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Biomethanation Plant for Vegetable Waste and Utilization of Biogas Slurry

Ms.Jyothilakshmi.R[1],Dr.S.V.Prakash[2]
1.Asst.Professor ,Dept. Mechanical Engineering,M.S.Ramaiah Institute of Technology
2.Professor, Dept. Mechanical Engineering,M.S.Ramaiah Institute of Technology

Abstract: As India is moving towards sustainable development as for as energy needs are concerned, biogas as biofuel may provide a sustainable solution to energy crisis by displacing oil use in agriculture and transport sector. Biogas is an obvious choice and has a promising future in india due to tropical location, very high population of livestock and wide variety of substrates available inabundance for biogas generation. An estimate indicates that India has potential of generating $6.38*10^{10}m^3$ of biogas from 980 million tons of cattle dung produced annually. The heat value of this amounts to $1.3*10^{12}$.In addition to gas around 350 million tons of organic manure would also be produced. If organic wastes such as sewage, municipal solid waste, waste from industrial effluents can also be taken as feedstock to increase biogas potential further. Current study deals with these aspects and also effective utilization of slurry which is the byproduct of biogasification.

Keywords: BIMA Digester, Biogas, vegetable waste, Bio Energy

1. INTRODCUTION

Market wastes comprising of vegetable,fruits and flowers of varying constituents are generated in large quantities in cities and towns. These wastes being organic in nature cause odour if they are not disposed properly.In the present day practice market wastes are collected and dumped along with municipal solid waste in the landfills.Ministry of Non-conventional energy sources(MNES)has identified market waste as one of the key sectors having potential for energy generation under UNDP/GEF((United nationsDevelopment programme/Global environment facility).

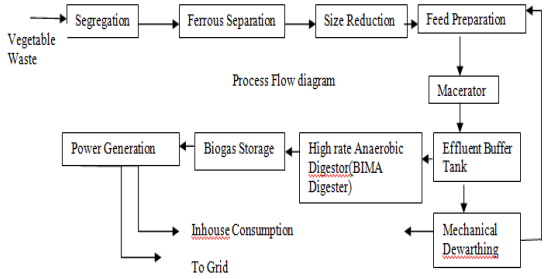


Fig No.1: *Block diagram of biomethanation plant*

1.1Waste Characteristics

Major components of the waste generated include vegetable wastes(21%),fruit wastes(15%),flower wastes(10%),banana stem and related materials(38%) and packing materials(hay,straw,paper etc 16%).Contamination is around 10%.The moisture content is 75%.The total solids and the volatile solid content are 25% and 73.7% respectively.However the overall efficiency of the biogas yield depends on biodegradable nature of the constituents of the waste as they degrade with different efficiencies.

Tables

Table 1. Organic Wastes and their estimated availability in India

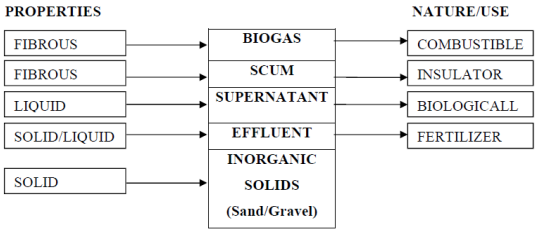
Sl.	Organic Wastes	Estimated quantity
1	Municipal solid	3.00 crore tons/year
2	Municipal liquid	1200 crore litres/day
3	Distillery	8057Kilolitres/day
4	Food,fruit & veg	45 lakh tons/year
5	Dairy industry wastes	5-6 crore litres/day
6	Paper and pulp	$1600m^3$/day
7	Tannery(2000 units)	$52500m^3$ waste

Table 2: Design Data

Material Balance	**Quantity**
Feed rate	30 tons/day
Water required to reduce the solid	32.5m3/day
Percentage conversion of volatile	55%
Total VS in the feed	5700Kg/day
VS loading rate	3Kg/m3/day
Hydraulic retention time	36.6 days
Biogas produced	2500m3/day
Sludge production(25% solids)	10tons/day
Energy Balance	
Energy generated in the plant	5250Kwh/day
Auxiliary [power rrequirement	470Kwh/Day
Net energy for export	4780

1.2 Biodigesters

The biodigester is a physical structure, commonly known as the biogas plant.Since various chemical and microbiological reactions take place in the biodigester, it is also known as bio-reactor or anaerobic reactor. The main function of this structure is to provide anaerobic condition within it. As a chamber, it should be air and water tight. It can be made of various construction materials and in different shape and size. Construction of this structure forms a major part of the investment cost.



Source: Lagrange, B. (1979)

Table above shows the various stages of decomposition and the forms of the material at each stage. The inorganic solids at the bottom of the tank are rocks, sand,gravel, or other items that will not decompose. The effluent is the semisolid material left after the gases have been separated. The supernatant is biologically active liquid in which bacteria are at work breaking down the organic materials. A scum of harder-to digest fibrous material floats on top of the supernatant. It consists primarily of plant debris. Biogas, a mixture of combustible (burnable) gases, rises to the top of the tank.The content of biogas varies with the material being decomposed and the environmental conditions involved. When using cattle manure, biogas usually is a mixture of gases in the composition as shown in Table 1.1.

The largest, and for fuel purposes the most important, part of biogas is methane.Pure methane is colourless and odourless. Spontaneous ignition of methane occurs when 4-15% of the gas mixes with air having an explosive pressure of between 90 and 104 psi. The explosive pressure shows that biogas is very combustible and must be treated with care like any other kind of gas.

2. STEPS IN THE PROCESS

1. Size reduction:The segregated waste is fed into the shredder to reduce the size of the waste to a uniform size of around 15-20mm.Shredders with the handling capacity of 4tons/he are available.
2. Anaerobic digestionBIMA(Biogas induced Mixing arrangement) digesterhas an unique system of mixing which does not require mechanical moving partsand also has an ability to control scum and sedimentation while hadling high solid concentration.
3. Biogas collection:The biogas generated as result of stabilization of the waste,leaves the BIMA digester to a dry type gas holder made of a synthetic membrane (polyester).The biogas would have a composition of 60% methane and 40%carbon dioxide.
4. Power generation:The biogas after removal of hydrogen sulphide is used as fuel in the engine to produce electricity.The gas is drawn from the gas holder by gas blowers and fed into the gas engine.An alternator is connected to the engine to produce electricity.
5. Dewatering of digested substrate:The residue from the digester is collected in an effluent buffer tank for dewatering.Dewatering is carried out in a screw press of capacity upto 6m3/hr.As the screw is rotated, the material is moved forward and consequently the pressure is increased. The centrate is discharged through the openings in the curb and the dewatered cake is discharged at the other end of the press.The cake from screw press would be converted into manure by composting.
6. Odour control system:Receiving area,conveyer,shredder,feed preparation tank and

screw press are connected through PVC pipelines to the biofilter to reduce the odour inside the plant.The foul air from each location are sucked and passed through the media impregnated with microorganisms to remove odour.

3. USES OF BIODIGESTED SLURRY

Biodigested slurry is the by-product obtained from the biogas plant after the digestion of the dung and generation of the gas.It is a very good manure.The nutrients contents NPK get enriched in the biodigested slurry.The elemental analysis of biodigested slurry using X-ray reveals that the

Silicon,Phosphorous,Sulphur,Potassium,Calcium and iron are present with

65.595,8.275,3.117'7.623,11.693 and 3.698 percent respectively.

The biodigested slurry has a great potential as organic manure and it can be applied to all crops.Biodigestd slurry is as valuable as main product of the biogas plant.In addition it reduces pollution,save energy required to produce chemical fertilizer.

Following are different methods of applying biodigested slurry as manure:

1.Air dried biodigested slurry can be applied by spreading on the agricultural land
2.The liquid slurry can be mixed directly with the running water in the irrigation canal.
3.It can be coated in seeds prior to sowing
4.Can be used for fish culture The nutrient values of bio digested slurry can be increased considerably by means of enrichment. It can be enriched with fertilizer nitrogen, phosphate etc.

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