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The Alternate Low Cost Non Conventional Energy Production Plant - Bio Gas Plant in a Tertiary Hospital Center

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Abstract: ***Management of hospital wastage is a very serious problem all over. Disposal of hospital waste involves serious health risk to the persons involved. To manage this problem a novel way was found in government Maternity Hospital, Tirupati. Low cost Non conventional biogas plant was constructed in 2005 at the back of the hospital. A cylindrical well of two cubic meters, 12 feet depth of concrete was constructed along with a dome in addition to inlet of 2x2 feet, out let of 2x2 feet at the ground level. Daily the hospital sanitary workers emptied the hospital waste excluding Bio, blood products which are carried by bio-waste consultancy carriers. Plastic material including covers, sharp objects, syringes are separated and excluded and disposed separately(1). cotton materials, waste papers, eaten and left food, fruits, rotten eggs, coconuts after drinking the water, old used cloths, used packing material, lime powder, used bleaching powder, and other waste are dumped in the inlet of biogas plant(2). The biological hospital waste is made like slurry. This is thrown in to the biogas well through the inlet. Small quantity of water added to the slurry. The anaerobic digestion of Biological products produces methane gas at a temperature of 33º-38ºC. at a ph of 7. The mesophilic and thermophilic flora present in the well of the plant causes destruction of the disease producing virus, bacteria, protozoa, and helminthes up to 99%. The sludge produced can be dried and used as composed manure with preservation of minerals(3).anaerobic digestion takes place inside the well for 3 to 6 weeks and methane gas produced from this bio gas plant is used to heat water for 2 hours per day by connecting to a stove. The Methane gas can be used as an alternate fuel for heating purpose. This method of hospital waste management is low cost, easily manageable with less man power and produced biogas which can be used as a fuel.(4)***

Keywords: Anaerobic digestion, Hospital wastes, Methanogenesis, biogas, sludge, slurry

1. Introduction

Waste disposal is one of the major problems being faced by all nations across the world(5). The conservation of nature is law of conservation. According to law of conservation, the waste is not a problem but a part of this cycle. The daily per capita solid waste generated in our country ranges from about 300 g to 500 g.11 if we carefully analyse this waste we will realise that majority of it is biodegradable. Waste like glass, metals and paper would be recyclable. The biodegradable waste if handled properly would maintain the natural balance of essential elements and thereby promote more harvests from nature.

Disposal of biodegradable waste can be achieved by several means like incineration(6), landfills, dumping in the sea or other water bodies, composting etc. These methods have their own hazards. Incineration can lead to respiratory illnesses. Moreover, it may lead to disruption of biogeochemical cycles of several elements and will have long term effects on biosphere. Vermiculture has been used in recent past in urban area, however, it has limitations of space. One of the economic ways would be to bio gas plants based on biodegradable Hospital waste.(7)

2. Advantages

Bio Gas Plant would serve many purposes such as:

1. Environment friendly disposal of waste is the need of hour considering mass pollution everywhere.
2. Generation of fairly good amount of fuel gas, which will definitely support the dwindling energy resources.(8)
   Generation of high quality manure, which would be weed less and an excellent soil conditioner. It must be noted that need for replenishing the soil with high quality organic manure has been identified in tenth five-year plan.
3. It would reduce the menace of street dogs and other nuisance animals.
4. Methane gas is a colourless, odourless and inflammable gas. The gas generated in this plant can also be used as a source of natural gas. The composition of biogas is:-
5. Methane (CH4): 70-75%
6. Carbon Dioxide (CO2): 10-15%
7. Water vapours: 5-10%

There is a definite need for developing means to handle enormous amounts of biodegradable hospital waste that is generated daily.

The hospital waste disposal becomes a universal menace. At Government Maternity Hospital, Tirupati, Andhrapradesh, India, we tried an alternative approach for the hospital waste disposal.

The hospital generates organic waste around 150 kgs a day, gauge, linen, waste paper, the 1000 patients, attendees, staff used food residues such as bread, milk products, rotten fruits, coconuts, eggs, bones, soda lime, used bleaching powder and etc The same was hitherto buried in a remote corner of the hospital, which invariably

invited stray dogs and pigs to the vicinity, spreading infection. An alternative disposal system, the Non-Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP), Tirumala Tirupati devasthanam, and Dr.T.Seshasai found a way out by building a biogas digester behind the hospital. This biogas plant was constructed in 2005 with cooperation of NEDCAP's district manager, C.B. Jagadeeswara Reddy and T.V. Satyanarayana, an Executive Engineer. TTD.

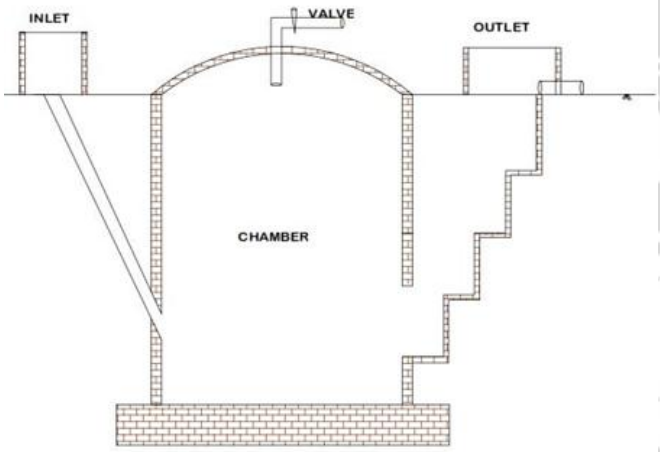
Architecture of the Plant:

This plant contains a central well with a dome, an inlet and outlet. At the top of the dome a gas out let pipe with a valve is fixed.

The plant is made of bricks by digging of a cylindrical pit of 2 cubic meters, with a depth of 12 feet.

This is connected with an inlet of 2X2 feet tub, and the tub is connected with a 10 feet 6 inches PVC pipe to the central well. An outlet of 2X2 feet 6 inches lower to the inlet and cover by concrete slabs.

A dome is made with concrete on the well. This is connected with a one inch pipe which is connected inside hospital to a gobar gas stove.



BIOGAS PLANT FOR HOSPITAL WASTAGE

Bio gas plant is having a inlet, connected to cylindrical shaped well with a pvc pipe of 10 inches diameter, a dome with a outlet pipe and a tap, the out let in side, Initially the plant is filled with dung and mixed with water made slurry. Daily the hospital sanitary workers emptied the hospital waste like, cotton materials and discarded food materials, dried leaves swept from the compound. Plastic material including covers, sharp objects, syringes, Bio, and blood contaminated containers are separated and excluded and disposed separately by the pollution control board. The biological hospital waste called as slurry is thrown in to the biogas well through the inlet. Small quantity of water added to the slurry. Anaerobic digestion takes place for 3 to 6 weeks and the digested sludge due to the pressure of the methane gas is pushed out through outlet. This sludge is dried in open air under sunlight and dried cakes are formed. This is used as compost manure for the lawns and plants inside the hospital compound.

3. Anaerobic Digestion

Anaerobic digestion (AD) is a microbial decomposition of organic matter into methane, carbon dioxide, (9).

Inorganic nutrients and compost in absence of oxygen. This process is also known as bio-Methanogenesis the process of the anaerobic digestion to methane: hydrolysis, acid forming and methanogenesis.

Hydrolysis- Hydrolysis is a reaction that breaks down the complex organic molecules into soluble constituents. This reaction is catalyzed by enzymes excreted from the hydrolytic and fermentative bacteria. End products of this reaction are soluble sugars, amino acids; fatty acids.:

(Shefali & Themelis 2002)
C6H10O4 + 2H2O ____6 H 12 O6 + 2H 2(10)

Acid-forming stage- microorganisms known as acid formers that transform the products of the hydrolysis into simple organic acids and alcohol, carbon dioxide and hydrogen.

Conversion of the glucose to ethanol:
Conversion of the glucose to propionate: (10)

The acetogenesis is completed through carbohydrate fermentation and results in acetate, CO_ and H_, compounds that can be utilized by the methanogens. The presence of hydrogen is critical importance in acetogenesis of compounds such as propionic & butyric acid. These reactions can only proceed if the concentration of H_ is very low (Ralph & Dong 2010). Thus the presence of hydrogen scavenging bacteria is essential to ensure the thermodynamic feasibility of this reaction (10).

Methanogenesis- targeted.

The reactions that occur during this stage are as follows (10).
- Acetate conversion:
2CH_CH_OH + CO_ _____COOH + CH_
Followed by: CH_COOH _____ + CO
- Methanol conversion:
2
CH_OH + H_ _____ + H_O
- Carbon dioxide reduction by hydrogen
CO_ + 4H_ _____ + H_O

The Ph maintained usually around 6.0 to 7.0. Some acid producing bacteria can reduce the ph to 4.2. But buffering with lime can increase the ph 7.0 to 7.2. The decaying organic matter produces [1]the acetic acid that is converted to methane. Methanogenic bacteria produce methane from hydrogen gas and carbon dioxide;. Methane can also be produced by the reduction of methanol; approximately 70 percent of the methane produced was from acetic acid.

4. Temperature

Methomogenic bacteria can produce a temperature of 33º-38ºC. The digestion proceeds best at 30ºC-40ºC with a mesophilic flora, and at 50ºC-60ºC if a thermophilic flora is developed and adapted Pure methane is a colorless and odorless gas. It generally constitutes between 50 % and 70 % of the gas produced by anaerobic digestion. The other 30-50 percent is primarily carbon dioxide, with a small amount of hydrogen sulfide.

The slurry can be in the digester for 20 to 30 days. The gas regulates the digestion process and the fiber such as dry leafs, fiber such as wheat straw materials will improve the process. *c

The biogas yield from straw can be increased by pre-treatment, making the material more accessible to microbial degradation (11), Furthermore, by co-digestion with more nitrogen-rich materials, for example, animal manure or food waste, the nutrient limitation can be overcome (12)

Usage of the Biogas Plant:

Hospital waste was put in the inlet with small quantities of water which is used to clean the bucket and for hand wash. The sludge after 3 to 6 weeks of digestion period passed through the outlet on the ground and dried in open atmosphere and dried up like a dung cake can be used as fertilizer for the garden thermophili c bacteria is present in decaying plant matter and compost. Nevertheless, since the die-off rate is expected to be sufficiently high (90 percent), anaerobic digestion of organic material for biogas production provides a public health benefit beyond that of any other treatment likely to be in use in rural areas of developing countries. pH treatments The raising of the pH to at least pH 12 by the use of lime has the effect of suspending microbiological activity. Lime(2) conditioning in specific conditions (pH of 12.5 for 2-4 months) can cause a helminth reduction of 98.5% and a virus inactivation of 90% .

5. Using Digester Sludge

Sludge is used as a fertilizer and environment friendly.

The cost of the construction of the Bio gas plant is Rupees 8000 only, as a permanent concrete structure. at any time the hospital biodegrable waste is digested by this plant. The dumping such type of waste can create nuisance of flies, mosquitoes, birds, waste pickers, and transport of the waste daily a big problem as delay in transport will spread the filthy odor and spread the communicable disease. Burning the waste is not possible as 100% burning is not possible in the dumps and a lot of smoke nuisance prevails. This saves 5 lakhs rupees/year at current day cost of management of hospital waste.

The Non-Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP) engineer told that the present Bio gas can produce the methane which is equal to 12 LPG 14.5 Kg cylinders annually(14). The staff and patients are using the methane gas for boiling water and milk.

This biogas plant is first of its kind in the country. Its uses are:

- Cent per cent disposal of biodegrable hospital waste.
- Two hours' non-stop gas supply a day
- Used for boiling water for sterilization

6. Conclusion

When hospital waste disposal has become a universal menace, the Government Maternity Hospital, Tirupati, has succeeded in making wealth out of waste(14). In what is claimed to be the first-of-its-kind technique adopted in the country, the hospital has devised a mechanism to dispose of biomedical waste and even produce methane from it.

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