Implementation of Low Cost Technology for Biogas Generation and Reuse of Sludge in Brick Manufacturing

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Abstract: **Biogas is known as a source of renewable energy and it's made mostly of methane (60-70%) and a mixture of CO_2 (carbon dioxide), H_2S (hydrogen sulfide), NH_3 (ammonia), and SO_2 (sulfur dioxide). This gas is produced when biological matter (usually cow manure) is decomposed in an environment without the presence of oxygen with the help of bacteria. It has been popular as a source of energy for over 200 years. In order to generate biogas, the individual has to first build an anaerobic (no oxygen present) digester, or an enclosed tank (usually made of steel), where specific types of organic impurities are placed for bacteria to decompose them. In the environment, it is produced naturally in deep soils, lake bottoms, and wetlands. The dried waste sludge after the production of biogas is reused to produce "EcoFaeBrick", a quality, easily manufactured, low-cost sustainable building material made from cow dung. The bricks are not only 20% lighter, but they have a compressive strength 20% durable than clay bricks.**

Keywords: **EcoFaeBrick, Anaerobic, compressive strength, sustainable building material.**

I. INTRODUCTION

Green waste is organic material having the high nutritive value to microbes, which can be used for methane production and methane has good calorific value. In other words, it can be used as a domestic fuel. This fact can be understood in current performs of using low calorific inputs like cattle dung, distillery effluent, municipal solid waste (MSW) or sewage, in biogas plants making methane generation highly inefficient. We can make this system extremely efficient by using green waste /vegetables wastes.

Anaerobic digestion is controlled biological degradation process which allows efficient arresting and utilization of biogas (Approximately 60% methane and 40% carbon dioxide) for energy production. There are many reasons affecting the design and performance of anaerobic digestion. Some are related to feedstock characteristics, design of reactors and operation conditions in real time. Physical and chemical features of the organic wastes are essential for designing and operating digesters, because they disturb the biogas production and process stability during anaerobic digestion (Karve, A.D. 2006).

They include moisture content, volatile solid, nutrient contents, particle size, and biodegradability. The biodegradability of a feed is indicated by biogas production or methane yield and percentage of solids (total solid concentration) that are destroyed in the methane that can be produced per unit of volatile solids contained in the feedstock after subjecting it to anaerobic digestion for a sufficient amount of time under a given temperature. The current problem with the domestic biogas digesters is that the biodegradability of the feedstock inside the digester is incomplete and hence reduces the efficiency of biogas production in the digester. So, we need a multistage digester system for complete digestion of the feedstock.

With the increasing demand for high cost of building material, there is a need to search sustainable approaches to the needs of the building industry (Hilkiah Igoni et al. 2018) Bricks as the basic material towards construction can be produced by clay which is processed either through sun-dried or burned. In order to confirm the durability and optimal strength output with sun-dried clay bricks, fibrous materials are believed to enhance such characteristics (Millogo Y, Aubert JE 2015). This study intends to explore, how cow dung can be used to increase the quality of clay bricks that can be used for low cost building construction in various societies.

Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic environments (Karve, A.D. 2007). Natural generation of biogas is an important part of bio-geochemical carbon cycle. Biogas characteristically refers to a mixture of different gases formed by the breakdown of organic matter in the lack of oxygen. Biogas can be formed from raw material such as agricultural waste, manure, municipal discarded waste, plant material, sewage, green waste or food waste.

II. MATERIAL AND METHODS

A. Sampling of Water

Kitchen wastewater sample was collected in our college canteen. The collected the wastewater kept in bucket. Filter the wastewater using a cotton cloth. The filtered wastewater of 10% sample was used for further testing. Fresh cow dung was collected from the cow market.

B. Composition of Cow Dung

Cattle manure is basically made up of digester grass and grain. Cow dung is highly organic materials rich in nutrients. It contains about 3% nitrogen, 2% phosphorous, and 1% potassium (N:P:K;3:2:1). In addition, cow manure has high levels of ammonia and potentially dangerous pathogens.

C. Collection of Materials

To prepare Biogas plant, the necessary components required are: 20 litres of water bottles can, Gas pipe, Tyre tube, Black paint, 10ltrs of filtered wastewater, cotton cloth.

D. Bio gas plant

Working procedure of biogas plant are as follows. Mix the equal proportion (1:1) of the 10kg of cow dung and 10ltrs of kitchen filtered wastewater. Filled the slurry in 20ltrs water bottle can. The water bottle is painted in black colour (Because black colour absorb the heat and maintain the desired temperature in the bottle, then reduce the oxygen content in the water. Therefore, anaerobic reaction take place within the container). The tube is used to connect the water bottle and tyre tube & air tight purpose, cello tape is used. Place the set up in the dark room to undergo anaerobic reaction. Then after some days of decomposition in the absence of oxygen produces biogas which starts to get filled in the tyre tube.

E. Dewatering of water sludge

The biogas which is produced during anaerobic decomposition was collected in empty tyre tube. The hydrated sludge is removed from the water bottle & dried in hot air oven to dewater the sludge. The dried sludge can be used to make ecofaebrick.

Manufacturing Process of Brick:

Brick is one of the most common masonry units as a building material due to its properties. It has the widest range of products, with its unlimited assortment of patterns, textures and colures. And it has three ways to form the shape and size of a brick: extruded (stiff mud), moulded (soft mud) and dry-pressed (Morān J I et al. 2008).

The majority of brick are made by the extrusion method. Brick achieves its color through the minerals in the fired clay or through coatings that are applied before or after the firing process. This provides a durable color that never fades or diminishes. Brick will vary in size due to the manufacturing process. The method used to form a brick has a major impact on its texture(Danso H et al. 2015)

. Sand-finished surfaces are typical with moulded brick. A variety of textures can be achieved with extruded brick. Brick manufacturers address sustainability by locating manufacturing facilities near clay sources to reduce transportation, by recycling of process waste, by reclaiming land where mining has occurred, and by taking measures to reduce plant emissions. Most brick are used within 500 miles of a brick manufacturing facility(El-Shekeil YA et al. 2012).

A. Mix propotion

Clay, fly-ash and cow dung sludge are manually fed into a pan mixer where water is added in the required proportion for intimate mixing. The proportion of the raw material is generally in the ratio,

For first brick manufacturing:- Clay 90%, Flyash 5% and Cow dung sludge 5%

For second brick manufacturing:- Clay 80%, Flyash 10% and Cow dung sludge 10%

B. Hand Moulding of Bricks

The bricks which are used for small scale projects in such cases the hand moulding is preferred..The moulds are in rectangular shape made of wood or steel which are opened at the top and bottom (Ghavami K et al. 1999). The longer sides of moulds are projected out of the box to serve it as handles .If we consider durability factor in construction steel moulds are better than wooden moulds.

C. Drying of Bricks

After moulding process the bricks contain some amount of moisture in it .So, drying is to be done otherwise they may cracked while burning The drying of raw bricks is done by natural process (Aubert JE et al. 2015). The bricks are laid in stacks and it consists 8 to 10 stairs & arranged in such a way that circulation of air in between the bricks should be sufficient. The brick are dried for 3 to 10 days depending upon the climatic conditions. In some situations artificial drying is adopted under special driers or hot gases.

D. Burning of Bricks

In the process of burning , the dried bricks are burned either in clamps (small scale) or kilns (large scale) up to certain degree of temperature .In this stage ,the bricks will gain sufficient strength and hardness ,so it is important stage in the manufacturing of bricks .The temperature required for burning is about 900 to 1200^{o}C. If they burnt beyond this limit they will be brittle and easy to break. Hence burning should be done properly to achieve the required strength in brick (Ngowi AB 1997).

E. Tests on Bricks

Various types of tests on bricks are conducted to check the qualities of bricks for construction purposes. Tests on bricks are conducted at construction site as well as in laboratory. The tests which are required to find the good quality of bricks for construction purposes are discussed below.

Compression Test

The method of testing of solid bricks and perforated bricks for compressive strength as per IS:3495 [Part 1-1976(8)] is briefly explained as follows. The brick specimen is immersed in water for 24hours. Then they are removed from water Then the specimen is placed in a compression testing machine with flat faces horizontal and the mortar filled face upwards (Morel JC

et al. 2013). The load is applied at the rate of 14 N/mm2 till the brick specimen fails (Vilane BRT 2010). The maximum load which the specimen fails is divided by the average wet area of the bed faces of the brick to get the compressive strength.

Water Absorption Test:

Water absorption test is used to find out the amount of water absorbed by the brick .To do this weight of brick is noted then it is kept immersed in water for 24 hours. After that it is taken out and weighed. The increase in weight is found out. It is expressed as percentage of water absorption. Permissible value is 20%.

Hardness Test:

When scratches are made on the surface of the brick by finger nail no impression should be left on the surface of the brick, under sufficient hardness.

Colour Test:

A good brick should possess bright and uniform colour throughout its body.

Soundness Test:

When two brick struck with each other it should give clear bell ringing sound.

Structure Test:

A brick is broken and its structure examine it should be homogenous, compact free from any defects such as holes, lumps etc (Pacheco-Torgal F& Jalali S 2012).

Efflorescence Test

It's a deposition of water soluble salts either upon the surface or with in the brick pores or brick masonry it is white in colour and crystalline in structure the rating of efflorescence reporting that nil, slight, heavy, moderate or serious in accordance with definition states that IS:3495(Part III) – 1976(8).

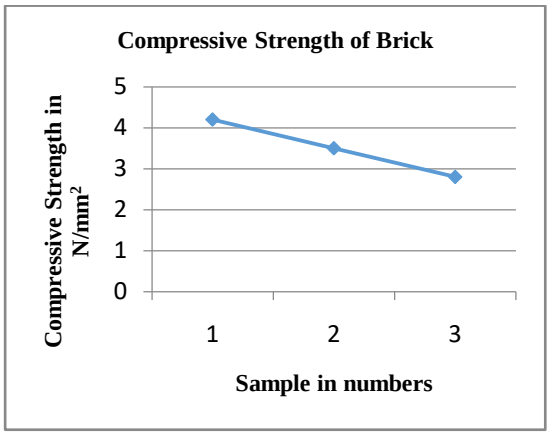
III. RESULTS AND DISCUSSION

A. Compression Test

Three bricks were made which are free from surface cracks. Measure the size of specimen and place the specimen on the compression testing machine. Apply load to brick the maximum load at which brick falls is noted and the ratio of load to area give the compressive strength. The compression test has been conducted for conventional brick and ecofeabrick respectively. The results are tabulated as below and suitable graphs are plotted. The compressive strength reduces as the percentage of Cow dung ash increases. Introduction of cow dung ash beyond 10% will greatly affect its Strength properties of the specimen negatively.

Table 1: Compression Strength of Bricks

% Cow dung added	Clay(%)	Flyash (%)	Compression strength (N/mm^2)
0	100	0	4.2
5	90	5	3.5
10	80	10	2.8



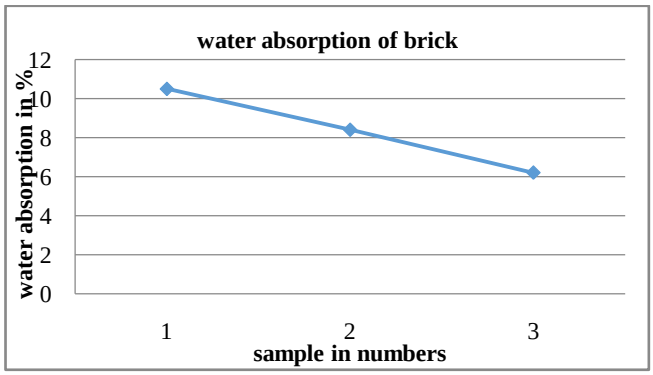
Graph 1: Compressive strength of Bricks

B. Water Absorption Test

The water absorption test has been conducted for conventional brick and ecofeabrick respectively. The results are tabulated as below and suitable graphs are plotted. The water absorption value increases for conventional brick & cow dung & flyash of 5% brick but the value decreases for cow dung & flyash of 10%.

Table 2: Water Absorption Test Results

Sample	1 (Conventional brick)	2 (5+5%Cowdung & flyash)	3 (10+10% Cow dung & flyash
Dry weight (Kg)	2.850	2.320	1.805
Wet weight (Kg)	3.270	2.850	2.030
Water absorption (%)	10.5	8.4	6.2



Graph 2: Water absorption of bricks

Soundness Test

Soundness test of bricks confirms the nature of bricks against sudden effect. In this test, 2 bricks are selected randomly and hit with one another. Then sound formed should be clear bell ringing sound and brick should not break. Then it is said to be good brick. two prepared brick struck with each other & heard a clear bell ringing sound .

Hardness Test

A good quality brick should repel scratches against sharp things. Accordingly, for this test a harsh tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be firm brick & adequately hard. There was no scratches found on ecofeabrick. Therefore the prepared ecofeabrick has a good hardness

Efllorescence

The soluble salts, if existing it cause efflorescence in brick work. For finding out the occurrence of soluble salts in a brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry in shade. The absence of grey or white deposits on indicates absence of soluble salts. If the white deposits cover about 10 per cent surface, the efflorescence is believed to be slight and it is considered as moderate, when the white deposits cover about 50% of surface. If grey or white deposits are found to be more than 50% of surface, the efflorescence becomes heavy and it is treated as serious, not suitable for construction.

IV. CONCLUSION

The green waste as a source of biogas, there will be a reduction in the volume of household garbage. If compact biogas plant is installed and operated in large number of households and requires lesser area for landfill. Since biogas plant is simple to use and fabricate, therefore, the design can easily be replicated and installed at large scale such as community hostels, canteens, farms, poultry, temples Etc. The green waste as a source of biogas, there will be a reduction in the volume of household garbage. If compact biogas plant is installed and operated in large number of households and requires lesser area for landfill. “EcoFaeBrick“, a quality, easily manufactured, low-cost sustainable building material made from cow dung. The bricks are not only 20% lighter, but they have a compressive strength 20% stronger than clay bricks and their production doesn’t rely upon devastating quarry mining techniques. The EcoFaeBrick mission is to provide a highly economical solution to a waste problem while helping to curb the destruction of the local environment caused by clay quarries, (Aubert JE et al. 2013). The waste sludge was used to Prepare ecofeabrick after biogas production and the prepared bricks has weight and water absorption capacity is lower than conventional bricks and it is also eco-friendly. Cow dung brick can be considered as a sustainable building material. These bricks are eco-friendly, and lighter in weight. The brick obtained by partial replacement of clay with Cow dung resulted in less strength. The brick obtained by 10% replacement of clay is of third class brick.

- Due to the adoption of hand mixing and moulding, therefore well mixing and compaction of brick does not take place.
- The void spaces in the brick increased due to burning of cow dung. Cow dung ash can also is used as a supplementary cementing material. But the usage of cow dung ash with concrete is limited because of its lower compressive str

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