AFPRO'S
FIELD GUIDE TO BIOGAS TECHNOLOGY

RAYMOND M. MYLES
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AFPRO
INDIA

ACTION FOR FOOD PRODUCTION (AFPRO)
NEW DELHI - 110 058

AFPRO's

FIELD GUIDE TO BIOGAS TECHNOLOGY

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ACTION FOR FOOD PRODUCTION(AFPRO)

Action for Food Production - AFPRO is a non-profit technical service Indian organisation registered under the Societies Registration Act, 1960. AFPRO works in support of and in collaboration with the Government of India without consideration for race, caste, creed or religion. Through its staff at its headquarters in New Delhi, and its seven field units at Ahmednagar, Bangalore, Coimbatore, Patna, Varanasi, Hyderabad and Aligarh, it provides technical support and assistance to grass-roots level rural development organisations in the field of agriculture and rural development. AFPRO has expertise in water resources development, agro-forestry, general agriculture, appropriate agricultural and rural engineering and bio-energy technology, livestock management, decentralised rural energy planning and implementation. It promotes technologies relevant to rural areas, provides training to upgrade the skills of voluntary agency staff; helps voluntary agencies formulate viable plans of development, and monitors and evaluates them on behalf of both funding(overseas and Indian) and local project implementing organisations. AFPRO also provides a reference service in rural and agricultural and low-cost renewable energy technologies.

In its efforts to provide technologies relevant to rural peoples which would improve their quality of life, AFPRO identified the fixed dome biogas plant and demonstrated it to its grass-roots level partners in various agro-climatic areas in the country. When the technology found acceptance at the village level, AFPRO devised a strategy in which rural voluntary agencies were helped to build a cadre of skilled masons necessary to spread the technology. AFPRO's active involvement in the promotion of biogas technology began nine years ago. Today AFPRO provides technical assistance to 50 voluntary organisations which work through 100 centres throughout India to spread this technology by training masons and building biogas plants. Over 500 construction training programmes have been conducted so far, training approximately 5000 masons, and over 15,000 plants have been constructed by AFPRO and its related grass-roots level voluntary agencies.

Under the National Biogas Development Programme, AFPRO and its related agencies have developed capabilities of constructing about 10,000 biogas plants annually in some of the remotest corners of India and provide regular and efficient post-plant installation services(pre-testing of new plants before commissioning, follow-up, routine service, maintenance and repairs) to plant owners.

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BIOGAS TECHNOLOGY

1.0 INTRODUCTION :

1.1 Nature has a provision for destroying and disposing off wastes and dead plants and animals. This decay or decomposition is carried out by tiny micro-organisms called bacteria. Making of farm yard manure(FYM) and compost is also through decomposition of organic matter(O.M). When a heap of vegetable or animal wastes and weeds etc., die or decompose at the bottom of back-water or shallow lagoons, bubbles can be noticed rising to the surface of water. Sometimes these bubbles burn with dancing flame at dusk. This phenomenon was noticed for ages which puzzled man for a long time. It was only during the past hundred years that this secret was unlocked by some Scientists, as the decomposition process. The gas thus produced was and still called as "Marsh Gas". The technology of scientifically harnessing this gas under artificially created conditions is known as Biogas Technology.

1.2 Biogas technology has a very significant role to play in integrated agricultural operations, rural sanitation, large scale dairy farms & sewage disposal etc. It is estimated that cattle dung, when passed through a biogas unit, yields 30-40% more net energy and about 35-45% more Nitrogen in manure as compared with heat obtained by burning dung cakes and ordinarily prepared compost, respectively. Besides, from a biogas plant both the products are obtained.

There are about 250 million bovine(cattle and buffaloes) population in India and one biogas unit for small family requires about 3-5 cattle heads, thus about 10 million family size plants fed on cattle and buffalo dung can be installed. On the whole, as per the estimates of NCAER total energy produced by livestock excreta amounts to about 80% of the rural fuel requirement.

2.0 BIOGAS PLANT :

Biogas is a mixture of a few gases, such as Methane, Carbon-dioxide, Hydrogen and Ammonia etc., formed as a result of anaerobic digestion of organic wastes. A biogas plant is commonly described as underground masonry, well shaped fermentation tank connected with inlet and outlet tanks and covered by an inverted floating or fixed gas storage tank.

2.1 Process description :

Biogas generation is a process widely occuring in nature and can be described as a biological process in which biomass or organic matter, in the absence of Oxygen, is converted into Methane and Carbon-dioxide. It is characterised by low nutrient requirement, and high degree of waste stablization process where biogas is one of the two useful end products; the other being enriched organic manure in the form of digested slurry. It is essentially a three stage process involving following reactions:-

1) Hydrolysis
2) Acid formation and 3) Methane generation.

For all practical purposes the first two steps are often defined as a single stage i.e hydrolysis and acid formation stages are grouped as acid formation stage. Micro-organisms taking part in this phase are termed as acid formers. As a group, these organisms are rapidly growing and are not much dependent upon surroundings.

Products of first two stages serve as the raw material for third stage where organic acids are utilized as carbon source by Methane forming micro-organisms which are also known as Methanogens. The methanogens are more susceptible to their surroundings. The tolerated pH range is 6.8 to 7.5 with optimum 7.0. Any departure from this range is inhibitory. Atmospheric Oxygen is extremely toxic for methanogens as they are strict anaerobes.

2.2 Parameters affecting anaerobic digestion :

There are several parameters which affect the anaerobic digestion/ gas yields and they can be divided into two parts :

(i) Environmental factors :

There are a few environmental factors which limit the reactions if they differ significantly from their optimum levels. Factors of most interest are : (a) temperature, (b) pH and (c) nutrient contents of the raw materials.

a) Temperature :

It is a factor which affects most small & medium size biogas installations in developing countries. There are three zones of temperature in which biogas is produced by anaerobic fermentation of organic matter, viz.: 1) Mesophillic , 2) Thermophillic and 3) Psycrophillic zones. The optimum temperature of digester slurry in Mesophillic zone is 35^0C, 55^0C in Thermophillic zone and 10^0C in Psycrophillic zone. In different temperature zones different sets of microbes(bacteria) especially the methanogens remain active; whereas the other two groups of microbes either remain dormant and thus more or less inactive as far as the anaerobic digestion is concerned or get killed. However, the rate of fermentation is much faster at high temperature.

Most rural household biogas plants(digesters) in developing countries operate at ambient temperatures, thus digester slurry temperature is susceptible to seasonal variations but is more dependent on the ground temperature than the atmospheric temperature. As a result gas output in winter falls by upto 50%. Below a slurry temperature of 10^0C all the reactions cease to take place but revive gradually with the rise in temperature.

b) pH :

The pH range suitable for gas production is rather narrow i.e 6.6 to 7.5. Below 6.2 it becomes toxic, pH is also controlled by natural buffering effect of NH_4^+ and HCO_3^- ions. pH falls with the production of volatile fatty acids(VFAs) but attains a more or less constant level once the reactions progress.

c) Nutrient concentration :

Biogas producing raw materials can be divided into two parts i.e 1) Nitrogen rich and 2) Nitrogen poor. Nitrogen concentration is considered with respect to carbon contents of the raw materials and it is often depicted in terms of C to N ratio. Optimum C/N ratio is in the range of 25 to 30:1. In case of cattle dung the problem of nutrient concentration does not exist as C/N ratio is usually around 25:1.

(ii) Operational factors :

Operational factors contributing to the gas production process are : (a) retention time(RT) - also referred as detention or residence time, (b) slurry concentration and (c) mixing.

a) Retention Time(RT)

It is the period during which any organic matter is subjected to the anaerobic environment and reaction in a biogas digester. When the organic matter is fed in the form of slurry the term used is Hydraulic Retention Time(HRT); whereas if it is fed in the solid form(usually 20-30% T.S), the term used is Solid Retention Time(SRT).

Retention time is proportional to the temperature of the process. At 25-30^{0}C retention period of 40-55 days, at 35-37^{0}C, 20 days and at 55^{0}C, 6-10 days are recommended.

Retention time has a direct bearing on the size of the digester as it is equal to retention time multiplied by the volume of daily feed.

b) Slurry Concentration

This is denoted by dry matter concentration of the inputs. The optimum level for cattle dung slurry in the range of 8 to 10% and any variations from this, result in lower gas output. Mixing four parts of dung with five parts of water forms a slurry with dry matter concentration of about 9%, whereas 1 part of dung to 1 part to water would give a slurry concentration of 10%. This also affects the loading rate etc.

c) Mixing & stirring

Proper mixing of manure to form an homogenous slurry before it is fed in the digester, is an essential operation for better efficiency of biogas systems; whereas proper stirring of digester slurry ensures repeated contact of microbes with substrate and results in the utilization of total contents of the digesters. An extremely important function of stirring is the prevention of formation of scum layer on the upper surface of the digester slurry which, if formed, reduces the effective digester volume and restricts the upward flow of gas to the gas storage chamber.

Mixing results in premature discharge of some of the inputs and a perfectly unmixed system is likely to result in better reaction rate but for the problem of scum formation.

3.0 BENEFITS OF USING THE BIOGAS PLANT :

1. The biogas plant converts cattle dung into two useful products viz.: inflamable gas(biogas) and good quality manure.
2. Biogas provides a smokeless, high efficiency fuel for cooking, lighting and producing motive power.

3. The manure obtained from biogas plant has higher nutritive value as compared to that of ordinary farm yard manure.

4. Biogas plants keep the household and surroundings clean.

5. Biogas plants prevent deforestation.

6. Control environmental pollution and promote public health.

4.0 BROAD CLASSIFICATION OF RURAL HOUSEHOLD DIGESTER :

There are three basic methods by which rural household biogas digesters in developing countries are operated in practice, namely: (i) batch, (ii) semi-continuous and (iii) semi-batch digesters.

(i) Batch digester :

In this process whole of digester is filled with raw materials for gas production alongwith some starting(seed) material. This is allowed to ferment and produce gas over a certain length of time and when gas yields become very low the digester is emptied of all the sludge which can be applied as manure. In this system gas production begins at a low level and goes on increasing only to drop down again after reaching the peak. Because of variable gas production level, high cost and periodic emptying and filling of digesters, this process has not become popular. Examples of the digesters are small size garbage plant and crop-residues plant.

(ii) Semi-continuous digester :

The rural household digesters are fed once a day and the fresh input displaces the same volume of spent materials from the digester. Everyday a certain quantity of fresh inputs is fed into the digesters which is expected to remain in the digester for a prescribed retention time and produces gas over this length of time before being discharged out.

(iii) Semi-batch digester :

A combination of batch-fed and semi-continuous fed digestion is known SBF digestion. Such a digestion system is used where the waste like garbage etc., which are available on daily or weekly basis but cannot be reduced to make slurry. In semi-batch system, the animal manure can be added on daily basis after the initial loading is done with garbage, agricultural wastes, leaves, crop residence or water hyacinth etc.

5.0 SIZE SELECTION OF RURAL HOUSEHOLD BIOGAS PLANTS :

Size of the rural household biogas plant to be installed, should be selected on the basis of gas requirement and the livestock manure availability with the beneficiaries. Since, cattle dung is the main substrate for the biogas plant in rural India, the table given below shows the relationship among plant capacity, daily cattle dung requirement and gas use.

S.No	Plant capacity Cu.m(cft)	Daily dung requirement (kg)	Approximate no. of cattle	No. of family members
1.	1(35)	25	2 - 3	3 - 4
2.	2(70)	50	4 - 6	5 - 8
3.	3(105)	75	7 - 9	9 - 12
4.	4(140)	100	10 - 12	13 - 17
5.	6(210)	150	12 - 20	18 - 25

6.0 POPULAR DESIGNS OF BIOGAS PLANT MODELS :

There are three popular Indian designs of biogas plants namely : KVIC, Janata and Deenbandhu biogas plants. For construction of KVIC & Janata model plants - Indian Standard IS:9478-1986 released by Bureau of Indian Standards should be followed. Brief description of the three models is given below :

6.1 KVIC plant :

It was in or around the year 1945 that Scientists at Indian Agricultural Research Institute(IARI), New Delhi worked on semi-continuous flow digesters and in the year 1961 Khadi and Village Industries Commission(KVIC) patented a design which is being popularised by various agencies in many countries. This design consists of a deep well shaped underground digester connected with inlet and outlet pipes at its bottom, which are separated by a partition wall dividing the 3/4th of the total height into two parts. A mild steel gas storage drum is inverted over the slurry which goes up and down around a guide pipe with the accumulation and withdrawl of gas. Now FRP and ferro-cement gas holders are also being used in KVIC plant.

6.2 Janata plant :

The Janata model is a fixed roof biogas plant which was developed by PRAD in 1978. This is also a semi-continuous flow plant. Main feature of Janata design is that the digester and gas holder are part of a composite unit made of bricks and cement masonry. It has a cylindrical digester with dome shaped roof and large inlet and outlet tanks on two sides. It requires shuttering for making the dome shaped roof and skilled and trained master mason is a must for the construction of Janata biogas plant. This plant costs about 20-30% less than the cost of KVIC floating drum type plant.

6.3 Deenbandhu plant :

As a result of concerted efforts to reduce the cost of biogas plants, AFPRO designed and developed a new low cost fixed roof biogas plant which has been named Deenbandhu Biogas Plant(DBP). The reduction in cost of DBP has been brought about without adversely affecting the efficiency of biogas plants.

After intensive trial and testing under controlled conditions and field applications, designs of DBP have been standardized for family size installations. The designs of Deenbandhu biogas plants have been approved by the Department of Non-Conventional Energy Sources(DNES), Govt. of India for extension under the National Project on Biogas Development(NPBD).

Deenbandhu biogas plants are built with locally available building materials such as bricks, cement and sand. Unlike Janata biogas plants, for constructing plants of this design no shuttering is required for making the dome shaped roof. This also results in less labour and time required for completing the construction. Details of constructional methodology and other aspects related to Deenbandhu biogas plants can be obtained from "A Manual on Deenbandhu Biogas Plants" prepared by AFPRO and published by and available from Tata McGraw-Hill Publishing Co. Ltd, New Delhi.

7.0 COMPARISION AMONG FAMILY SIZE KVIC, JANATA AND DEENBANDHU BIOGAS PLANTS :

S. No.	KVIC	Janata	Deenbandhu
1.	The digester of this plant is a deep well shaped masonry structure. In plants of above $3m^3$ capacity a partition wall is provided in middle of the digester.	Digester of this plant is a shallow well shaped masonry structure. No partition wall is provided.	Digester is made of segments of two spheres: one each for the top and bottom

S No.	KVIC	Janata	D enbandhu
2.	Gas holder is generally made of mild steel. It is inverted into the digester and goes up and down with formation and utilisation of gas.	Gas holder is an integral part of the masonry structure of the plant. Slurry from the gas storage portion is displaced out with the formation of gas and comes back when it is used.	The structure described above includes digester and the gas storage chamber. Gas is stored in the same way as in the case of Janata plants.
3.	The gas is available at a constant pressure of about 10 cm of water column.	Gas pressure varies from 0 to 90 cm of water column	Gas pressure varies from 0 to 75 cm of water column.
4.	Inlet and outlet connections are provided through A.C pipes.	Inlet and outlet tanks are large masonry structures designed to store the slurry displaced out of the digester with the formation of gas.	Inlet connection is through A.C pipe.Outlet tank is a large masonry tank designed to store slurry displaced out of the digester with the formation of gas.
5.	Gas storage capacity of the plant is governed by the volume of gas holder.	It is the combined volume of inlet and outlet dis-placement chambers(portions of inlet and outlet tanks above the second step).	It is the volume of outlet displacement chamber.
6.	The floating mild steel gas holder needs regular care and maintenance to prevent the gas holder from getting worn out because of corrosion. It also has a short life span.	There is no moving part and hence no recurring expenditure. It also has a long working life.	There is no moving part and hence no recurring expenditure. It also has a long working life.
7.	Installation cost is very high. A 2 cu.m plant costs over Rs.5,700.00.*	It is cheaper than the KVIC type plants. A 2 cu.m plant costs about Rs.4,500.00*	It is much cheaper than KVIC and Janata type plants. A 2 cu.m plant of this design costs Rs.3,300.00.*
8.	Digester can be constructed locally the gas holder needs sophisticated workshop facilities.	Entire plant can be built by a trained mason using locally available materials.	Entire plant can be built by a trained mason using locally available materials.

* Cost comparision of 55 days HRT plants of KVIC, Janata & Deenbandhu models based on estimation of average cost of building materials, labour and masons as on January 1, 1987, from AFPRO records.

Table -1

TABLE OF RECOMMENDED PIPE DIAMETERS FOR VARYING FLOW RATES AND DISTANCES BETWEEN BIOGAS PLANT AND POINTS OF USE

Distances / Flow rate	25 m	50 m	100 m	150 m	200 m	300 m	400 m	500 m
16 cft/hr	½"	3/4" for 25 m ½" for 25 m	3/4"	3/4"	1" for 150 m 3/4" for 50 m	1" for 200 m 3/4" for 100 m	1" for 350 m 3/4" for 50 m	1"
24 cft/hr	1/2"	3/4"	3/4"	1" for 100 m 3/4" for 50 m	1" for 150 m 3/4" for 50 m	1"	1½" for 200 m 1" for 150m 3/4" for 50m	1½" for 200 n 1" for 300 m
32 cft/hr	½"	3/4"	3/4"	1" for 100m	1" 1" for 50m	1½" for 50 m 1" for 200 m 3/4" for 50m	1½" for 350m 1" for 150m	1½" for 300 m 1" for 200 m
48 cft/hr	3/4"	3/4"	1" for 75m 3/4" for 25m	1"	1"	1½" for 100 m 1" for 150m 3/4" for 50m	1½" for 300m 1" for 100 m	1½" for 400 m 1" for 100m
64cft/hr	3/4"	1"	1½" for 50m 1" for 50 m	1½" for 100 m 1" for 50m	1½" for 150m 1" for 50m	1½"	1½"	2" for 150 m 1½" for 350 m

8.0 PIPELINE FOR BIOGAS PLANTS:

Employing correct size pipeline for transporting biogas from plants to the points of use is very crucial from the point of view of efficiency of gas utilization and the cost of installation.

The gas distribution pipeline has been designed and recommended pipe sizes for different combinations of flow rates and distances between gas production and utilisation points are given in Table 1. These recommendations are made for galvanised iron pipe.

8.1 Laying the gas distribution pipeline :

Like no uniform design can be prepared for suiting all the biogas installations, there is no laid down procedure for laying of gas pipeline for all biogas facilities.

Pipeline may have to be above or below the ground or it may be partly above and partly below the ground. While a properly laid underground pipeline would require less maintenance, it may get corroded faster at some places whereas in other places corrosion of above ground pipeline may be more rapid.

Employing high density polyethylene pipes enables us to overlook the problem of corrosion and in this case underground pipe may be preferred over the above ground pipe.

Various factors which need to be adhered to at the time of pipe laying are :

(a) Pipe and fittings to be used for laying gas distribution system must be of best quality. It is important from safety point of view and needs to be paid more attention for in-the-house connections. Extra emphasis must be given to the selection of valves to be employed.

(b) All underground pipes should be coated with protective paints to avoid corrosion. Underground pipes should be about 1 foot below the ground level.

(c) As far as possible only bends(not elbows) should be used for 90^0 turns in the pipeline. This reduces pressure drop.

(d) Only gate valves, plug valves and ball valves should be used for gas pipeline to minimise pressure loss during flow of gas through the valves.

(e) For connecting the burners with gas pipeline, use of transparent polyethylene tubes should be avoided and only neoprine rubber tube should be used.

(f) Biogas is saturated with water vapour and slight fall in temperature causes its condensation in the pipeline. Therefore, adequate arrangements to remove the consensate must be made, at the time of pipe laying. All the pipes must have some gradient and at all the low points water removers should be installed. Water accumulation in pipe results in drop in pressure which causes reduction in flow rate.

The water remover can be of two basic types :

(i) Manually operated water remover

A schematic diagram of this type of water remover is depicted in Fig.1. It is a 'T' joint at the lowest point of a certain section of gas pipeline. The vertical branch of the 'T' is kept in a perpendicular downward direction and it is connected to one foot long piece of pipe. The other end of this pipe is either plugged or fitted with a valve. The condensate in the pipeline will flow into this pipe and will be drained off manually at an interval of a week or ten days or as guided by experience.

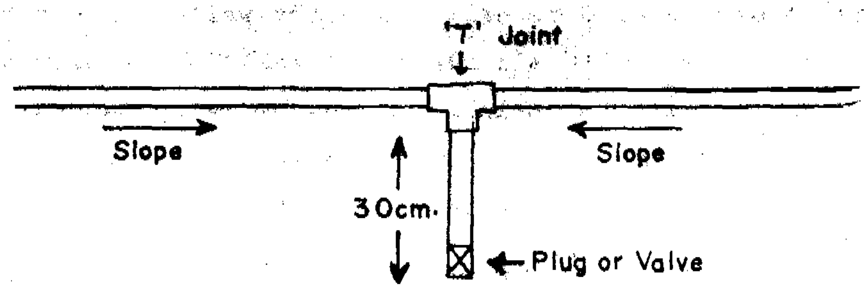


Fig. 1: schematic diagram of water remover

(ii) Automatic water removal siphon

In this type of water removers the vertical branch of 'T' joint should be atleast of 1"(25 mm) diameter. It is connected to a 'U' shaped assembly as shown in Fig.2.

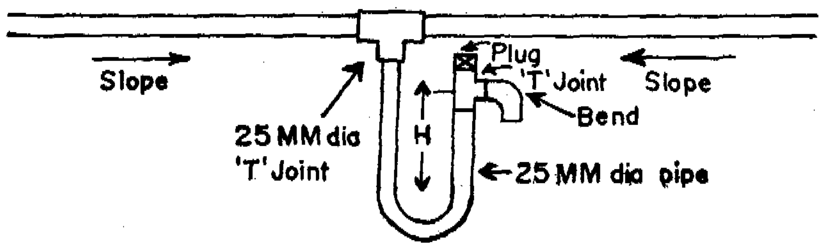


Fig.2: Automatic water removal siphon

Height of the free arm of the U tube,(marked H)should be atlest 100 cm for Deenbandhu plants, 110 cm for Janata biogas plants and 20 cm for KVIC type biogas plants. The upper end of free arm of 'U' should be a little below the gas pipeline. A bend facing downwards is also provided on top of the free arm of'U' for draining out the condensate. The 'U' tube will always be kept filled with water which can be ensured by periodic checks. When some condensate flows into the fixed arm of the'U', equal quantity of water from the 'U' will be discharged through the bend fitted to the free arm.

(g) Whole gas distribution system should be divided in a few sections so that anyone of them can be isolated from rest of the pipeline if it were to be repaired. This can be done by providing UNIONS at points where bends have been employed.

(h) Above ground pipe should be only along the walls and not hanging free. It should be hooked all along the walls(especially on both sides of valves) with the help of clamps at every two meters or so and no pipe should sag at any point. There should be a continuous slope in the directions of water remover.

(i) Gas cock in the houses should be out of the reach of children.

(j) At the time of installation, whole pipeline should be tested for any leakage at a pressure of 1 kg/cm^2, if possible.

(k) Burners should be connected in such a way that gas taps are in the front so that to operate the burner the user does'nt have to take her/his hand over the burner.

(l) Sketch of sample layout for pipeline from biogas plant to the house is shown in Figure 3. Normally, atleast one water remover for 100 m pipe length should be installed. Details of in-the-house connections are not shown in the figure as it will vary from house to house. However, all the points mentioned above must be kept in mind while laying pipeline in the house.

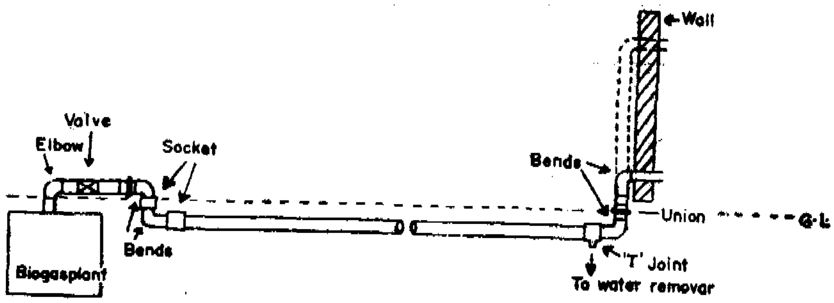


Fig.3 : Sketch of sample layout of pipeline from biogas plant to the house

9.0 UTILIZATION OF BIOGAS :

Biogas is a very clean fuel, which can be used for cooking, lighting and generating motive power. Gas required for different uses is as follows :

1. Biogas requirement for cooking is 8 to 10 cft(0.25 to 0.3 cu.m) gas per head per day. Standard biogas stoves consume 16 cft (o.425 cu.m) gas per hour.

2. Biogas lamp consumes 4-5 cft(0.15 cu.m) gas per hour.

3. Dual fuel (diesel & biogas) engines consume 15-16 cft(0.425 cu.m) gas per hour per hp.

10.0 UTILIZATION OF BIOGAS PLANT EFFLUENT :

The digested slurry(dung and water mixture) available from biogas plants is highly nutritious organic manure. To derive maximum benefit from biogas plants it is necessary to use this manure efficiently. One of the ways - which is most common and recommended -is to have manure flowing into the pits covered by a layer of wastes from the cattle shed, household and the farm. The sizes and their numbers alongwith details of costs for different capacities of biogas plants are given below :

DETAILS OF COMPOST PITS

Table-2

Plant size	1 m^3	2 m^3	3 m^3	4 m^3	6 m^3
No. of compost pits	2	2	2	3	3
Size of each pit(in meters)	1.5x1x1	1.5x2x1	1.5x3x1	2x2x1	2x3x1

COST OF COMPOST PITS

Plant size		1 m^3		2 m^3		3 m^3		4 m^3		6 m^3	
Material	Rate	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
1. Brick	450/- per 1000	800	360/-	1000	450/-	1200	540/-	1800	810/-	2200	990/-
2. Cement	65/-per kg	2	130/-	2	130/-	2	130/-	3	195/-	4	260/-
3. Sand	2.5 per cft	15	37.50	15	37.50	15	37.50	20	50/-	30	75/-
4. Labour for	15/-per day	4	60/-	6	90/-	8	120/-	12	180/-	16	240/-
5. Masons for construction	35/- per day	2	70/-	2	70/-	3	105/-	4	140/-	5	175/-
6. Labour for construction	15/- per day	2	30/-	3	45/-	5	75/-	7	105/-	10	150/-
Total			687.50		822.50		1007.50		1480/-		1890/-
Say			700.00		825.00		1025.00		1500.00		1900.00

DIMENSIONS OF DEENBANDHU BIOGAS PLANTS
(FOR 55 DAYS HRT)

SYMBOL	PLANT CAPACITIES				
	1 cu.m	2 cu.m	3 cu.m	4 cu.m	6 cu.m
A	1125	1400	1590	1750	1975
B	450	560	636	700	790
C	75	75	75	100	100
D	2250	2800	3180	3500	3950
E	95	340	460	500	725
F	200	150	180	230	250
G	0	75	150	150	200
H	320	565	685	725	950
I	537	647	723	812	902
J	445	640	790	880	1200
K	350	450	480	550	550
L	287	267	317	317	372
M	1000	1000	1000	1000	1200
N	940	1465	2080	2420	3030
O	190	175	175	120	230
P	75	75	75	100	100
Q	150	150	150	150	230
R_1	1125	1400	1590	1750	1975
R_2	1820	2210	2475	2660	3180
S	1919	2304			
T	75	75	115	115	115

FIXED DOME BIO-GAS PLANT (JANATA)

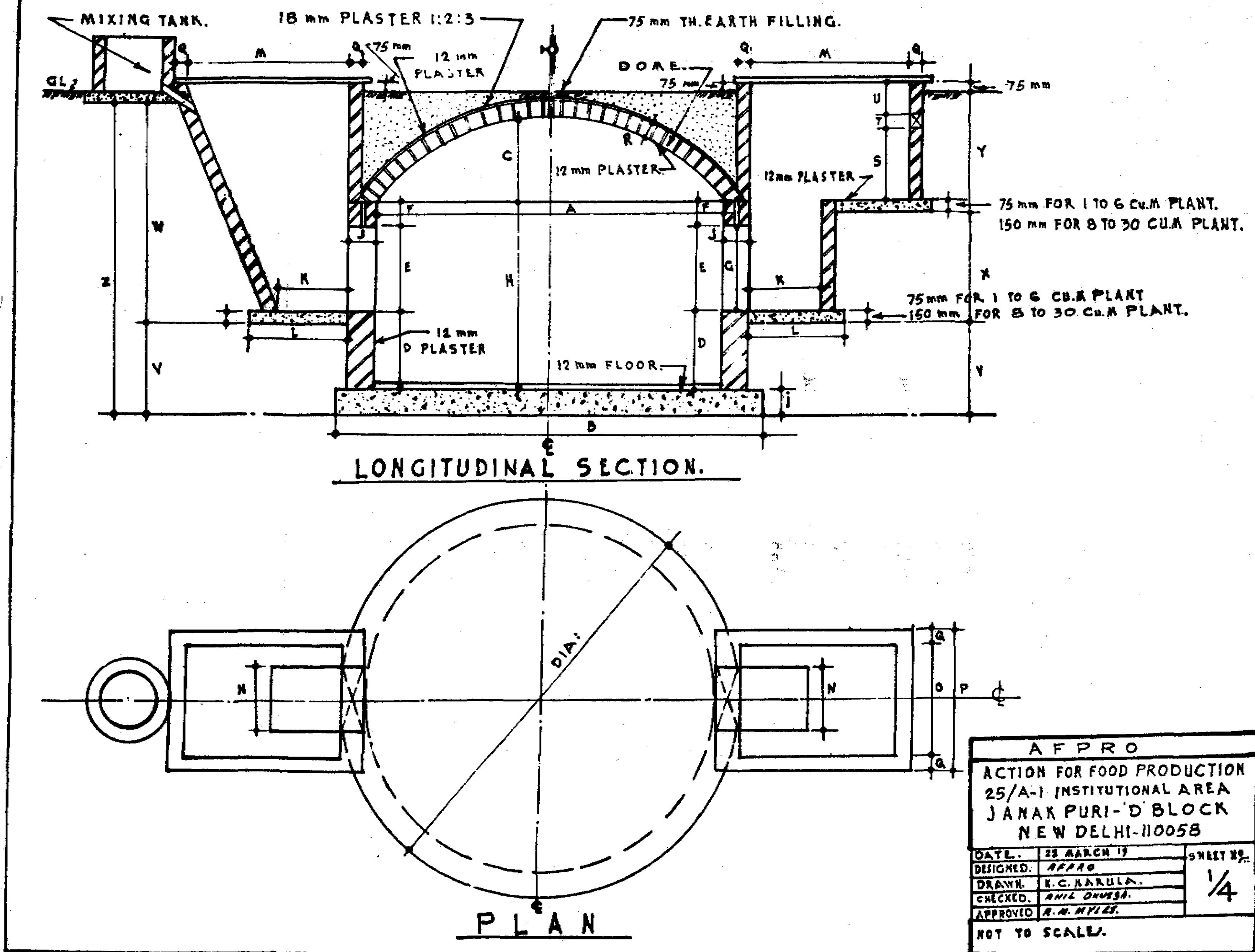


Fig.2

DIMENSIONS OF JANATA BIO-GAS PLANTS
1 TO 50 CUM CAPACITY
(FOR 30 DAYS HRT)

PLANT CAPACITY (CUM) / SYMBOL	1	2	3	4	6	8	10	15	20	30
A	1600	2000	2300	2540	2920	3200	3440	3940	4340	4970
B	1960	2380	2680	2920	3530	3810	4050	4550	5180	5810
C	370	500	520	600	670	725	780	900	1000	1100
D	135	340	470	495	590	590	617	646	630	924
EJ	610×610	610×610	610×610	610×700	610×750	1000×900	1000×1000	1000×1200	1000×1400	1000×1400
F	165	210	240	265	300	330	358	410	450	516
G	610	610	610	700	750	900	1000	1200	1400	1400
H	910	1160	1320	1450	1640	1820	1975	2256	2480	2840
I	150	150	150	150	230	230	230	230	300	300
J	115	115	115	115	230	230	230	230	345	345
K	610	610	610	610	610	610	750	750	1000	1000
L	800	800	800	800	800	800	940	1055	1305	1508
M	945	1110	1180	1000	1000	1000	1200	1200	1400	1500
N	610	610	610	610	610	1000	1000	1000	1000	1000
O	610	750	1000	1350	1820	2580	2800	4720	5920	6620
P	840	980	1230	1580	2050	2810	3050	5180	6380	7120
Q	115	115	116	115	115	115	118	230	230	230
R	115	115	116	115	116	115	115	115	115	190
S	300	420	450	530	600	570	540	490	450	600
T	150×150	150×150	150×150	150×150	150×150	230×230	230×230	230×230	230×230	230×230
U	227	227	227	227	227	307	392	562	702	727
V	222	427	557	582	757	682	709	738	792	1086
W	1452	1627	1677	1872	2027	2337	2520	2892	3232	3473
X	775	820	850	965	1050	1230	1358	1610	1850	1916
Y	677	807	827	907	977	1107	1162	1282	1382	1557
Z	1674	2054	2234	2454	2704	3019	3229	3630	4024	4559
MIXING TANK DIA:	610	610	610	610	610	610	610	750	750	1000
MIXING TANK HT.	610	610	610	610	610	610	610	750	750	1000

DATE. 25-5-86 DRAWN. K.C.NARULA. APPROVED. R.M.MYLES.
DESIGNED. AFPRO. CHECKED. ANIL DHUSSA SHEET No. 2/4

ACTION FOR FOOD PRODUCTION AFPRO
25/A-I INSTITUTIONAL AREA, D BLOCK
JANAK PURI, NEW DELHI-110058

DIMENSIONS OF JANATA BIO-GAS PLANT
1 TO 30 CUM CAPACITY.
(FOR 40 DAYS HRT.)

PLANT CAPACITY (CUM) / SYMBOL.	1	2	3	4	6	8	10	15	20	30
A	1730	2220	2500	2750	3150	3465	3735	4270	4700	5390
B	2110	2600	2880	3130	3760	4075	4345	5110	5540	6230
C	370	500	520	600	670	725	780	900	1000	1100
D	240	480	606	646	673	698	726	895	910	1130
E	610×610	610×610	610×610	610×700	610×900	1000×1000	1000×1100	1000×1200	1000×1400	1000×1500
F	140	170	204	224	257	282	304	350	380	440
G	610	610	610	700	900	1000	1100	1200	1400	1500
H	990	1260	1420	1570	1830	1980	2130	2445	2690	3070
I	150	150	150	150	230	230	230	300	300	300
J	115	115	115	115	230	230	230	345	345	345
K	610	610	610	610	610	610	750	750	1000	1000
L	800	800	800	800	800	800	940	1055	1305	1305
M	945	1110	1130	1000	1000	1000	1200	1200	1400	1500
N	610	610	610	610	610	1000	1000	1000	1000	1000
O	610	750	1000	1350	1820	2575	2500	4185	5080	6660
P	840	980	1230	1580	2050	2850	2730	4645	5540	7120
Q	115	115	115	115	115	115	115	230	230	230
R	115	115	115	116	115	115	115	115	115	190
S	300	420	450	530	600	600	800	550	520	660
T	150×150	150×150	150×150	150×150	150×150	230×230	230×230	230×230	230×230	230×230
U	227	227	227	227	227	277	332	502	632	667
V	327	587	693	733	840	790	818	1057	1072	1292
W	1427	1687	1641	1831	2134	2389	2566	2832	3162	3497
X	750	780	814	924	1157	1282	1404	1550	1780	1940
Y	677	807	827	907	977	1107	1162	1282	1382	1557
Z	1754	2334	2334	2564	2974	3179	3384	3889	4234	6789
MIXING TANK DIA.	610	610	610	610	610	610	610	750	750	1000
MIXING TANK HT.	610	610	610	610	610	610	610	750	750	1000

DATE... 27-5-86 DRAWN... K.C.NARULA. APPROVED.. R.M.MYLES.
DESIGNED...AFPRO. CHECKED...ANIL DHUSSA. SHEET No 3/4

ACTION FOR FOOD PRODUCTION-AFPRO
25/A-1 INSTITUTIONAL AREA 'D' BLOCK
JANAK PURI, NEW DELHI-110058

DIMENSIONS OF JANATA BIO-GAS PLANT.
1 TO 30 CUM. CAPACITY.
(FOR 55 DAYS HRT.)

PLANT CAPACITY (CUM) SYMBLE.	1	2	3	4	6	8	10	15	20	30
A	1900	2370	2720	3000	3420	3800	4000	4510	5120	5845
B	2280	2750	3100	3610	4030	4410	4610	5350	6110	6835
C	450	685	685	685	735	840	900	1000	1100	1300
D	365	580	746	725	660	945	1000	1000	1000	1267
E/	610×610	610×610	610×610	610×760	610×1000	1000×1000	1000×1175	1000×1565	1000×1600	1000×1700
F	125	153	218	230	290	240	230	272	320	373
G	610	610	610	760	1000	1000	1175	1565	1600	1700
H	1100	1343	1574	1715	1960	2185	2425	2837	2920	3340
I	150	150	150	230	230	230	230	300	300	300
J	115	115	115	230	230	230	230	345	345	345
K	610	610	610	610	610	810	750	750	1000	1000
L	800	800	800	800	800	800	940	940	1300	1300
M	750	850	1216	1372	1520	1000	1000	1000	1200	1500
N	610	610	610	610	610	1000	1000	1000	1000	1000
O	610	610	800	950	1350	1635	2160	3420	5010	5987
P	840	840	1030	1180	1580	1865	2390	3880	5470	6447
Q	115	115	115	115	115	115	115	230	230	230
R	115	115	115	115	115	115	115	115	115	190
S	380	610	610	610	610	650	670	630	600	530
T	150×150	150×150	150×150	150×150	230×230	230×230	230×230	230×230	230×230	230×230
U	227	232	232	232	202	342	382	522	658	1016
V	452	667	833	892	827	1037	1092	1162	1162	1429
W	1492	1755	1820	1982	2332	2462	2707	3219	3408	3849
X	735	763	828	990	1290	1240	1425	1837	1920	2073
Y	757	992	192	992	1042	1222	1282	1382	1488	1776
Z	1944	2422	26[illegible]3	2874	3159	3499	3799	4381	4570	5278
MIXING TANK DIA: HT.	610 610	610 610	610 610	810 810	610 610	610 610	610 610	750 750	750 750	1000 1000

DATE...29-5-86 DRAWN...K.C.NARULA. APPROVED...R.M.MYLES.
DESIGNED...AFPRO CHECKED...ANIL DHUSSA. SHEET No... 4/4

ACTION FOR FOOD PRODUCTION-AFPRO
25/A-1 INSTITUTIONAL AREA, 'D' BLOCK
JANAK PURI, NEW DELHI. 110058

DIMENSIONS OF GAS HOLDER

Capacity m^3	1	2	3	4	6	8	10
Diameter (cm)	110	125	150	165	200	225	260
Height (cm)	100	100	100	100	100	125	125

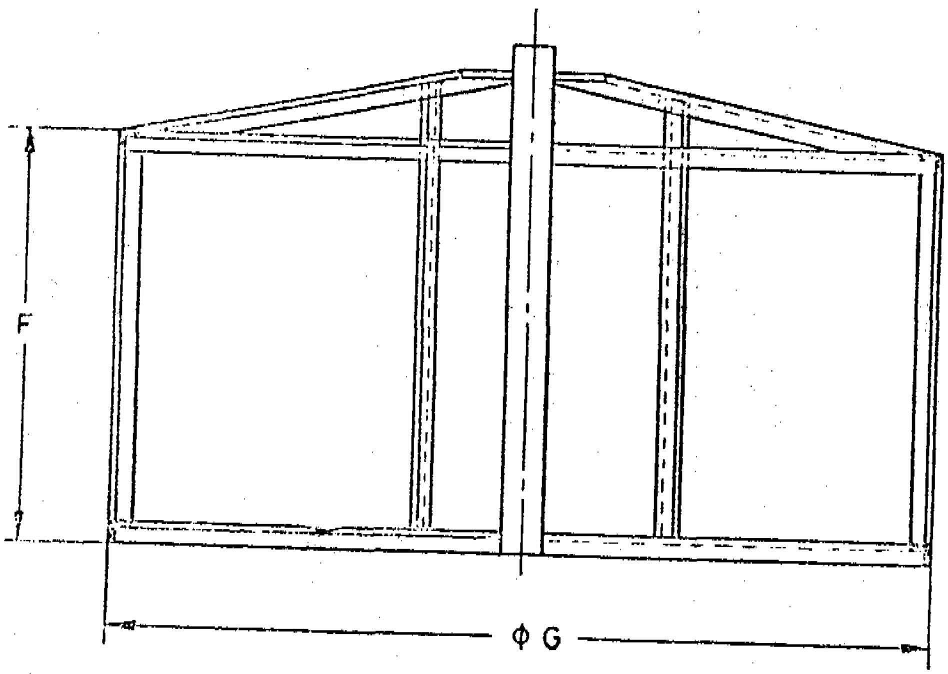
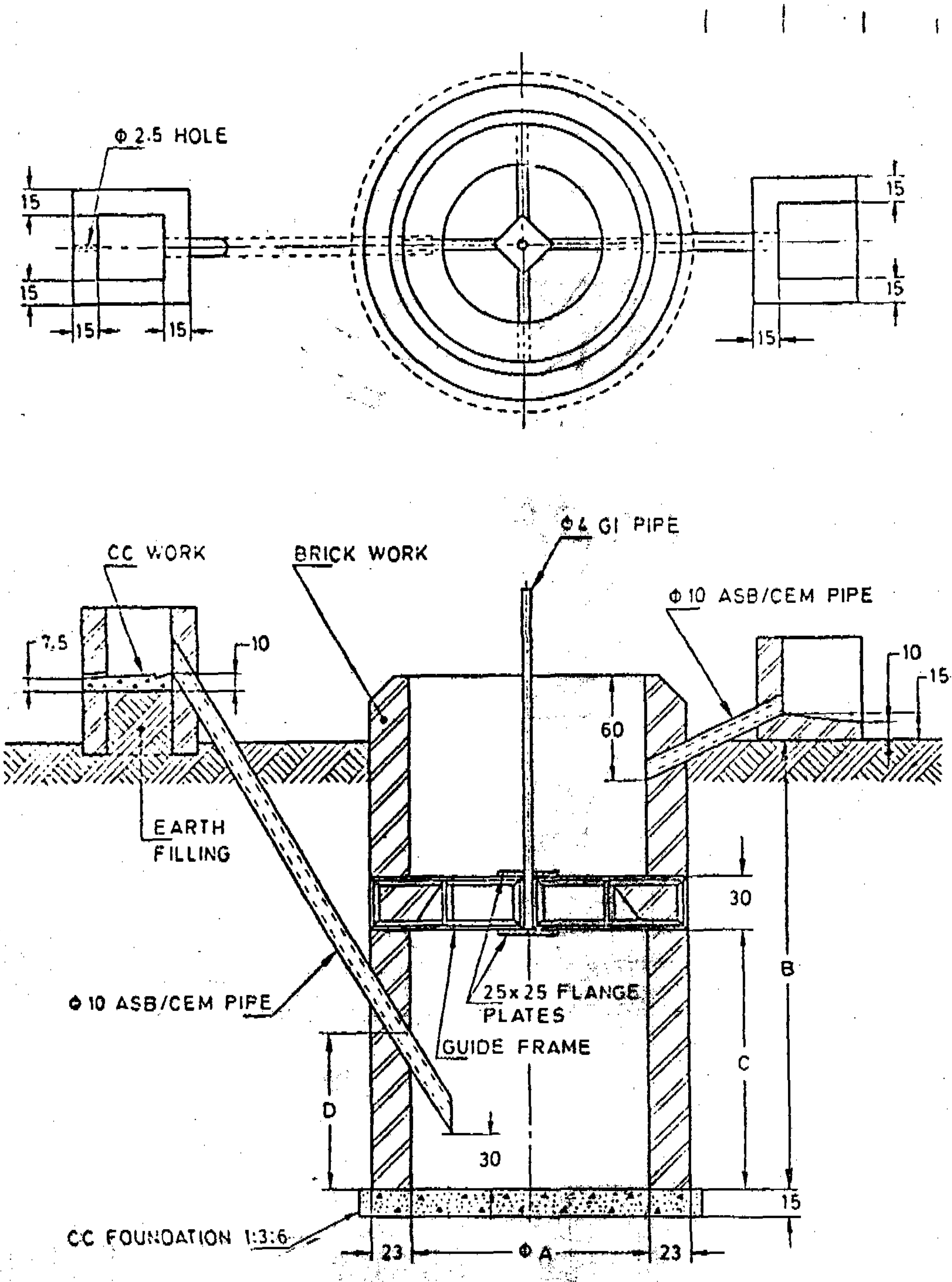
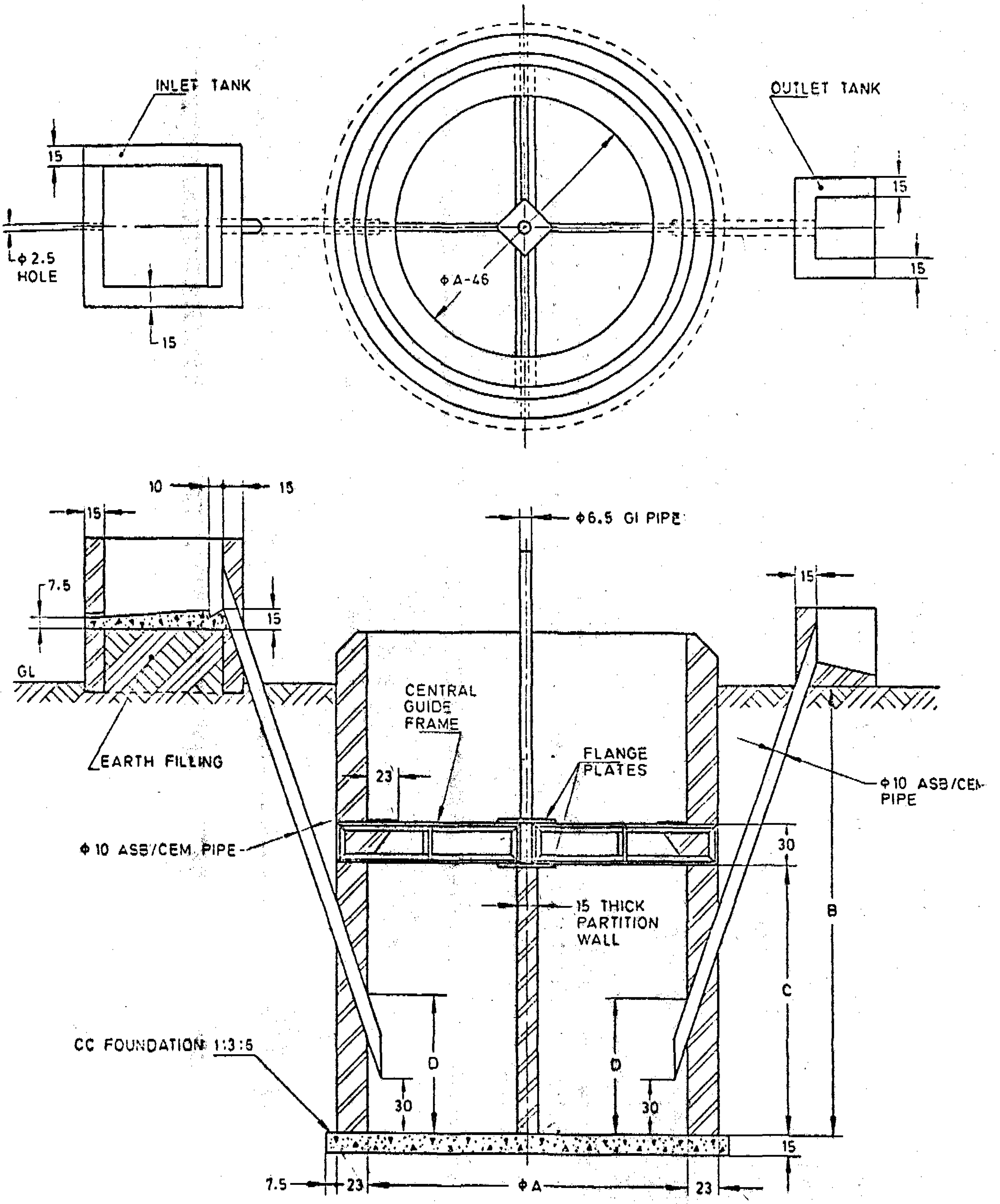


FIG. 3 GAS HOLDER



All dimensions in centimetres.

FIG. 4 FLOATING DRUM BIO-GAS PLANT (1, 2 AND 3 m^3)



All dimiensions in centimetres.

FIG.5 FLOATING DRUM BIO-GAS PLANT (4 m³ ABOVE)

QUANTITY OF FRESH MANURE AVAILABLE AND GAS PRODUCED FROM DIFFERENT FEED-STOCK

Category of animal (source of feed-stock for biogas production)	Fresh(green) dung(excreta) per day (kg)	Moisture percentage (%)	Gas yield per kg. of fresh(green) manure Cu.m	Lts.	Cft.	Average gas yield per animal/person per day Cu.m	Lts.	Cft.
a.	b.	c.	d.	e.	f.	g.	h.	i.
1. Cattle								
- Large	15	80-85	0.04	40	1.4	0.60	600	21.0
- Medium	10	80-85	0.04	40	1.4	0.40	400	14.0
- Small	8	80-85	0.04	40	1.4	0.32	320	11.2
- Calf	4	80-90	0.04	40	1.4	0.16	160	5.6
2. Buffalo								
- Large	20	80-85	0.04	40	1.4	0.80	800	28.0
- Medium	15	80-85	0.04	40	1.4	0.60	600	21.0
- Small	10	80-85	0.04	40	1.4	0.40	400	14.0
- Calf	5	85-90	0.04	40	1.4	0.20	200	7.0
3. Pig								
- Large	2.0	75-80	0.07	70	2.5	0.14	140	5.0
- Medium	1.5	75-80	0.07	70	2.5	0.10	100	3.7
- Small	1.0	75-80	0.07	70	2.5	0.07	70	2.5
4. Poultry								
- Large	0.15	70-80	0.06	60	2.1	0.009	9	0.32
- Medium	0.10	70-80	0.06	60	2.1	0.006	6	0.21
- Small	0.05	70-80	0.06	60	2.1	0.003	3	0.11
5. Goat/Sheep								
- Large	5.0	75-80	0.05	50	1.75	0.25	250	8.80
- Medium	2.0	75-80	0.05	50	1.75	0.10	100	3.5
- Small	1.0	75-80	0.05	50	1.75	0.05	50	1.8
6. Duck	0.15	70-80	0.05	50	1.75	0.008	8	0.26
7. Pigeon	0.05	70-80	0.05	50	1.75	0.003	3	0.11
8. Horse	15.00	80-85	0.04	40	1.4	0.60	600	21.00
9. Camel	20.00	70-85	0.03	30	1.05	0.60	600	21.00
10. Elephant	40.00	70-85	0.02	20	0.7	0.80	800	28.00
11. Human Excreta								
a. Adult	0.40	75-80	0.07	70	2.5	0.028	28	1.0
b. Children	0.20	75-90	0.07	70	2.5	0.014	14	0.5

11.0 **DO's and DONT's :**

DO's

- Select the size of the biogas plant depending on the quantity of dung available with the beneficiaries.
- Instal the biogas plant at a place near the kitchen as well as the cattle shed as far as possible.
- Ensure that the plant is installed in an open space, and gets plenty of sunlight for the whole day, all round the year.
- Ensure that the outer side of the plant is firmly compacted with soil.
- Feed the biogas plant with cattle dung and water mixture in the right proportion - add 1 part of cattle dung to 1 part of water by weight to make a homogenous mixture.
- Ensure that the slurry (mixture of dung and water) is free from soil, straw etc.
- For efficient gas utilization, use good quality and approved burners and gas lamps.
- Open the gas regulator/cock only at the time of its actual use.
- Adjust the flame by turning the air regulator till a blue flame is obtained - this will give maximum heat.
- Light the match before opening the gas cock.
- Cover the top of the inlet and outlet tank opening with wooden, stone or RCC cover, to avoid accidental falling of cattle and children.
- Purge air from all delivery lines allowing gas to flow for a while prior to first use.

DONT's

- Do not instal a bigger size of biogas plant if you don't have sufficient cattle dung or any other feed-stock to be used for gas production.
- Do not instal the gas plant at a long distance from the point of gas utilisation to save the cost of pipeline.
- Do not instal the plant under a tree, inside the house or under shade.
- Do not compact soil loosely around the plant; otherwise it may get damaged.
- Do not add more than the required quantity of water - doing so might affect the efficiency of gas production.
- Do not allow soil or sand particles to enter into the digester.
- Do not allow the scum to form in the digester, otherwise the production of gas might stop.
- Do not burn the gas directly, i.e from the gas outlet pipe even for the testing purpose as it can be dangerous.
- Do not use burner in the open; otherwise there will be enormous loss of heat.
- Do not leave the gas regulator(valve) open when the gas is not in use.
- Do not use the gas if the flame is yellow. Adjust the flame by the air regulator till it is blue in colour.
- Do not let any water accumulate in the gas pipeline; otherwise the required pressure of gas will not be maintained and the flame will sputter.
- Do not make digested slurry pit more than 1.0 m (30 ft) deep.
- Do not inhale the biogas as it may be hazardous.
- Do not hurry to get gas after initial loading of slurry, as it may take 10-25 days for gas production in freshly loaded plants. No foreign material should be added.

12.0 MAINTENANCE OF BIOGAS PLANTS :

The rural household biogas plant is simple to operate and handle as far as the beneficiaries are concerned. The following simple guidelines for general care and maintenance will increase the operational life and working efficiency of a biogas plant several-folds.

- The gate valve should be opened only when the gas has to be actually used.
- Before opening the valves, one must ensure that all the preparation for cooking have been made. This would avoid the unnecessary wasteful consumption of gas.
- The air injector should not be closed very tightly on the side of the burner. The inflow of the air should be adjusted properly in the injector.
- The outlet tank of the plant should never be left uncovered.
- In addition to the above, the daily, weekly, monthly, yearly and five yearly care and maintenance should be done as per the schedule given below:

DAILY

- Add the recommended quantity of raw material.
- Use proper slurry mixture
- Use clean feed-stock, free from soil, straw etc.
- Clean the mixing tank after use.

WEEKLY

- Use a long bamboo pole for stirring the slurry through the outlet tank in case of a fixed dome plant and rotate the drum in case of KVIC type plant.
- Clean gas burners and other appliances.
- Open the tap of the manual moisture trap to drain off moisture condensed in the pipeline.

  The nozzle of the biogas lamps should be properly cleaned.

MONTHLY

- Remove digested slurry from the slurry collection tank to the compost pit.
- If compost pits are provided next to the outlet tank, then check the level of slurry in it. If filled, divert the slurry to the next compost pit.
- Check gate valve, gas outlet pipe and fittings for leakage.
- Check the moisture trap(water removal system) for any possible leakage.

ANNUALLY

- Check for gas and water leaks from pipe and appliances.
- Repair the worn-out accessories.
- Replace damaged or non-working accessories. Open the gate valve and remove all the gas from the plant. After this, check the level of slurry in the outlet chamber. If the slurry level is above the second step counted from the bottom in the outlet chamber(i.e above the initial slurry level), remove it up to the second step.

FIVE YEARLY

- Empty the plant and clean the sludge and inorganic material from the bottom of the plant.
- Give a thorough check to the entire gas distribution system for possible leakage.
- Repaint the ceiling of the dome and gas storage chamber with black enamel paint.
- Recharge(reload) the paint with fresh slurry.

TROUBLE SHOOTING

Common troubles with biogas plants and their remedies are given below :-

a. **Installation defects**

Installation defects	caused by	remedy
Cracking of digester wall	Sinking of foundation or improper back filling	Repair the foundation and/or digester and do proper back filling.
Gas leakage	Improper construction of gas storage chamber and dome or improper welding of iron gas holder of floating dome type plant.	Check and repair
Accumulation of water in pipeline	Improper installation of water trap	Check levels and fit the water trap properly. Remove water periodically from the pipe.

b. **Operational defects**

No gas after first filling of plant.	Lack of fermentation time.	It takes 2-4 weeks for initial gas production.
Slurry level would not rise in inlet and outlet chambers(tanks)	-insufficient addition of slurry -formation of hard scum	- add more slurry - break scum with long bamboo poles periodically
No gas in burner but plenty in the plant	-gas pipe locked -gas outlet pipe clogged with scum or straw etc.	Open pipeline and water trap and remove water - open gas outlet valve and clean it.
Flame dies soon	Insufficient pressure	Check quantity of gas in the plant.

****

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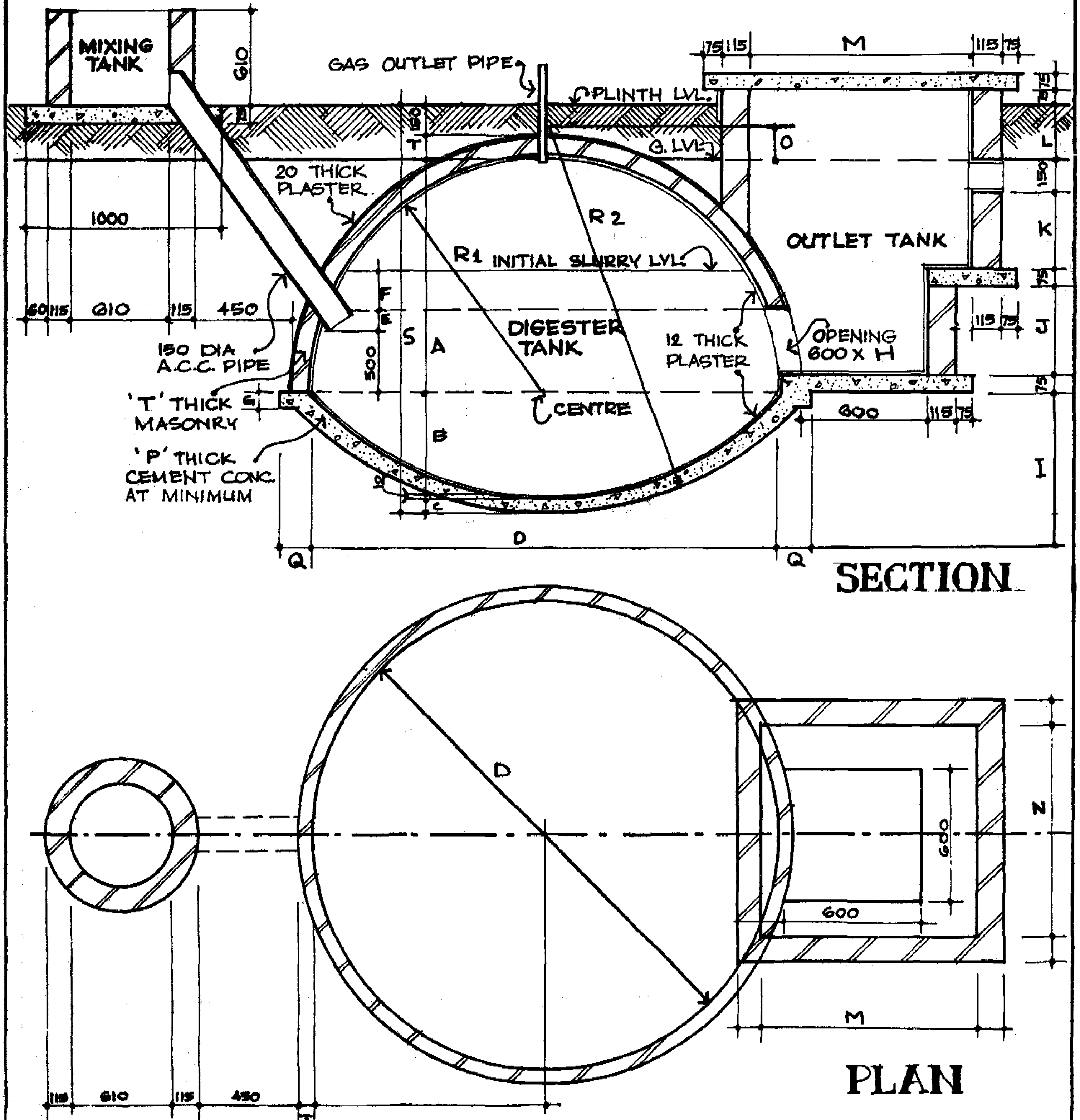
FIG-1



DEEN BANDHU BIO GAS PLANT CAPACITY ' 'M^3

1. ALL DIMENSIONS ARE IN M.M. 2. DIMENSIONS TO BE READ NOT TO BE MEASURED 3. IN CASE OF A DISCREPANCY AFPRO 25-1/A INST. AREA D. BLOCK JANAK PURI N.D. TO BE CONTACTED

DIMENSIONS OF DEENBANDHU BIOGAS PLANTS

(FOR 40 DAYS HRT)

SYMBOL	PLANT CAPACITIES				
	1 cu.m	2 cu.m	3 cu.m	4 cu.m	6 cu.m
A	1050	1275	1450	1590	1800
B	420	510	580	636	720
C	75	75	75	100	100
D	2100	2550	2900	3180	3600
E	70	245	350	420	570
F	180	175	200	240	290
G	0	75	100	150	200
H	295	470	575	645	770
I	507	597	667	748	832
J	400	570	700	810	960
K	350	400	430	460	460
L	257	262	277	317	327
M	1000	1000	1000	1000	1200
N	940	1650	2325	2890	3620
O	138	148	183	102	268
P	75	75	75	100	100
Q	150	150	150	150	200
R_1	1050	1275	1450	1590	1800
R_2	1695	2015	2280	2420	2870
S	1814	2129	2374	2635	2929
T	75	75	75	115	115

TABLE 2 DIMENSIONS OF FLOATING DRUM TYPE BIO-GAS PLANTS

(*Clause* 7.1 and *Fig.* 4 *and* 5)

All dimensions in centimetres.

Dimensions	Plant Capacity, m^3																				
	For 30 Days Retention Period							For 40 Days Retention Period							For 55 Days Retention Period						
	1	2	3	4	6	8	10	1	2	3	4	6	8	10	1	2	3	4	6	8	10
A	120	135	160	180	220	240	275	120	135	160	180	220	240	275	120	135	160	180	220	240	275
B	157	187	202	212	212	242	232	177	257	277	292	292	332	317	227	327	377	427	427	477	477
C	170	95	110	135	135	125	115	170	165	185	200	200	200	200	170	220	270	320	320	345	345
D	112	70	70	70	70	70	70	112	110	100	90	90	90	120	112	175	180	180	210	210	205

Table-3

Cost comparision between KVIC and Janata Biogas Plant

Sl.	Size of plant (cft)	cu.m	KVIC Plant* (As on March 1983) 40 days HRT Rs.	30 days HRT Rs.	Janata Biogas Plant (As on March 1983) 55 days** HRT Rs.	40 days*** HRT Rs.	30 days**** HRT Rs.	Remarks
1.	(35)	1	-	-	3080	2770	2465	Cost of 1 cu.m KVIC plant not available.
2.	(70)	2	6272	5418	5320	4790	4255	
3.	(105)	3	7616	6622	5880	5290	4700	
4.	(140)	4	8666	7336	7280	6552	5825	
5.	(210)	6	10542	8960	8960	8060	7170	
6.	(280)	8	12516	10584	11480	10330	9185	
7.	(350)	10	14840	12740	14000	12600	11200	
8.	(525)	15	22120	18480	20300	18270	16240	
9.	(700)	20	29820	24640	25200	22600	20160	
10.	(875)	25	32900	28280	29750	26775	23800	
11.	(1050)	30	-	-	33600	30240	26880	Cost of 30 cu.m KVIC plant not available

* Figures taken from Gobar Gas- why and how, KVIC, Bombay - March 1983 and inflated by 40% to get cost estimates as on January, 1987.

** Average cost of Janata biogas plant 55 days HRT(Hydraulic Retention Time) has been worked out from AFPRO files- Average of all India(excluding North Eastern regions and remote areas as well as remote hilly regions above 1000 mt. height) cost - March 1983, inflated by 40% to get cost estimates as on January 1, 1987.

*** Average estimated cost for Janata biogas plant(JBP) with 40 days HRT has been taken as 10% less than the cost of Janata plant with 55 days HRT.

**** Average estimated cost for JBP of 30 days HRT has been taken as 20% less than the cost of Janata plant with 55 days HRT.

NOTE: i) For hilly N.E regions, remote hilly areas add 20 to 40% to the average cost for both KVIC and Janata plants.

ii) In the estimated cost, 10 mts.(30ft) G.I pipeline and one single deluxe burner with cock is included for both the plants (KVIC and Janata)

LIST OF BUILDING MATERIALS, APPROXIMATE COSTS AND GOVT. SUBSIDIES AVAILABLE FOR DEENBANDHU BIOGAS PLANTS

Plant size		1 cu.m		2 cum		3 cu.m		4 cu.m		6 cu.m	
Material	Rate(Rs)	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
Bricks Ist class	450/- per 1000	700	315/-	1000	450/-	1300	585/-	1600	720/-	2200	890/-
Cement	65/- per kg	8	520/-	14	910/-	16	1040/-	22	1430/-	28	1885/-
Stone chips	4.5 per cft	30	135/-	40	180/-	50	225/-	60	270/-	80	360/-
Sand	2.50 per cft	30	75/-	40	100/-	50	125/-	60	150/-	85	212.50
Coarse sand	3.50 per cft	30	105/-	40	140/-	50	175/-	60	210/-	85	297.50
G.I Pipe 1/2"dia with sockets		7"	15/-	7"	15/-	7"	15/-	7"	15/-	7"	15/-
A.C Pipe 6" dia	5/- per ft	6 ft	30/-	6 ft	30/-	6ft	30/-	6 ft	30/-	6 ft	30/-
Iron bars(6 mm dia) for outlet tank cover	10/- per kg	5	50/-	7	70/-	10	100/-	12	120/-	15	150/-
Paint	55/- per lit	1	55/-	1	55/-	1.5	82.50	2	110/-	3	165/-
Labour(pit digging)	15/- per day	8	120/-	10	150/-	14	210/-	18	270/-	24	360/-
Mason	35/- per day	8	280	11	385/-	13	455/-	16	560/-	22	770/-
Labour(plant construction)	15/- per day	16	240/-	22	300/-	26	390/-	30	450/-	44	660/-
Misc & transport etc.			100/-		150/-		175/-		200/-		300
	Total		2040/-		2935/-		3607.50		4535/-		6155/-
Govt Subsidy as on 1.4.87	For General category		830/-		1560/-		1900/-		2140/-		2610/-
	For SC/ST/SF/MF		1250/-		2350/-		2860/-		2140/-		2610/-
	For hilly areas/ desert distt & some N.E.States		1500/-		2940/-		3660/-		4390/-		5350/-

For Arunachal Pradesh/Meghalaya, Manipur & Mizoram	2250/-	4410/-	5400/-	6580/-	8020/-

NOTES :

1. Rates of building materials, labour etc., are as on April 1, 1987.
2. These costs are for 40 days HRT Deenbandhu biogas plants recommended for plains of India. Cost of 55 days HRT plants would be higher by about 10% for similar conditions.
3. For hilly and desert regions and north-eastern regions of India add 20% & 40%, respectively, to these average cost estimates worked out for the plains.
4. Add Rs.800.00 as cost of pipeline, accessories and appliances to the total cost of construction.

GOVT. SUBSIDIES AVAILABLE FOR BIOGAS PLANTS

Plant size		1 cu.m	2 cu.m	3 cu.m	4 cu.m	6 cu.m
Govt. subsidy as on 1.4.87	For General Category	830	1560	1900	2140	2610
	For SC/ST/SF/MF	1250	2350	2860	2140	2610
	For hilly areas/ desert distt. & some N.E. States	1500	2940	3660	4390	5350
	For Arunachal Pradesh/Meghalaya, Manipur & Mizoram	2250	4410	5400	6580	8020

NATIONAL PROJECT ON BIOGAS DEVELOPMENT STATE-WISE/AGENCY-WISE TARGET FIXED FOR 1987-88

Unit---- Nos.

QUARTERLY BREAK-UP OF THE TARGET

Sl. no	State/UTs	Annual target	I Qtr. 15%	II Qtr 10%	III Qtr 15%	IV Qtr 60%
1.	Andhra Pradesh	1000	1500	1000	1500	6000
2.	Arunachal Pradesh	5	1	1	1	2
3.	Assam	2000	300	200	300	1200
4.	Bihar	5000	750	500	750	3000
5.	Gujarat	7500	1125	750	1125	4500
6.	Haryana	2000	300	200	300	1200
7.	Himachal Pradesh	3000	450	300	450	1800
8.	Jammu & Kashmir	100	15	10	15	60
9.	Karnataka	5000	750	500	750	3000
10.	Kerala	2500	375	250	375	1500
11.	Madhya Pradesh	2000	300	200	300	1200
12.	Maharashtra	30000	4500	3000	4500	18000
13.	Manipur	15	3	2	3	7
14.	Meghalaya	50	8	5	8	29
15.	Mizoram	60	9	6	9	36
16.	Nagaland	10	2	1	2	5
17.	Orissa	3000	450	300	450	1800
18.	Punjab	1300	195	130	195	780
19.	Rajasthan	3000	450	300	459	1800
20.	Sikkim	30	5	3	5	17
21.	Tamil Nadu	18000	1950	1300	1950	7800
22.	Tripura	10	2	1	2	5
23.	Uttar Pradesh	18000	2700	1800	2700	10800
24.	West Bengal	3000	450	300	450	1800
1.	A&N Islands	5	1	1	1	2
2.	Chandigarh	5	1	1	1	2
3.	Dadar & Nagar Haveli	10	2	1	2	5
4.	Delhi	100	15	10	15	60
5.	Goa, Daman & Diu	100	15	10	15	60
6.	Pondicherry	100	15	10	15	60
	Sub-total	1,10,900	16639	11092	16639	66530
	KVIC	10,000	1500	1000	1500	6000
	Grand total	1,20,900	18139	12092	18139	72530

NATIONAL PROJECT FOR BIOGAS DEVELOPMENT

TARGET OF TRAINING COURSES FOR 1987-88

S. No	State/UT/Agency	C&M	UT	RT
1	2	3	4	5
1.	Andhra Pradesh	10	50	5
2.	Assam	5	10	-
3.	Bihar	40	50	10
4.	Gujarat	40	400	20
5.	Haryana	10	50	5
6.	Himachal Pradesh	5	30	2
7.	Jammu & Kashmir	2	10	1
8.	Karnataka	20	100	20
9.	Kerala	30	100	10
10.	Madhya Pradesh	20	300	40
11.	Maharashtra	100	300	50
12.	Mizoram	1	2	nil
13.	Orissa	30	200	5
14.	Punjab	10	100	1
15.	Rajasthan	10	50	40
16.	Sikkim	1	1	-
17.	Tamil Nadu	50	440	20
18.	Uttar Pradesh	50	800	20
19.	West Bengal	24	300	6
20.	Delhi	-	-	-
21.	Goa, Daman & Diu	1	5	-
22.	Pondicherry	1	2	
23.	KVIC	20	150	-
24.	AFPRO	50	50	20
	G. Total	530	3500	275

C&M = Construction-cum-Maintenance

UT = Users Training

RT = Refresher Training

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