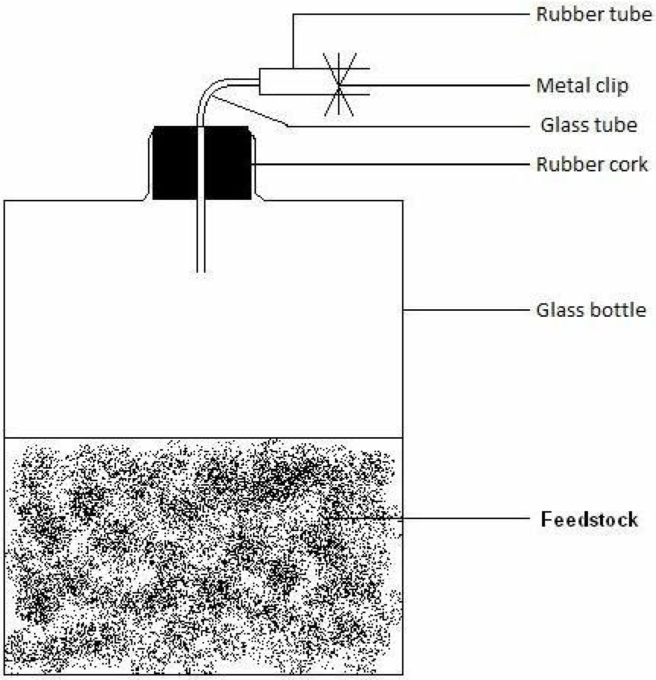

Figure 1. Sealing of bottles with rubber cork and glass tube arrangement

Three days after bottling, the amount of gas evolved is measured by water displacement method daily until the biogas production ceases. The methane content of the gas was measured using saccharometer. The following analyses were under taken before and after the digestion of the mixed feedstocks.

2.3 Total Solids

The total solid content of the pungam cake and cow dung can be determined by the procedure given by APHA (American Public Health Association), 1989 [8][9][10]. A 10 g of freshly collected sample has to be taken in a disc and placed inside a hot air oven at 105^{o}C for one hour. Then it is taken out and cooled to room temperature in desiccators and weighed. The percent of total solids is computed using the formula,

Percentage of total solids (%) = $\frac{(C-A)}{(B-A)} * 100$

Where,

A – Mass of empty clean and oven dried silica crucible, g
B – Mass of silica crucible + sample, g
C – Mass of silica crucible + sample after oven drying, g

2.4 Volatile Solids

The volatile solid content of sample can be determined by adopting the following procedure furnished by APHA, 1989. A know mass of residue obtained from the determination of the total solids is placed in a silica crucible and ignited in a muffle furnace at 550±50^{o}C for 30 minutes. Then the crucible is taken out of the muffle furnace, partially cooled in air, kept in a desiccators for few minutes and then weighed. Volatile solids is computed using the formula given below,

Percentage of volatile solids (%) = $\frac{(B-C)}{(B-A)} * 100$

where,

A – Mass of empty clean and oven dried silica crucible, g
B – Mass of silica crucible + sample, g, C – Mass of silica crucible + sample after ignition, g .

2.5 Measurement of biogas using water displacement method

The biogas produced from each sample is measured daily by water displacement method (Figure 2). The evolved gas is collected in a graduated measuring jar kept on a platform in inverted position inside a tub of water. The platform has a hole connecting its top to one side of the platform as shown in the figure. The gas outlet of the experimental bottle is connected to the measuring jar. When the cock of the biogas is released, the evolved biogas gets filled in the measuring jar displacing the equal volume of water in the tub.

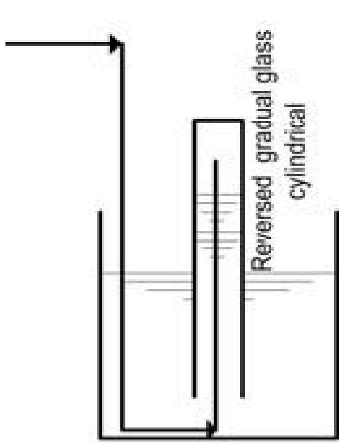

Figure 2. Measurement of biogas using water displacement method

2.6 Measurement of methane content of the biogas

The methane content of the biogas is measured using saaccharometer. 5 ml of biogas is injected by means of a syringe into the saccharometer containing 10 per cent NaOH solution. The carbon dioxide present in the biogas is dissolved in NaOH solution and methane goes to the top and the volume of the undisclosed biogas i.e. methane is measured.

$$\text{Methane content, \%} = \frac{\text{volume of undissolved biogas,ml}}{\text{volume of biogas injected,ml}} * 100$$

3. Results And Discussions

The experimental results are displayed and the relationship between the factors influencing the biogas production and their quantity and quality are discussed.

3.1 Total Solids

The total solid content of cow dung and pungam oil cake were determined as 22.13 and 92.44 per cent respectively.

Table 3. Total solid content of feedstock

S. No	Feedstock	Total solid, %			Average Total Solids, %
		Replication 1	Replication 2	Replication 3	
1.	Cow dung	22.68	22.90	20.80	22.13
2.	Pungam oil cake	92.37	92.38	92.56	92.44

3.2 Volatile Solids

The volatile solid content of cow dung and pungam oil cake was determined as 14.50 and 82.40 per cent respectively.

Table 4. Volatile solid content of feedstock

S. No	Feedstock	Total solid, %			Average Volatile solids, %
		Replication 1	Replication 2	Replication 3	
1.	Cow dung	13.91	15.47	14.12	14.50
2.	Pungam oil cake	83.42	81.94	81.84	82.40

3.3 Biogas production

The daily biogas production of different treatments were observed and tabulated in the Annexure. From daily biogas production values weekly gas production were calculated and tabulated in the Table 5.

Table 5. Total gas production from different treatments

Treat-ments	Weekly biogas production, ml							Total
	1	2	3	4	5	6	7	
S1	727	327	190	1044	1500	1450	217	5753
S2	1370	1494	340	740	77	87	27	4103
S3	574	414	190	194	64	117	19	1515
S4	1310	270	124	144	264	150	7	2094
S5	867	2800	307	297	124	144	20	4505

The above data is shown in the form of bar chart in figure below.

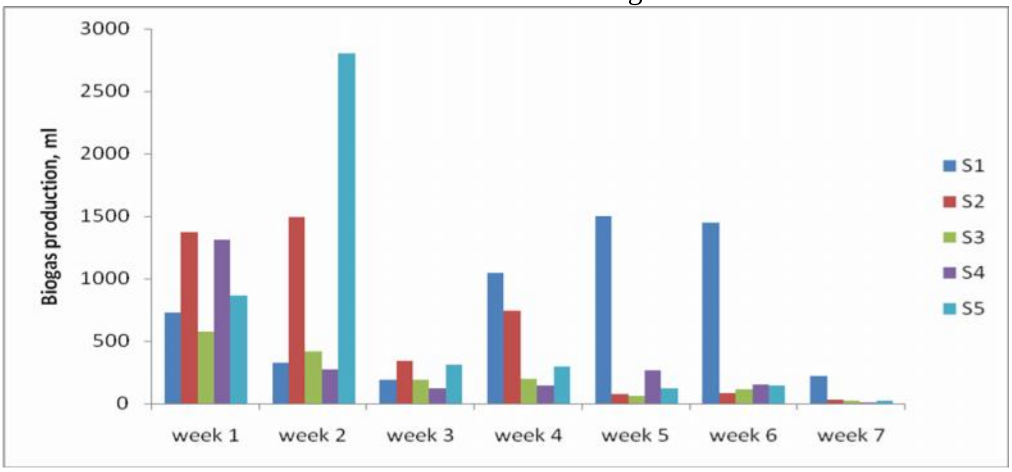

Figure 3. Weekly biogas production

The graph above shows the variation in the biogas production for all 5 samples in different weeks.

The maximum gas production was observed for the treatment S1 followed by S5. It was also observed that the maximum methane production was observed for the treatment S5 (3603 ml) followed by S1 (2992ml) and the minimum was observed for S3 (939 ml). It was concluded that with a Hydraulic Retention Time of 14 days maximum gas production was observed in S5 (100% pungam cake).

4. Conclusions

Renewable energy holds ample promises for sustainable development of the world. In this regards, biomass has its own importance owing to its availability, mostly in rural and forest areas. Thus, impetus should be provided to promote environmental friendly technologies like biomass energy to fulfill the ever growing energy demands of the swelling world population.

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