Biogas Plant Construction Manual

Fixed-dome Deenbandhu model digester:
2 to 6 cubic meter size
(measured as biogas generated per day)

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Forward

The Biomass for Sustainable Rural Development project is a joint programme between the Egyptian Environmental Affairs Agency (EEAA), Ministry of State for Environmental Affairs, Global Environmental Facility (GEF) and the United Nations Development Programme (UNDP) The project is to facilitate and accelerate the market development for new bio-energy technologies in Egypt. The aim is to remove certain technological and capacity barriers in the development of a biogas project for Egypt. SKG Sangha (SKGS) was selected as an organisation to install 100 domestic biogas plants in two governorates, Fayoum and Assiyut in households selected by the Biomass Project. SKGS will install, monitor and maintain units for a period of ten months. During the course of plants installation, they will train local masons in biogas plant construction,and also train supervisory staff in measuring design parameters, and in monitoring and maintenance. These staff will be selected by the Biomass Project. The design of the plant used is a fixed dome system, based on the Indian Deenbandhu model adapted by SKGS for Egyptian conditions. As the mean temperature of the Egypt is about 21 degrees Celsius the plant has been designed to have 50 days hydraulic retention time (HRT). The project will be implemented by SKGS and monitored by the Biomass Project. A primary list of probable beneficiaries will be made by the local body of the governorate, scrutinized by the biomass project and then sent to SKGS for a final selection of beneficiaries. The selected beneficiaries will be provided with a suitable size biogas plant based on the cattle population and number of members in the household.

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Contents List

List of Figures

List of Pictures

List of Tables

1. Introduction

A biogas plant is a civil construction of an underground tank, which provides and anaerobic (air free) environment. All types of soft biomass wastes can be fed into this plant. Different types of bacteria decompose this feed material and generate biogas. Biogas is a combination of gases such as methane, carbon dioxide and hydrogen sulfide. Usually biogas contains about 65% methane and about 35% carbon dioxide with traces of other gases. The waste which comes out of a biogas plant, after treatment, is rich in beneficial bacteria and also major and micro crop nutrients. Biogas plants are used throughout the world to generate an alternative source of energy supply as well as to create well fermented slurry. The slurry can be used as a liquid or a solid manure in agricultural soils. Since human wastes can be added to biogas plants, they can help with sanitation. Millions of biogas plants have been installed in places such as India and China to provide sustainable energy to rural households and also to provide an overall improvement of human health and the environment. The use of biogas plants is preferred to the alternatives of burning other fuels, such as dried animal dung cakes, fuel wood and LPG for daily cooking needs. Feed material for these biogas plants are human waste, meat and vegetable market wastes, food processing factories waste and almost all types of animal dung.

Before a biogas plant can be built at a particular site, many factors need to be studied. These include the quantity of feed stock available on daily basis, the type of waste, the availability of water, the availability of space, the type of soil and the level of the ground water table on the site.

The installation of a biogas plant, especially the fixed dome model, requires well trained and experienced masons and the use of good quality materials. If the masons follow the design measurements strictly, the plant will be long lasting. The success or failure of a biogas plant mainly depends upon how and by whom it has been installed, what type and quality of materials have been used and how well the plant has been maintained.

There are many advantages of a fixed dome model of biogas plant. It is under ground, saves space and is weakly affected by climatic conditions. There are no moving parts and hence there is less wear and tear. There is almost no maintenance work to do and it costs less than other designs.

This manual has been prepared by SKG Sangha (www.skgsangha.org) which has a vast experience in the construction of fixed domel biogas plants (more than 105,000 in South India). They are experienced in on-the-job training of both masons and managerial personnel. They were asked to use this experience in a project for further propagation of biogas plants in Egypt.

This manual has been designed in such way that it can be used by a lay man, provided an experienced mason is available to construct a fixed dome biogas plant. A step by step description, along with figures and photos, provides a clear understanding and methods for installation of the unit.

2. Selection of construction materials:

Material Availability: The following materials are required for construction and use of a fixed dome model biogas plant:

1. Cement
2. Sand
3. Stone aggregates
4. A pipe to connect the digester and the inlet tank
5. Brackets welded galvanized iron pipe
6. Valve to control the gas flow
7. Bricks
8. High density poly ethylene (HDPE) pipe
9. Rubber hose
10. Brass nipple
11. Biogas burner
12. Water

2.1. **Cement:** Cement is usually available locally and can be bought at any quantity, but the quality of the cement is not usually known. Cement gradually loses its binding power during storage. It is better to fresh cement for good results. It is best to identify a wholesaler who gets fresh loads from factory every few days so that cement can be purchased from this establishment. The correct grade of cement to obtain for the construction of plants is "ordinary Portland 42.5 grade".

2.2. **Sand:** Sand is usually available, but the sand particle size must be correct to use it in civil works. A supplier should be found who can supply sand with suitably sized grains for civil works. If the sand contains lots of pebbles and stones, it has to be sieved before use. Sand should be free of earth and clay if it is to be used for biogas plant construction.

2.3. **Stone aggregates**: River bed pebbles are often used in concrete, but the pebble surfaces are usually smooth and cannot hold the cement in the concrete mix. Higher surface areas are needed for aggregate used for concreting. Even broken river pebbles do not work, as too much of the surface area is still too smooth. Broken granite stone is much better, even if it needs to be brought from a distance and is more expensive. The size of the pieces need to be 20 to 25 mm in size.

2.4. **A pipe to connect digester and inlet tank**: Many types of pipe can be used for this purpose, made from plastic, concrete or stone ware, which are usually used for drainage. A diameter of 15 centimeter should be used. If plastic drain pipes are used, such as PVC (polyvinyl chloride), a thick wall thickness should be used, between 4 and 6 mm.

2.5. **Gas outlet pipe with welded brackets**: Steel pipe is required, usually ½" diameter galvanised iron, with the top end threaded. Two steel wire pieces, each 300 mm long are welded either side of the pipe about 30 mm from the bottom. These hold the gas outlet pipe in the top of the dome. Class "B" galvanised iron can be used and a local welding shop can be contracted to do the welding.

2.6. **Main gas valve to control the gas flow**: A ½" diameter valve is screwed onto the thread of the gas outlet pipe. A ball valve is better than other types of valve, but it can be made of a range of materials. PVC valves with nylon sealing rings are good, although they are fragile and easily broken. Metal valves are more liable to leak. Also, if a metal valve is knocked, it can disturb the gas outlet pipe in the top of the dome, which is difficult to fix. A broken plastic valve can be replaced easily.

2.7. **Bricks**: Well burnt mud bricks are the best type to use for a fixed dome biogas plant. In many places, hollow brick are more easily available, as they are light weight. These tend to weaker and more easily broken. They have smaller surface areas onto which cement can bind. Solid bricks are better. A typical brick size is 220 x 100 x 70 mm.

2.8. **Gas transfer pipe**: A pipe is needed to connect the digester and the biogas burner. The pipe is placed above ground, so it needs to be strong and long-lasting. HDPE (high density polyethylene) is most suitable. A pipe with an outside diameter of about 20 mm, with a wall thickness of 3 mm is suitable.

2.9. **Rubber hose**: A length of rubber hose is used to connect a nipple in the end of the HDPE pipe to the biogas burner. The size of the hose depends on the size of the spigot on the biogas burner.

2.10. **Galvanized iron pipe lengths**: Steel pipe lengths are required to link the HDPE pipe to the main gas valve at one end and the rubber hose at the other. These are usually ½" diameter and about 150 mm long.

2.11. **Pipe nipple**: A brass nipple, with a spigot at one end and a pipe thread at the other, is required to link the galvanized pipe length to the rubber hose. The spigot should be same size as that of the biogas burner.

2.12. **Biogas burner**: Biogas needs specialized burners. LPG (liquid petroleum gas) burners are not suitable. A supplier of biogas burners is needed, usually from either India or China. It is possible to import some parts that are specifically made for biogas and use them to adapt LPG burners.

2.13. **Water**: Water is needed for construction. Irrigation canal water or ground water is best, as long as it does not contain mud. Piped water can be used, but it often contains chlorine, used to kill bacteria. This water should be left in a container, so the chlorine can come out of solution. It can also be aerated.

The quantities of these materials for each size of biogas plant are listed in the table at the end of the manual (Table 2).

3. Determining Plant Size

The main size of biogas plant used for the fixed dome model is between 2 and 6 m^3 as measured from the expected daily gas production, assuming a 50 day HRT (hydraulic retention time). There are many other designs of biogas plant that could be used, including much larger ones, but it is better to use a standard design and trained staff. The simple rule of thumb is that each person needs 0.4 m^3 of gas per day, so a family of 5 people needs a 2 m^3 biogas plant. It can be assumed that an average amount of dung from one cow is 10 kg, which can generate 0.4 m^3 of biogas each day, so the same family needs dung from at least 5 cattle.

4. Construction site selection

The selection of the construction site is important. The plant must be close to the source of feed material (usually the cattle shed) and also close enough to where the gas is to be used that the gas pipeline is not too long. A long gas line is expensive and more difficult to install. Water must be accessible, but the plant should not be built close to water water source, as there is a risk of pollution. The plant should not be built close to trees, as tree roots could grow into the plant and break the walls. All these factors need to be considered when choosing the best site. The gas pressure from a fixed dome plant is high, so transfer of gas along a pipeline is not usually a concern. The convenience of the user and the ease of daily feeding is often the main consideration.

5. Plan lay out for excavation of pit

Once the site is selected, the land needs to be cleared of plants and the shape laid out. The position of the inlet and outlet tanks need to be chosen, ensuring there is sufficient room around them (see Figure 1).

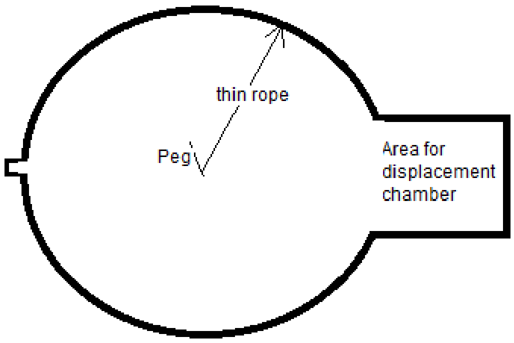

Figure 1 Pit Layouts

A wooden or metal peg is inserted into the soil at the centre of the main digester pit. A rope having the length of the radius of the outside of the floor is looped around the peg and the end used to make a circular mark, using a powder.

6. Excavation of pit for plant construction

The pit can be dug out either by machine or by hand. If a machine is available, the hole can be dug much more quickly, but it is difficult to dig a round hole by machine, so a larger rectangular pit must be made (see Picture 1). If manual labour is used, a cylindrical hole can be dug. Even if the main hole is dug by machine, manual labour is required to shape the hole and especially to shape the bottom portion of the pit that forms the concave floor. All of the soil excavated should be stored nearby, as it will be needed for backfilling around and above the biogas plant after it has been built.

Picture 1 Excavation of a pit for plant installation using machine

Picture 2 A trimmed pit ready for floor concrete

The concave floor should be carefully shaped as defined by the drawings and design parameters for the size of plant that is being built. The outlet pit also needs to be excavated (see Picture 2).

7. Casting the floor concrete

A mix of concrete made from 1:2:4 of cement, sand to stone aggregate is used for the floor. If the soil is weak, i.e. has a significant organic fraction, a stronger concrete can be used, such as a 1:1½:3 mix. If the soil is very weak, such as those named “black cotton soils”, steel rod reinforcement should be used. When the concrete is laid, it should be well compacted to give it strength. The shape should follow the drawing and the design parameters carefully. A simple level, made from a length of transparent plastic tube with water in it, should be used to ensure the flat part of the floor, around the edge of the concave section, is horizontal (see Picture 3). The floor extends over the base of the slurry outlet pit.

Picture 3 Using a simple level to ensure a horizontal floor

Picture 4 Construction of central pillar

8. Construction of central pillar

A central pillar is built of brick and a weak mortar, using a mix of 1:10 of cement to sand, with a length of 6 mm steel rod protruding 50 mm from the top. The top of the pillar needs to be level with the flat shoulder around the edge of the floor (see Picture 4). This pillar is used to guide the construction of the main dome.

9. Guide rod

The guide rod is made from a wooden plank about 50 mm wide and 20 mm thick. The length is determined by the radius of the dome and should be about 50 mm longer. One end can be notched, so it locates on the steel rod in the central pillar. The other end has a nail hammered into it at a position 20 mm longer than the inner radius of the plant, extending 50 mm from the bottom of the plank. Since the brick dome has layers of plaster and cement paste over it, the actual brick dome needs to be slightly larger. The guide rod is used to position each brick, as it is laid in the dome (see Pictures 5 and 6).

Picture 5 Guide rod

Picture 6 Guide rod in use

10. Laying of bricks as a foundation layer

A foundation layer of bricks is laid on the edge of the floor, while the concrete is still wet. The bricks are laid vertically, with the long edge pointing radially towards the centre of the dome (see Pictures 7 and 8). The centre of the bricks should be placed at the centre of the bricks of the dome. The bricks are placed on a thin layer of a mix of 1:4 mortar, with a layer of mortar between 10 and 15 mm between the bricks. The floor and dome foundation should be cured for 12 hours and kept wet with water while they cure. The remaining bricks also need to be soaked with water. Clean water can be poured over the pile of bricks until all the bricks are thoroughly wet. Mortar can be spread over the foundation layer of bricks.

Picture 7 Laying of first layer of bricks

Picture 8 Spacing first layer of bricks

11. Starting construction of the digester

Before construction of the dome is started, most of the bricks can be placed in the concave floor of the digester, so the mason has them close at hand. The position of each brick is determined by the nail in the guide rod. A mortar mix of 1:4, cement to sand should be used in the lower courses of bricks, but a stronger mix of 1:2½ should be used, when the height of the dome is over half its full height. As the courses are laid, care should be taken to avoid two joints in two courses coming in line. Half bricks can be added in a course to prevent this happening. As each brick is added, mortar should be spread below and on the side of the brick. Once the brick is in place, it needs to be tapped with the trowel handle to compress the mortar below and on the side of the brick.

The bricks for the outlet pit must be placed in the correct positions, so the outlet pit is the required size. The bricks for the pit and the dome should blend together. Part bricks may need to be added so they fit together (see Picture 9).

Picture 9 starting construction of the digester

12. Placing of inlet pipe

Picture 10 Placing of inlet pipe

Picture 11 Fitting of inlet pipe

The inlet pipe must be positioned directly opposite the centre of the outlet pit in line with the central pillar, at the right angle. The inlet pipe should be placed after the courses of bricks have reached the right height. If a PVC pipe is used, the surface should scratched with a saw blade, so a bond can be made between the pipe and the mortar. The pipe is held in the correct position with temporary supports and measurements made to ensure it is in the right place (see Picture 10 and 11). The bottom edge of the pipe just sits on the brick of the course below. A strong mortar is used around the pipe and triangular pieces of brick are cut to fit around the pipe and allow it to fit within the brick course (see Pictures 16 and 17).

Picture 12 Fixing of inlet pipe

Picture 13 Alignment of inlet pipe

13. Plastering the outside of the partly constructed digester

Once the height of the digester reaches the height defined for the top of the outlet tank, the outside of the bricks should be plastered with a 12 mm thick layer of 1:4 mix cement mortar. The digester construction can continue while the mortar sets hard. Once this mortar is dried, earth can be backfilled into the digester to the height of the mortared section and compacted. This provides more working space around the dome for the workers and ensures the lower volume of the earth around the plant is properly compacted.

14. Laying of brick layer as top of the digester slurry flow door

The dome needs to be extended over the outlet pit, so a bridge needs to be made over the gap. Piles of loose bricks are placed either side of the gap to support a wooden plank which is 600 mm long, 100 mm wide and 2 to 3 mm thick, placed over the gap (see Figure 13.1). The height of the plank should be 10 mm lower than the design measurement. Mortar can be used to adjust the height. A piece of paper, such as part of a cement bag or a newspaper, is placed on the plank. A layer of strong mortar is placed over the paper and on the wall on either side. A full brick is placed on either side, so they overlap the wall by 20 mm. The gap between the bricks should be filled with more bricks or parts of brick. The bricks need to be compacted and holes filled with strong mortar.

More courses of brick are added to the digester, using rich mortar over the area above the bridge. Once the rest of the digester has been completed (see paragraph 16 below), the wooden plank can be removed. Mortar can be used to shape the underside of the entrance to the outlet tank.

Picture 14 Support plank for box tank ceiling layer

15. Completing the digester dome

As the courses of bricks are laid higher up the dome, the walls slope more steeply inwards. When the angle of slope is more than 45°, the bricks will tend to fall. Hooks weighted with bricks are used to hold the bricks in place (see Figure 15.1). Once a full ring of bricks is complete, it will lock itself in place. When the rings of bricks reach the point where full bricks cannot be used, the final section can be filled with broken brick and mortar, with the gas outlet pipe fixed in place. A circular metal or wooden plate is used to support the bricks, mortar and gas outlet pipe, as they are put in place. A similar round plate is often used to hold mortar when it is used for plastering.

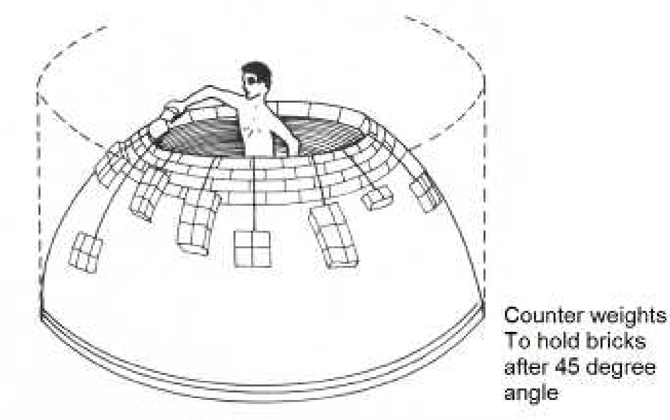

Figure 2 The use of weighted hooks to hold bricks

One layer of bricks is removed from the top of the central pillar, so the plate can be supported on the end of the guide rod placed vertically on top of the pillar. The plate is covered with layers of paper, from a cement bag or newspaper. Dry cement is poured over the paper and the gas outlet pipe, with welded wire pieces, is placed in the hole on the plate below. The gas outlet pipe should be plugged with screwed up plastic, to prevent cement or mortar entering the pipe. Strong mortar is placed in the hole and brick pieces packed in around the gas outlet pipe. More mortar is used to fill the hole and the top sprinkled with cement powder. The arrangement must be left for at least 10 minutes until it has begun to dry.

16. Sealing the dome

As the dome is built, the bricks can be sealed with a mix of cement and water (1:2). If a hole appears in the covering of cement paste, this indicates that there is an underlying hole in the brickwork that needs to be filled with strong mortar. A 12 mm thick layer of cement plaster of a 1:4 mix can then be used to cover the bricks to complete the dome. Once this plaster is set, soil is backfilled around the dome and compacted.

17. Displacement Chamber

The outlet tank needs to be built up to the level of the floor of the displacement chamber. The walls extend to the side of the dome, so bricks need to be cut so the walls fit to the dome surface. Soil needs to be excavated for the displacement tank. The soil can be used to backfill around the digester, although special care needs to be taken around the outlet tank, as the mortar will not be fully set. The size of the excavated area is defined in the drawings and design parameters. If the soil around the outlet tank settles, sand can be added to ensure the reservoir tank floor is level (see Picture 15).

Picture 15 Using sand to give a level base for the reservoir tank

Once the soil floor of the reservoir tank is compacted and level, a layer of concrete can be laid. An 80 mm thick layer of 1:2:4 mix (cement to sand to aggregate) and the floor needs to extend 100 mm wider than the tank walls. If the soil is of poor quality, steel reinforcing rod may need to be used. This is placed on the floor before the concrete is poured. Once the concrete has set, the first layer of bricks can be laid for the tanks walls (see Pictures 16 and 17). The positions of the bricks need to be carefully measured and the shape should be rectangular, with right angles at each corner.

A gap needs to be left in the side of the tank for a slurry outlet. This is placed just above ground level, so the slurry can flow into slurry storage pits. The position of the slurry outlet will depend on where the slurry pits will be located, so this needs to be agreed with the household. The outside of the reservoir tank should be plastered. Rough plaster can be applied up to the level of the outlet, as this will be underground. A fine plaster finish coat can be applied over the rest of the tank, as this will be visible when the plant is completed.

Picture 16 First layer of bricks

Picture 17 Bricks have to correctly placed

18. Finishing the main digester

Once the main dome has set, the guide pole and support plate should be removed from the digester pit, through the outlet pit. Any paper that sticks to the top of the dome should be pulled and scraped away. The central pillar should be knocked down and the bricks removed.

The sealing of the dome to prevent gas leakage requires several layers of cement plaster. The first layer is a 1:2 mix of cement and water, which should be applied over every part of the inside of the dome. The inside of the dome is then plastered with the second layer, a 12 mm thick layer of a 1:4 mix of mortar. The surface should be carefully smoothed with a wooden trowel. Any mortar dropped on the floor can be spread over the concrete. The inside of the dome is dark, so light must be directed into it. A light coloured plastic bag can be used on the floor to reflect light inside.

A third layer is a paste of 1:1 cement and water. This should be thoroughly mixed to a smooth paste, without lumps. A 1 to 1½ mm thick layer of this cement should be applied with a trowel as an even coat over the whole of the inside of the dome. Two more layers of a mix of 1:2 cement to water are finally applied, one when the cement paste has started to dry and a second coat just before the plant is ready to be fed. These coats can be applied with a paintbrush, with the mix being worked into the surface.

19. Casting of concrete slabs to cover the reservoir tank

The work of casting slabs can be done on a spare flat area of ground at a convenient time. Each slab is 600 to 700 mm wide, 1200 to 1400 mm long and 60 to 80 mm thick. They are reinforced with 9 to 10 lengths of 6 mm diameter steel rod. The concrete mix is 1:1½:3 of cement to sand to aggregate.

The ground is cleared and leveled and covered with a layer of sand, 10 to 20 mm thick. A layer of paper is placed over the sand, either from cement bags or a double layer of newspaper. The shape of the slab is defined by bricks, with paper covering them to prevent concrete sticking to them. A layer of 20 mm of concrete is spread over the space between the bricks. Steel rod is cut to the correct lengths and placed across first the width and then the length of the rectangle. The rods are bound together, at the places where they cross, with thin steel wire. The rest of the concrete is poured on top of the wires and spread and compacted evenly to the required thickness. A wooden plank can be used to ensure the top of the plate is level and properly compacted.

If there is room, all of the slabs can be made at the same time. Depending on the size of the plant that is being built, between 3 and 6 slabs are required.

20. Construction of inlet tank

The inlet tank is built over the end of the inlet pipe. Soil must be backfilled around the pipe and built up to a level 80 mm below the top of the pipe. The soil must be compacted, allowed to settle and made level. The floor of the inlet tank is poured over the flat soil and made 100 mm wider than the tank on each side. Once the floor is sufficiently set, the tank walls are made to the correct dimensions. The floor of the inlet pit is shaped in concrete, so it has a ridge close the the opening of the inlet pipe. The floor slopes away from the ridge to the side away from the inlet pipe, so that sediment can settle when the feed material is mixed and be prevented from entering the inlet pipe.

21 Curing of civil works

Cement structures take time (about 15 days) to attain full strength and should be kept moist with water during this time. When the digester is covered in soil, water can be poured over the soil regularly to keep the structure under it moist. The concrete slabs can be kept moist by covering them with sacking that is kept wet, or by ensuring water is poured over the slabs regularly.

21. Backfilling with soil and digging slurry store

The main digester must have at least 100 mm of soil over the top. Soil should be piled up around the inlet tank and the slurry reservoir, apart from around the slurry outlet. If this soil is kept wet, it will compact enough to give strength to the dome structure.

A pit is required under the outlet of the slurry reservoir to collect the effluent slurry. The size of the hole will depend on the size of the plant. The reservoir should hold about 10 days of feedstock. A 2 m^3 biogas plant is fed with 50 kg of dung, mixed with 50 litres of water, so the pit should hold 1 m^3 of liquid.

22. Gas pipe fitting

A length of HDPE pipe is used to take the gas from the biogas plant to the place where the gas is used, usually the kitchen. The main gas valve is screwed onto the gas outlet pipe on the top of the main digester. The plastic in the gas outlet pipe must be removed before the main gas valve is connected. One of the galvanized pipe (GI) lengths is screwed into the top of the main gas valve. The HDPE pipe is unrolled and laid between the biogas plant and the kitchen. The pipe is laid above ground and passed over a pole fixed in the ground, so the pipe slopes towards the main gas valve, to allow condensed water to run back into the plant.

The end of the HPDE pipe is heated, usually in a container of hot oil, so it softens and can be stretched to fit over the end of the galvanized iron (GI) pipe. A pipe clamp is put over the HPDE pipe, the softened pipe is pushed over the GI pipe and shaped by hand, using a cloth to insulate against the hot plastic. The clamp is pushed over the plastic and tightened. The other length of GI pipe is connected to the other end of the HDPE in the same way.

The HDPE pipe is passed through a hole made in the kitchen wall and fixed in a place that allows the biogas burner to be used easily. The pipe between the support pole and the kitchen is supported so it is out of the way. It can be attached to walls and trees to lift it above paths and yards. The HPDE pipe should not be allowed to form loops, as condensed water can form in these loops and prevent gas flowing.

The brass nipple is screwed into the GI pipe in the HDPE pipe in the kitchen, so that the rubber pipe can be connected between the pipe and the burner.

23. Starting a biogas plant

The plant needs to be filled with a mixture of fresh animal dung mixed 1:1 with water. The plants are designed to have a 50 day retention time, so 50 times the daily feed amount is required. A 2 m^3 plant (gas production per day) needs 50 kg of dung per day, so an initial feed needs 2500 kg of dung. The plant users should be advised to collect dung from the time a decision is made to build a biogas plant. The dung should be kept in the shade and kept moist. In this way, material is available to start the plant more quickly. Once the installation has cured, the dung can be mixed 1:1 with water and fed to the plant. The water should come from an irrigation canal or from a ground water supply. Tap water often contains chlorine, which acts as a disinfectant and kills the microbes that enables a biogas plant to function.

Once the plant is filled to the point where the slurry reaches the level of the top of the outlet pit (the floor of the reservoir tank), it should be left to generate biogas. This may take several days. The main gas valve is left open for several days and then closed. If gas is being generated, it will be released when the valve is opened. The rubber pipe to the burner can then be connected. The gas should be collected for another day and used to flush air out of the gas pipe. After another day, the gas can be tested to see if will burn in the biogas burner. If it burns badly, the plant may need to be left for another day or two until better quality gas begins to be generated.

Once good quality gas is being produced, the plant should be fed daily with the correct amount of cattle dung mixed 1:1 with water.

23. Construction dimensions of biogas plants of different sizes

The plant dimensions in mm are given in Table 23.1 for four sizes of biogas plant. The letters relate to codes in the drawing in Figure 23.1. The quantities of the different materials required to build the different sizes of plants are given in Table 23.2.

Sl. No.	Description	2 m^3	3 m^3	4 m^3	6 m^3
1	A – Height of the Mixing Tank	600	600	600	600
2	B – Thickness of Digester at gas outlet level	120	120	150	150
3	C – Width of the Displacement Tank	1000	1000	1200	1200
4	D – Displacement tank height above the hole	330	300	330	380
5	E – Width of the mixing tank concrete base	1000	1000	1100	1200
6	F – Width of mixing tank	600	600	700	800
7	G – Thickness of digester masonry work	70	70	100	100
8	H – Thickness of base concrete at digester base	70	80	100	150
9	J – Height of the tapper portion or height of the centre pillar	550	600	650	800
10	K – Height of the inlet pipe inner edge from the base concrete	300	400	500	600
11	L – Height of the arch from the bottom inner tip of the inlet pipe	250	250	250	250
11A	Height of Arch from the base concrete (K+L)	550	650	750	850
12	M –Initial slurry level height from the base concrete	730	870	980	1100
13	N – Radius of the Digester	1300	1500	1650	1900
14	P – Arch height from arch tank concrete base	480	580	680	780
15	Q – Length of the arch tank	700	700	900	900
16	R – Thickness of arch tank wall under the displacement tank wall	220	220	220	220
17	S – Arch tank height until the bottom of the concrete base of the displacement tank	580	720	830	950
18	T – Diameter of the digester	2640	3000	3300	3800
19	U – Height of the slurry exit hole from the bottom of the displacement tank	350	400	450	550
20	V- Width of the concrete under the digester base	250	250	250	250
21	W –Length of the Displacement tank	1900	2500	2500	3000

Table 1 Dimensions for standard Deenbandhu biogas plants

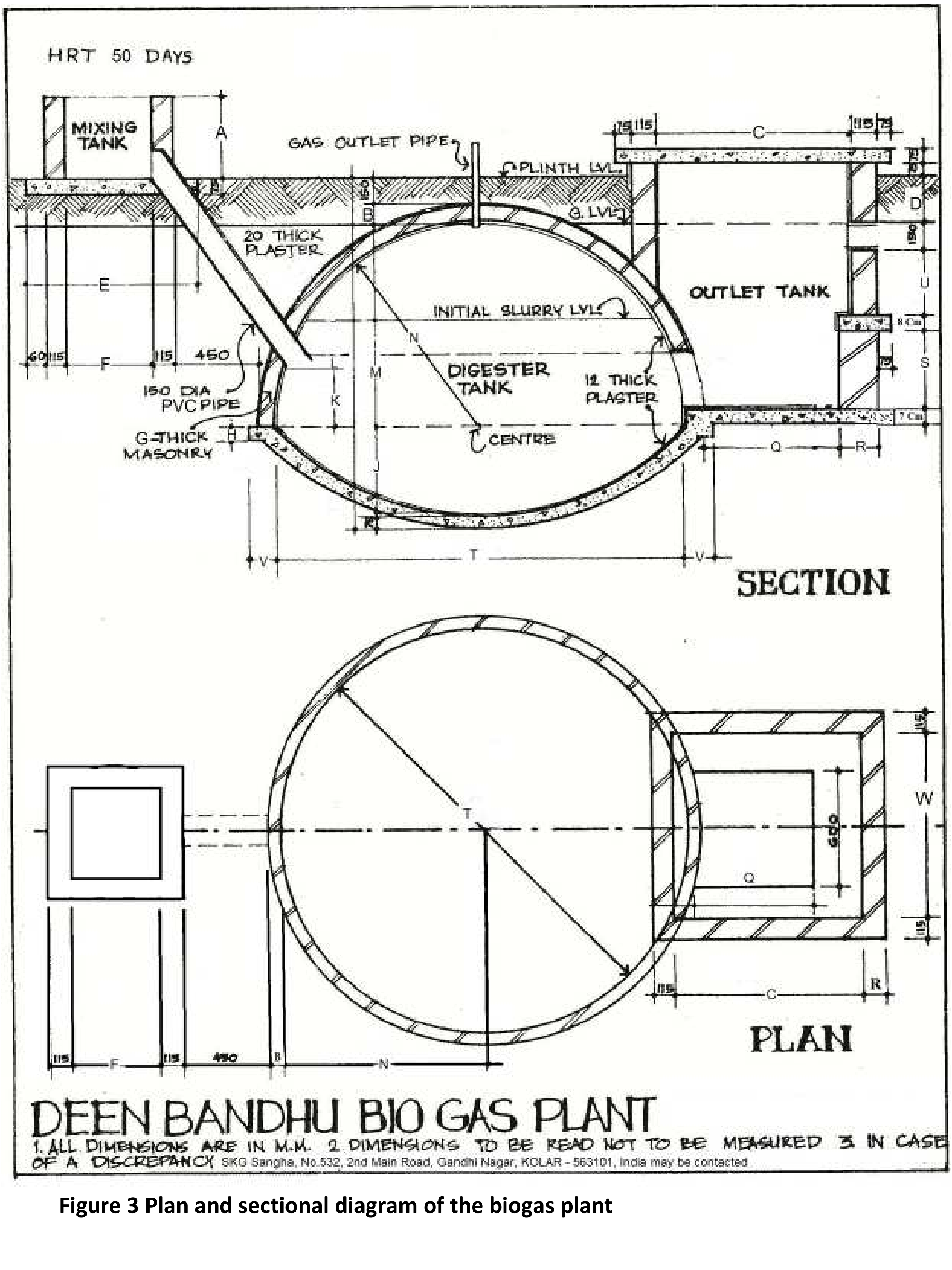

Figure 3 Plan and sectional diagram of the biogas plant

Sl.No	Description	2 m^3	3 m^3	4 m^3	6 m^3
1	Well burnt solid mud bricks of 220 x 100 x 70	1000	1200	1800	2600
2	Cement bags of 50 kg each, 42.5 grade OPC	17	19	25	35
3	Sand - course in cubic meters	1.5	2	2.5	4
4	Sand – fine in cubic meters	1.5	2	2.5	4
5	Broken granite stone aggregates m^3	1	1.5	2.5	3.5
6	6 mm iron wire in kilograms	8	10	20	25
7	Binding iron wire in kilograms	0.1	0.1	0.2	0.25
8	PVC – 150 mm diameter pipe in meters	1.35	1.5	1.7	2.1
9	Gas outlet pipe GI 20 diameter 300 long	1	1	1	1
10	Manual labour in man days – pit digging	6	10	15	25
11	Trained mason in man days	4	5	7	10
12	Manual labour in man days – for construction	15	20	25	35
13	Manual labour in man days – to complete plant	3	5	8	12
14	Manual labour in man days – water curing	4	4	4	5
15	Manual labour in man days – Initial feeding	4	6	8	15
16	PVC ball valve of 20 mm diameter	1	1	1	1
17	Biogas stove/Burner	1	1	1	1
18	GI nipples 20 mm diameter 100 long	2	2	2	2
19	Female threaded brass metal pipe nipple	1	1	1	1
20	Rubber hose in meters	1	1	1	1
21	HDPE pipe 20 mm diameter in meters	50	50	50	50
22	Plumber in man days	½	½	½	½
23	Supervision of work in man days	15	15	15	15
24	Fresh animal dung for initial feeding in tonnes	2.5	3.75	5	7.5

Table 2 Material required for biogas plant installation