Biogas manual

Biogas

Biogas is a mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. Biogas is mainly composed of 50 to 70 percent methane, 30 to 40 percent carbon dioxide (CO2) and low amount of other gases. Biogas is an odourless and colourless gas that burns with clear blue flame similar to that of LPG gas (Sa thianathan, 1975). Its calorific value is 20 Mega Joules (MJ) per m3 and burns with 60 percent efficiency in a conventional biogas stove. Biogas is produced by the degradation of biological matter under anaerobic reaction in absence of free oxygen in a digester.

Selecting a biogas plant site;

The criteria's for selecting an ideal plant site is that the ground (earth) should be hard and compact, not water logged and damp, dry and away from shade, have maximum sunlight hours. The length of gas delivery pipeline should be short for effective gas delivery. There should be enough space for slurry storage. Water line and cattle shed should be near to plant to avoid time in material transport.

Selecting a biogas plant size:

A biogas plant of specific capacity can be selected based on the daily availability of cattle dung and water requirements and on the cooking energy demands.

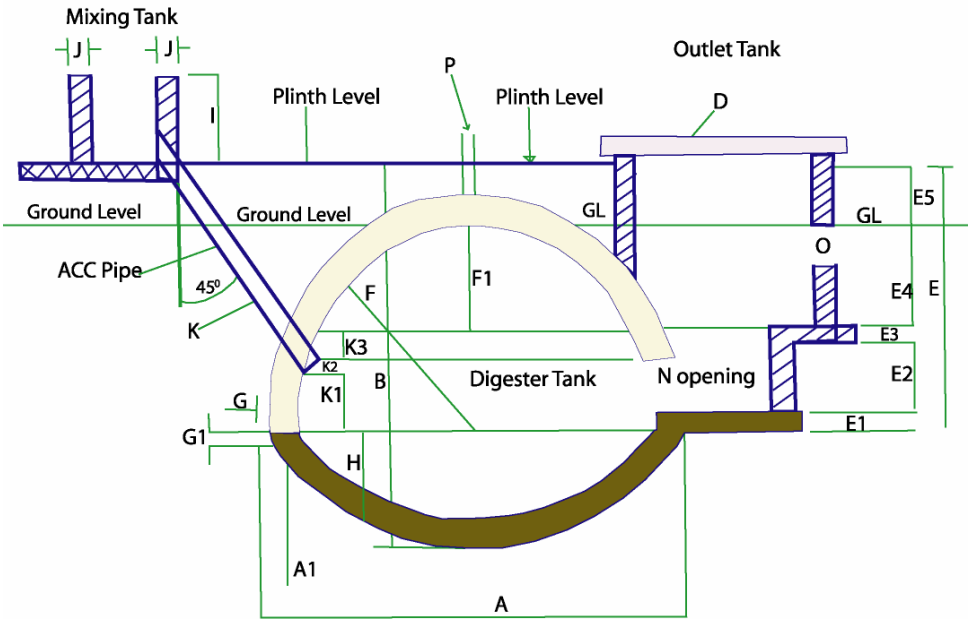
Family size biogas plant

Plant size	No of cattle's	Dung & Water mixture/day	Food prepared for persons/day
1 m^3	2-3	25 kg x 25 L	3-4
2 m^3	4-6	50 kg x 50 L	5-8
3 m^3	7-9	75 kg x 75 L	8-12
4 m^3	10-12	100 kg x 100 L	12-16

Establishment requirements

The biogas plant can be set up with Bricks (I Class), Cement, Stone chips of 1/2" single, Sand Coarse Sand, G.I.pipe 3/4" dia sockts 30 cm, A.C.pipe 6" dia, Iron bars (6mm dia) for outlet tank cover, Paint (gas leak proof dibhapoxy), Labour for digging pit, Labour for construction, Skilled masons, BG Stove, appliances 10 m pipe line, lamp, accessories.

Skemetic diagram of Deenbandhu biogas Plant



Dimensional feature of 2m^3 deenbandhu biogas plant

Sl no.	Excavation	Symbol	Length in mm
1	Circular portion of the main tank	A	3100
2	Wall thickness of the main tank	A1	150
3	Depth of the main tank	B	2304
4	Rectangular portion of the outlet chamber	D	1380 x 1845
5	Depth of outlet chamber (up to plinth level)	E	1657
6	Bottom portion of the outlet tank		
A	Foundation depth of outlet tank	E1	75
B	Depth of outlet tank	E2	640
C	Foundation depth of ODC	E3	75
D	ODC depth up to slurry discharge hole	E4	450
E	Height of plinth from GL	E5	267
Brick masonry work			
1	Radius of the upper hemispherical portion dome	F	1400
2	Height of the dome at the centre point	F1	1400
3	Wall thickness of the dome	G	75
4	Thickness of digester tank projection	G1	75
5	Height of the digester from C.C. base	H	560
Inlet tank			
1	Height of the inlet tank (from GL)	I	610
2	Thickness of the wall	J	115
3	Length of the inlet pipe (150mm dia)	K	1800
4	Height of the pipe from centre line	K1	300
5	Height of the pipe from bottom to top	K2	340
6	Height of the pipe from top slurry level	K3	150
Outlet tank			
1	Outlet slurry opening hole	N	600 x 565
2	Outlet slurry discharge	O	150 x 150
3	Gas outlet pipe(GI)1/2// with socket	P	175

Components of a biogas plant:

Foundation

The foundation of the plant is bowl shaped with a collar around the circumference. The construction of the digester dome is based on this collar.

Dome is divided in 2 parts, Digester & Gas storage.

Digester: The bottom part is called the digester, where the mixture of dung and water decomposes to produces gas due to bacterial activity.

Gas storage: gas produced by the bacterial activity is stored in the upper part of the digester dome called gas storage.

Gas outlet pipe:

A nipple is fitted on the top of the dome, which is connected to a GI pipe. The gas reaches the kitchen through this pipe.

Inlet:

The pipe through which fresh dung and water enters the plant is called Inlet pipe and is connected to a small tank for mixing dung and water.

Outlet

The portion of the plant where the slurry accumulates after coming out of the digester is called outlet tank. It is in two parts. The first bottom part is small and rectangular, which is connected to the dome opening, while the other part of outlet tank is dome shaped. A small slurry discharge hole is provided in the outlet tank. The volume of the dome upto the hole is equivalent to the gas storage volume. Only the amount of gas equivalent to this volume can be used in a burner or lamp. The main function of this part is to provide pressure for release of gas from the dome. The level of slurry rises upto the outlet hole in this tank when the plant is full with gas.

Temperature & pH criteria;

The biogas production rate is affected by three parameters, namely digester temperature, pH value of feed material and on the concentration of the input. For maximum gas production a temperature of 35^0 C and pH value in the range of 6 to 7 is ideal.

Testing the digester;

The digester of the Deenbandhu plant on completion is tested before commissioning through smoke test for detecting gas leakages. Smoke producing material is burnt inside the digester and thereafter all vents of the digester are closed and checked for leakage. Any section of the dome emitting smoke is identified and can be sealed.

Hydraulic testing for water leakages is done by filling half of the digester with water and marking the level. Thereafter after a period of 6 to 7 days the water level is rechecked. In case of leakages the water level will go down.

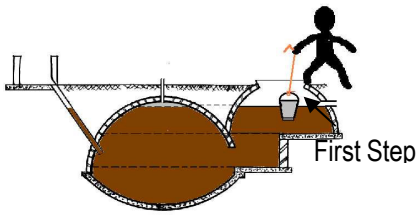
Starting a digester with feed material;

Initial digestion process with cattle dung feed should start with a few weeks depending upon the temperature. A 5-30% of effluent from a working biogas plant can be mixed with the initial feed to speed up gas production process.

Operation & maintenance;

In the event of new digester failing to start, check for correct temperature and feed composition and cracks in the digester. In case of low gas production check gas leakages in the gas pipeline, around valves and check for cracks in dome plastering.

The need for emptying the biogas plant may arises when the slurry level inside the digester has increased due to leakage in the plant or due to improper daily feeding. In the case of improper feeding, the slurry is emptied upto the first step only. While in the case of leakage, the plant will require to be emptied completely.



Bio-manure

Bio-manure (BgM) is a by-product obtained from the biogas plant after the digestion of dung or other biomass for the generation of methane rich gas. BgM supplies essential nutrients; enhances water holding capacity and soil aeration; accelerates root growths and inhibits weed seed germination.
Types of BgM are: liquid BgM; solid content 6%, pH value 6-9, nitrogen 1.8%
Semi-dried BgM; Solid content 15-20%, pH value 7-9.
Dry BgM; Solid content 20-30%, pH value 7-8, has micro-nutrients, less nitrogen, if this BgM is sun dried than there will be loss of nutrients.

BENEFITS;

Energy benefits

- Provides cooking and heating fuel (stoves and burners 55 % efficient)
- Lighting fuel (biogas lamps with mantles)

Environmental and social benefits

- Significantly reduce carbon dioxide emission and reduces fuel wood pressure.
- Biogas is a clean source of energy (no smoke and soot during combustion);
- Produce a pathogen free nutrient rich fertilizer.

Economic benefits

- Cheaper source of cooking energy (a 2 cubic meter biogas plant can replace, in a month, fuel equivalent to 26kg of LPG, or 37 litres of kerosene, or 88kg of charcoal, or 210kg of firewood)
- Jobs are created (builders and technicians)

References; AFPRO; Deenbandhu model 2000 biogas plant, IITG; biogas manual
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