Department of Mechanical Engineering,
Pulchowk campus, Institute of Engineering,
Tribhuvan University

Sustainable Energy Technologies
(Session 7)

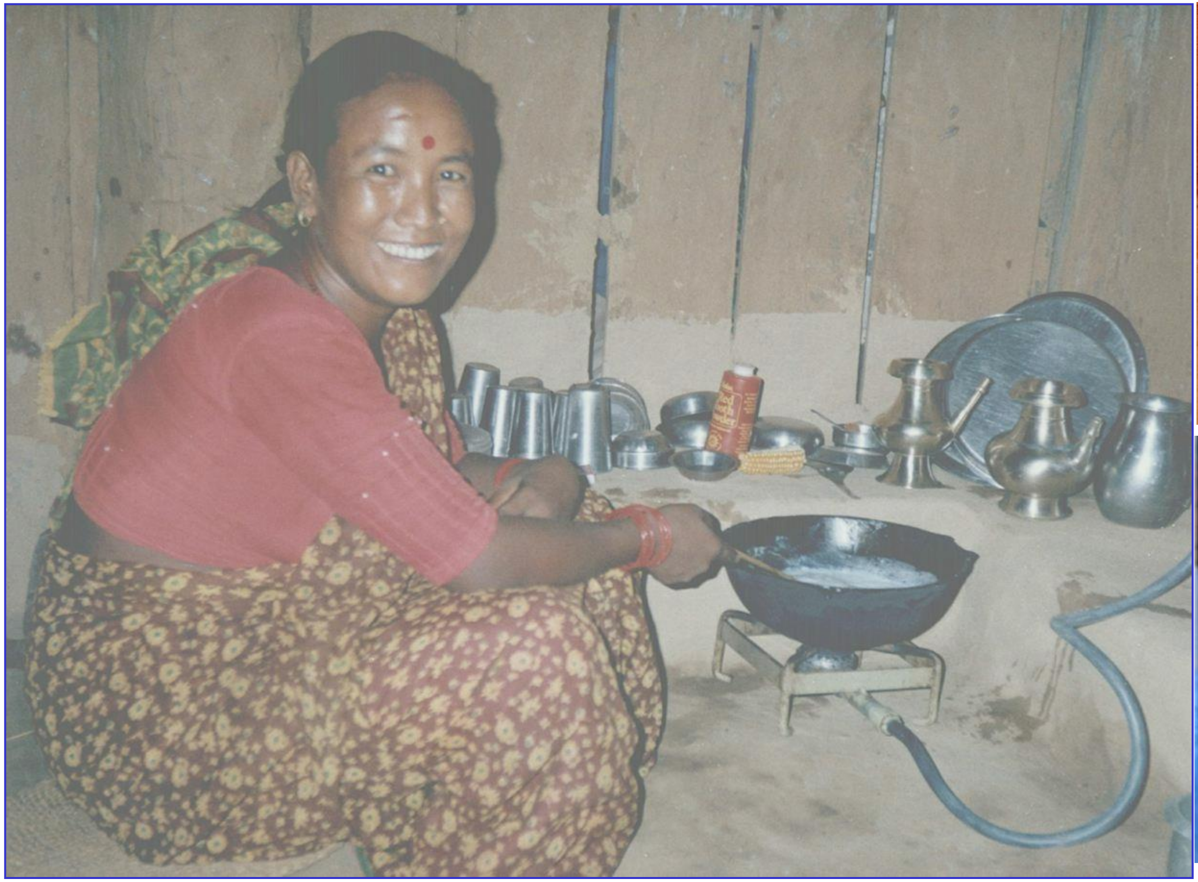
Biogas Technology

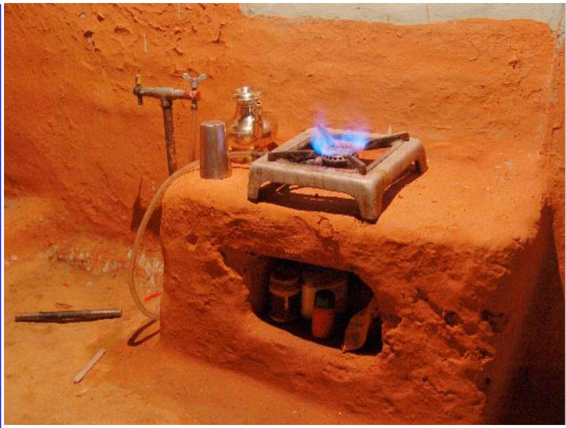
Dr. Shree Raj Shakya

2016

Life without Biogas!

Life with Biogas: Clean Source of Energy





Life with Bio-Slurry:
High Quality Organic Fertilizer

Biogas for Better Life!

Introduction of Biogas Technology (1)

- **Any organic material when subject to anaerobic fermentation (in absence of oxygen), produces a gas called “biogas”.**
  - **Biogas produced from cattle dung consists of around 60-70% methane.**
- **Actually, biogas production takes place naturally. The technology helps improve production, collection and use of it productively.**
- **Biogas can be used as an energy source for any purpose from cooking to electricity generation.**

Basics to Design Approach and Planning Concept

- **Design basics should answered following issues:**
  - **Why biogas plant?**
  - **What will be the feeding materials?**
  - **What are the possible end uses?**
  - **Cost benefit ratio**
  - **Consequences**

- **After ensuring above issues planning concept (Process) will start.**

Planning Concept

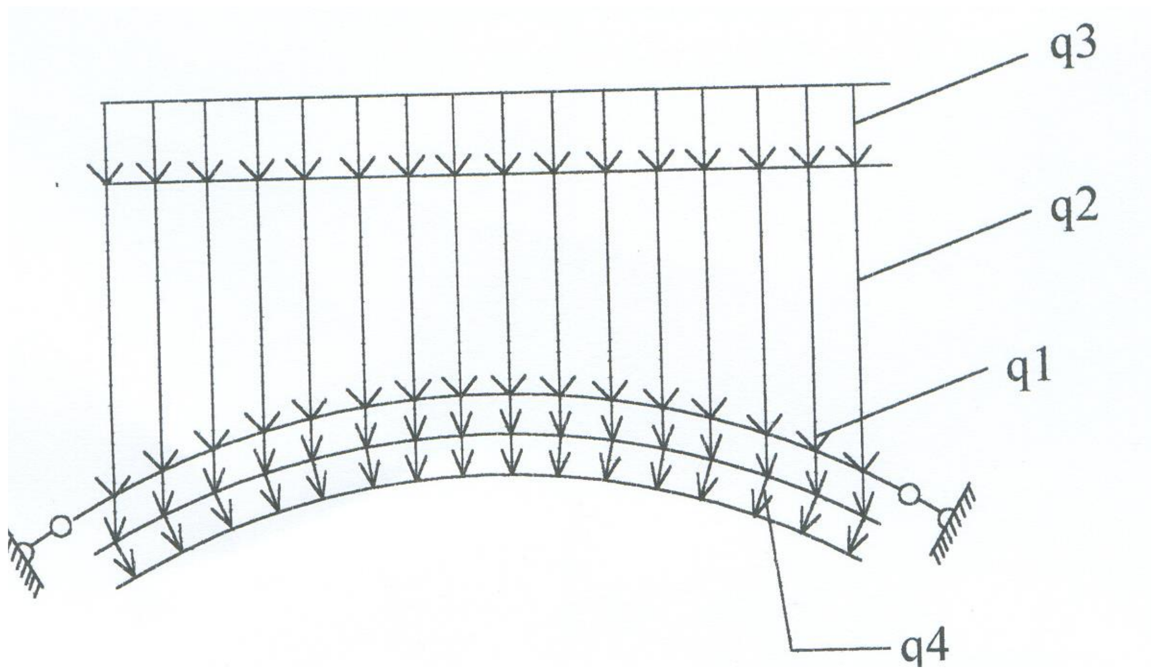
- **Gas production and consumption**
- **Design of particular model to fulfill the requirements of the users**
- **Availability of Construction and feeding materials**
- **Proper sizing**

Background and Introduction to the need for Biogas Plant Design

- **There are hundreds of designs of biogas plants experimented in the world. The idle model is that one where user gets full utilizations values , durable and replicable in other scenario also.**

Structural Design Aspect (1)

q1 = dead load, i.e. weight of the dome
q2 = load due to the compacted earth
q3 = load above the dome, such as due to people, cattle etc.
q4 = load due to gas pressure



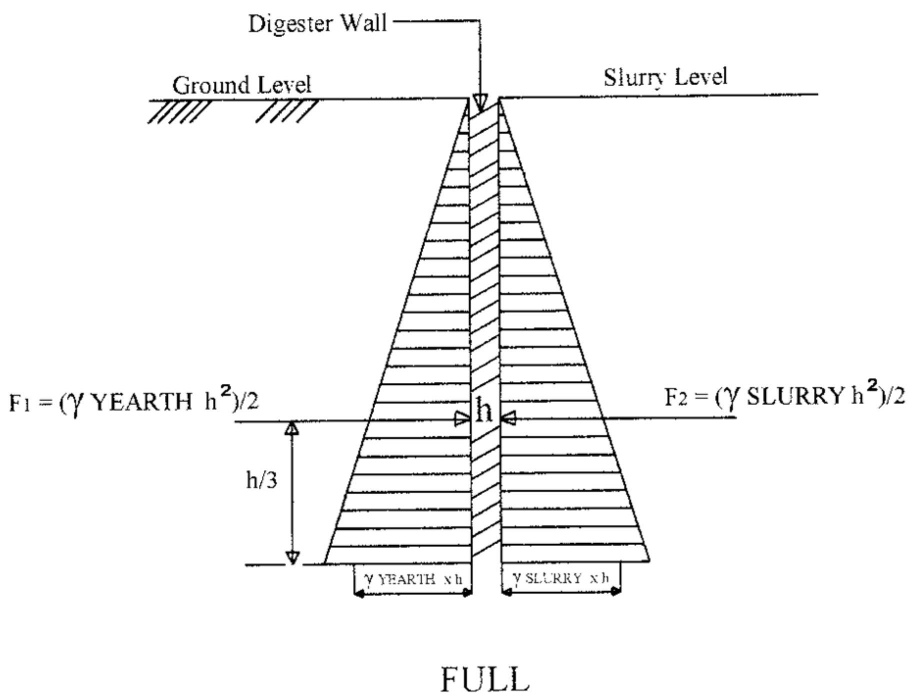
Structural Design Aspect (4)

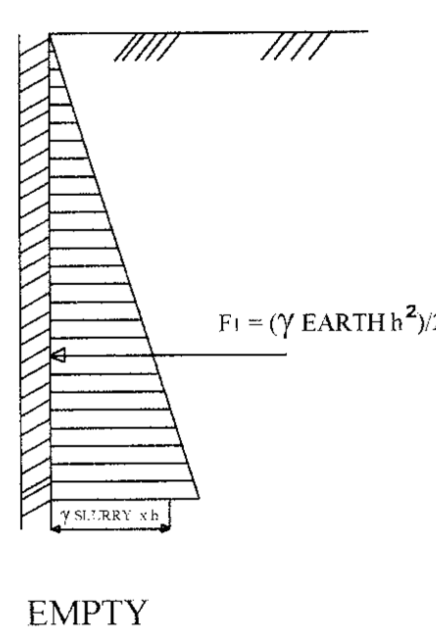
- As the dome are spherical in shape, membrane theory is used in the design of shell, in which normal shear , bending momentum and torsion are negligible, only direct stress-tension and compression are developed.

- Maximum compressive stress at the dome when plant is empty would be: $4000Kg/m^2$ to $5000Kg/m^2$

This compressive stress can be safely carried out by the spherical concrete dome of thickness 7.5cm at the top and 23-25 cm thick at the edge.

Structural Design Aspect (3)





Structural Design Aspect (2)

- Maximum compressive stress at the bottom of wall when plant is empty would be:

σ=Y_{earth}*h (σ= compressive stress, h=203cm, assume **Y_{earth}=1800kg/m^3)**

Therefore,

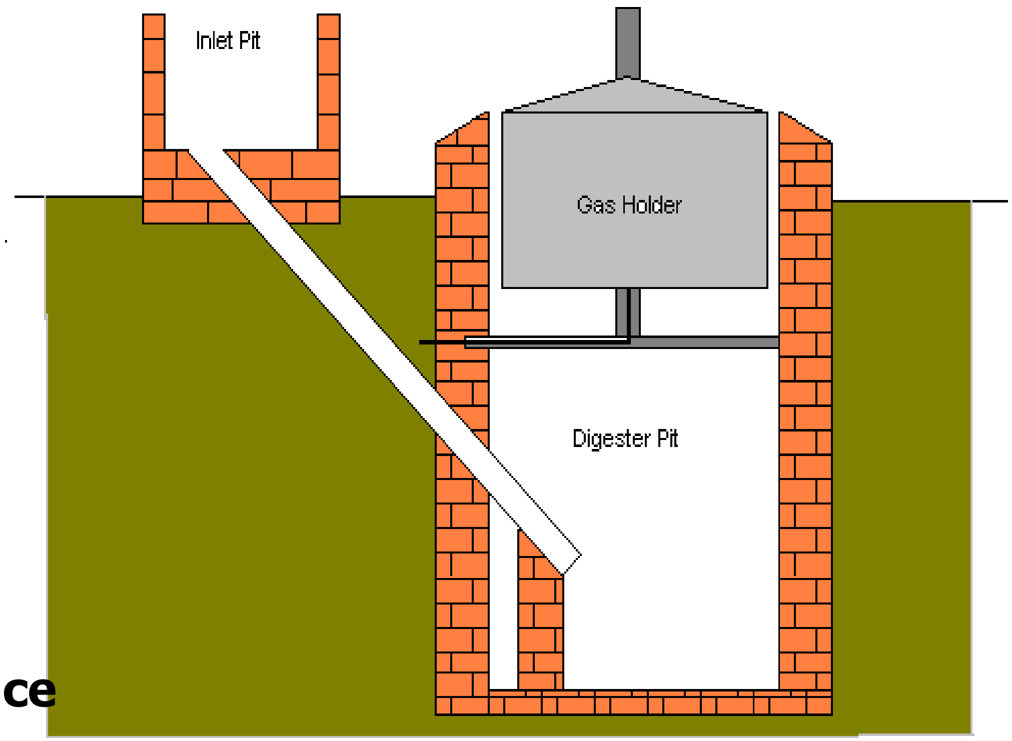
σ=1800*2.03

=3654kg/m^2 ~36.5KN/m^2

This compressive stress can be safely carried out by the 12cm thick brick masonry or 23cm thick stone masonry.

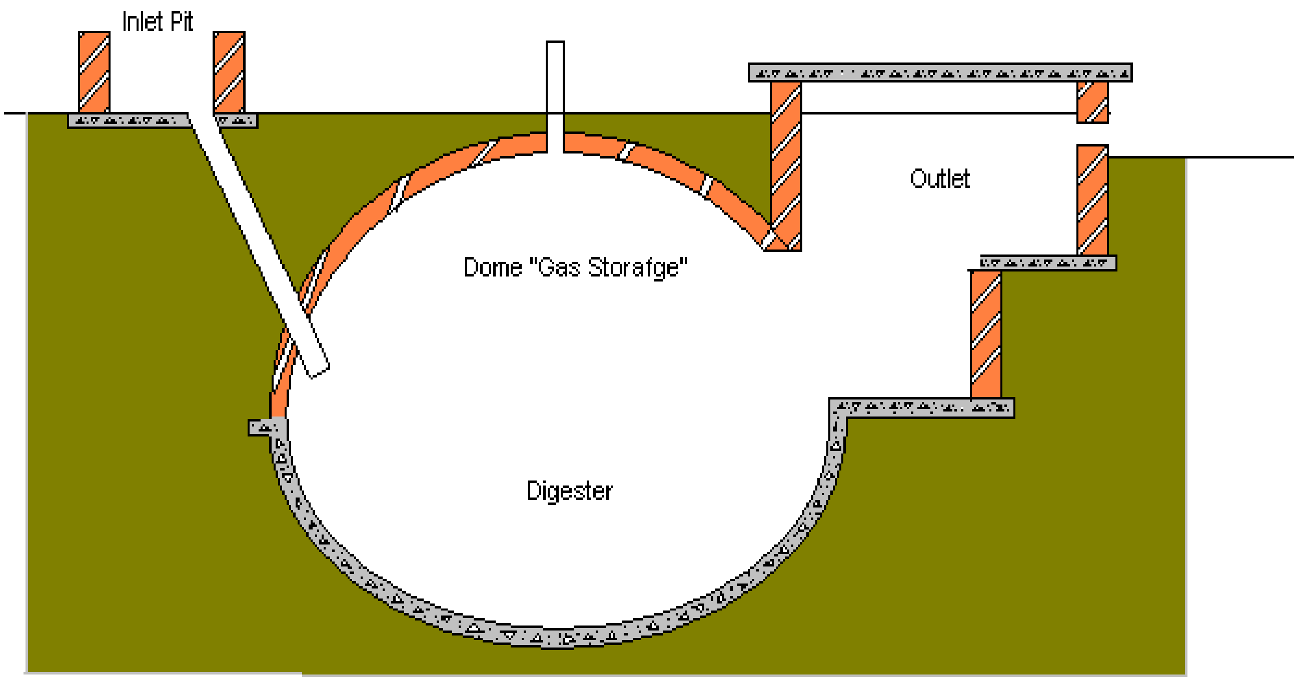
Review on popular Biogas Plant Designs

KVIC Design Floating Drum Type



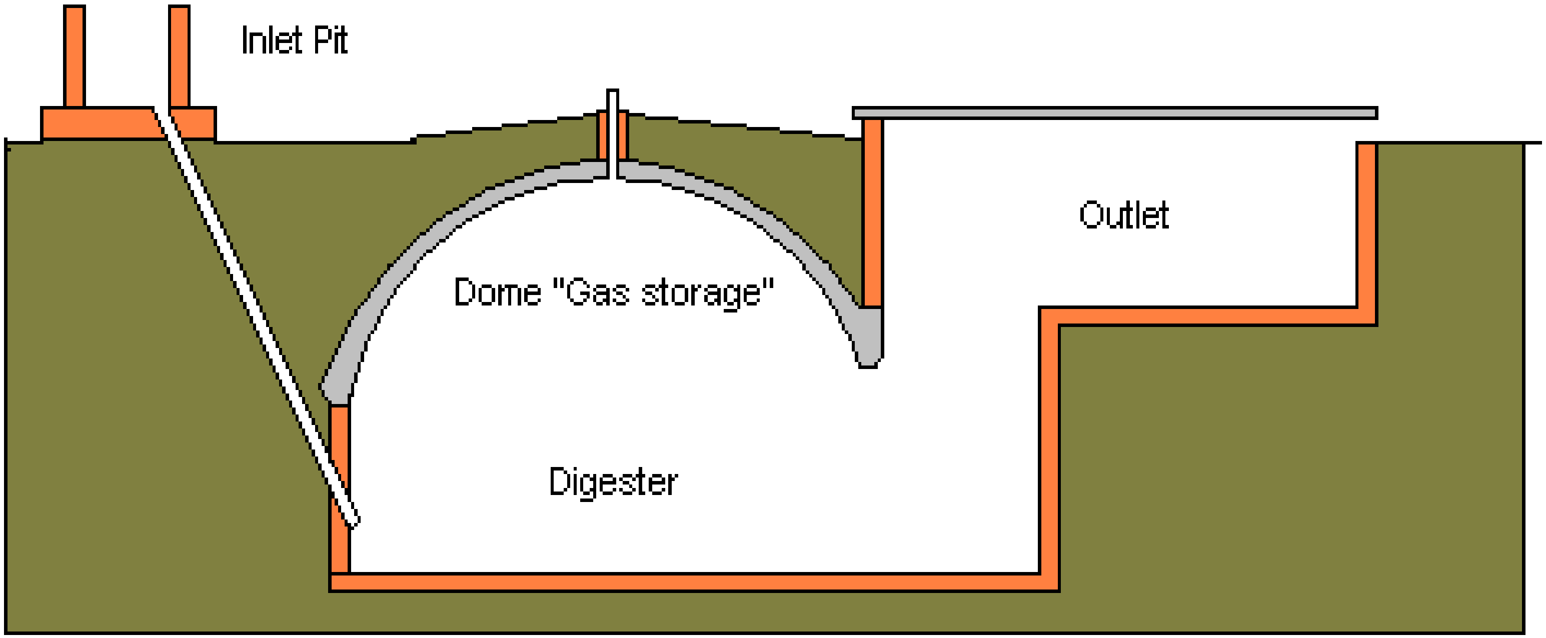
1. **Costlier to built**
2. **Difficult to transport**
3. **High investment in maintenance cost.**

Deenbandhu model



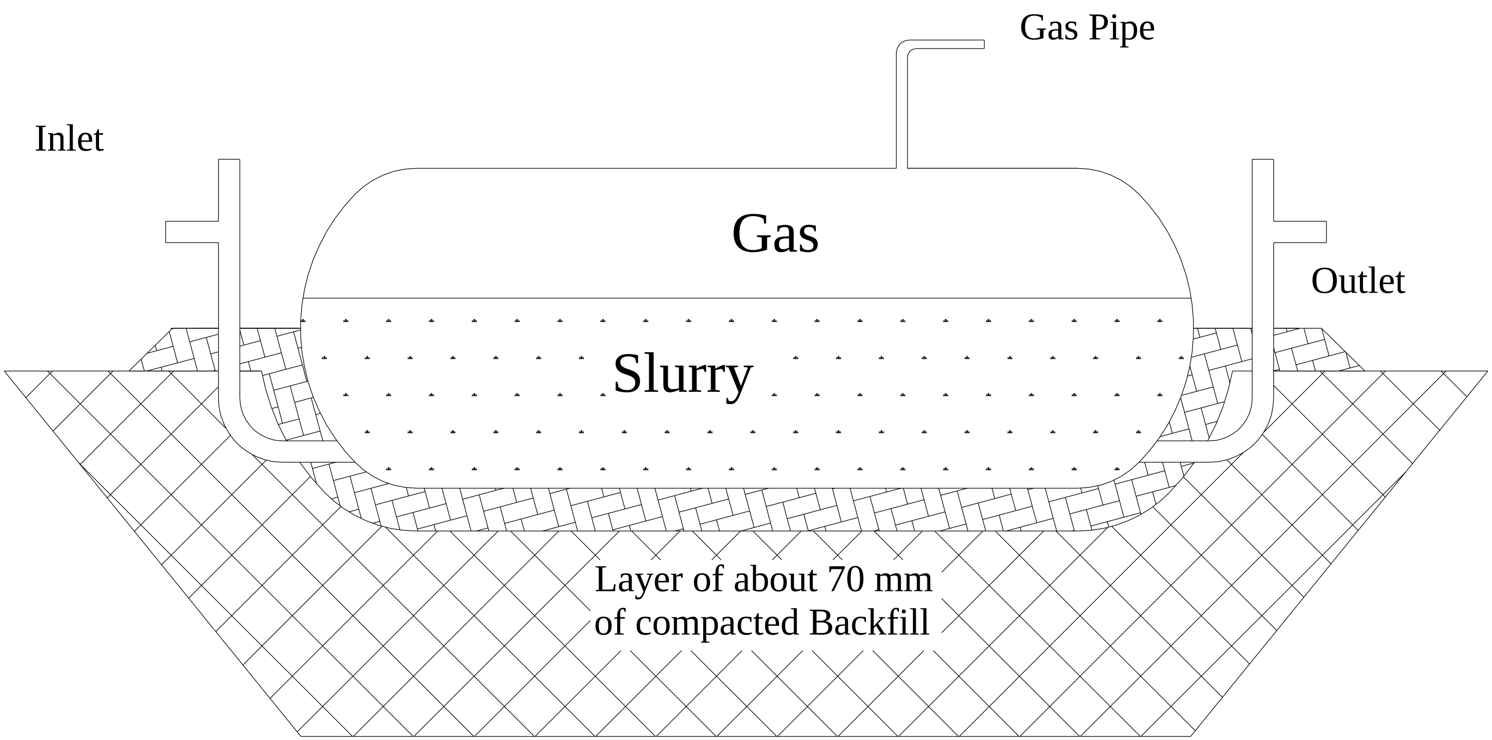
1. **High skilled mason required**
2. **Only could be constructed with bricks**
3. **No significant cost cut down.**

GGC 2047 model

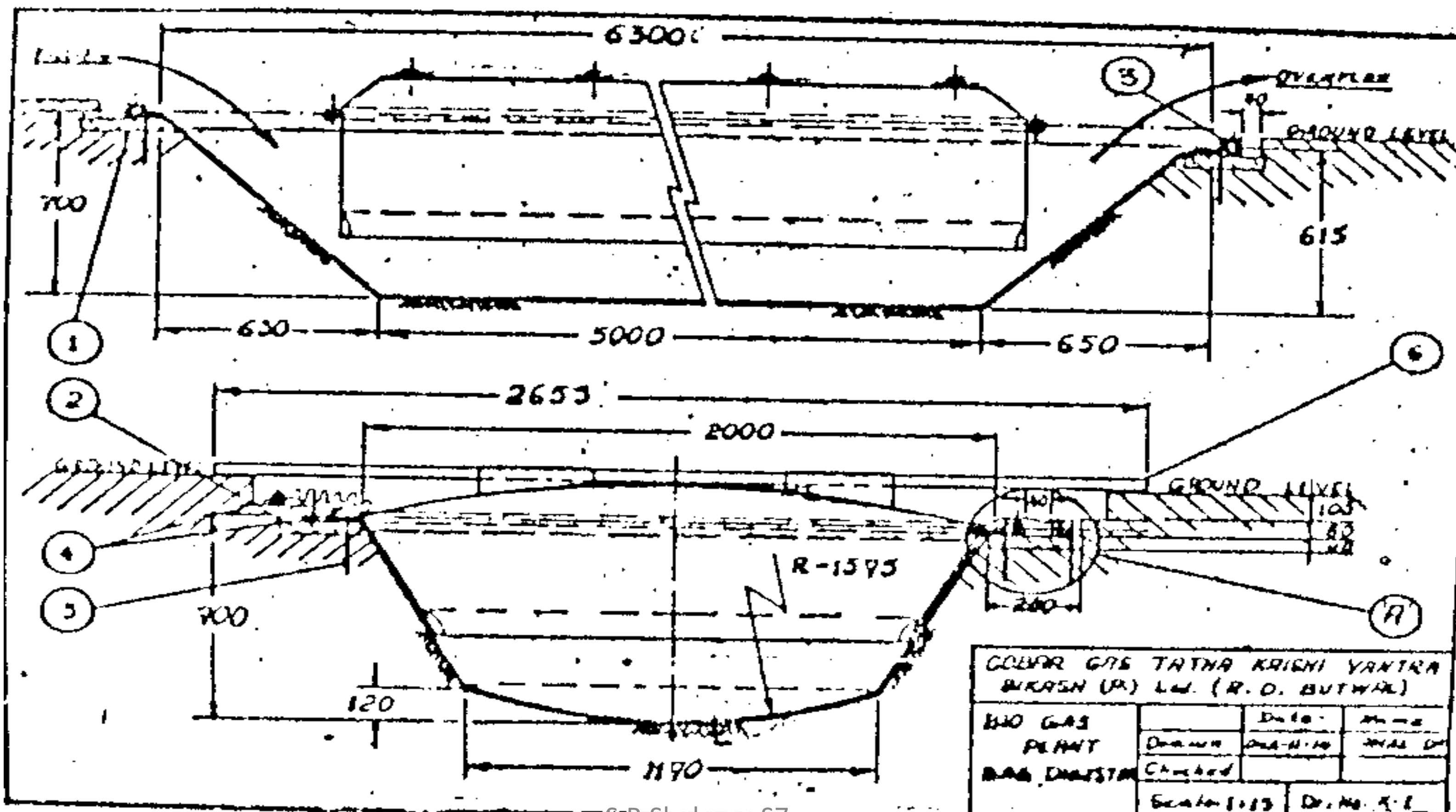


1. **Life of fixed dome is longer (20 to 50 years compared to KVIC)**
2. **Low maintenance cost**
3. **Could be built with locally available materials (stone / Brick)**

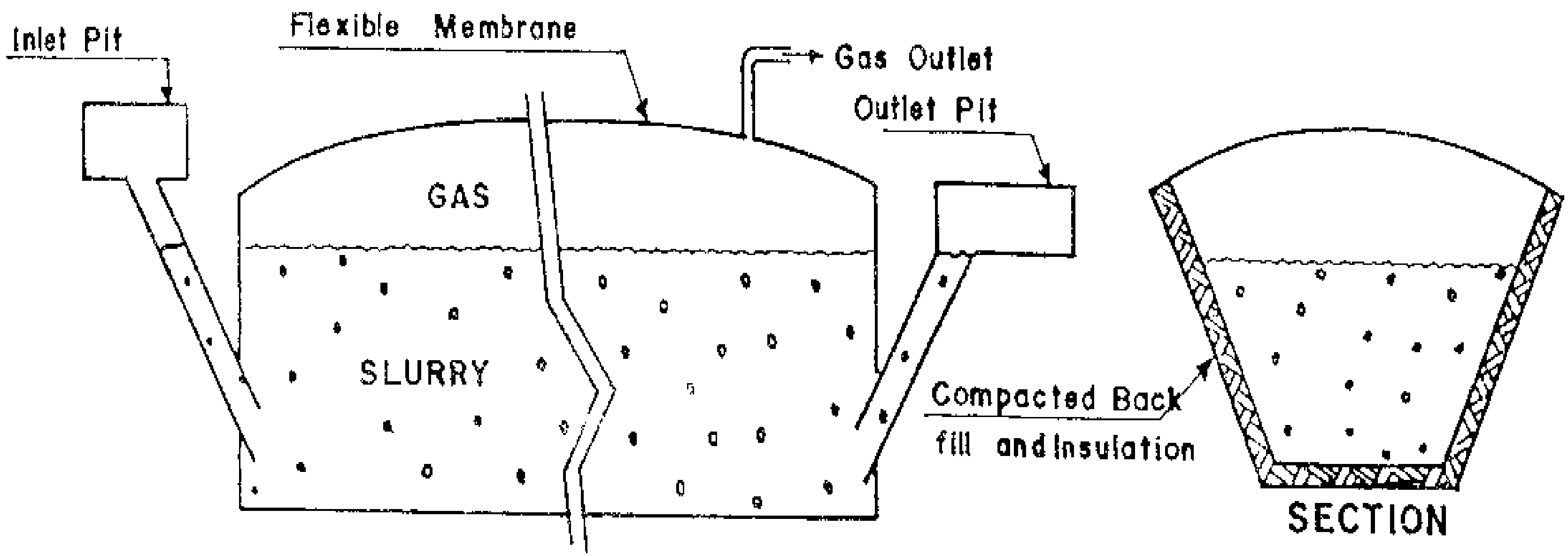
Taiwanese PVC Bag Digester



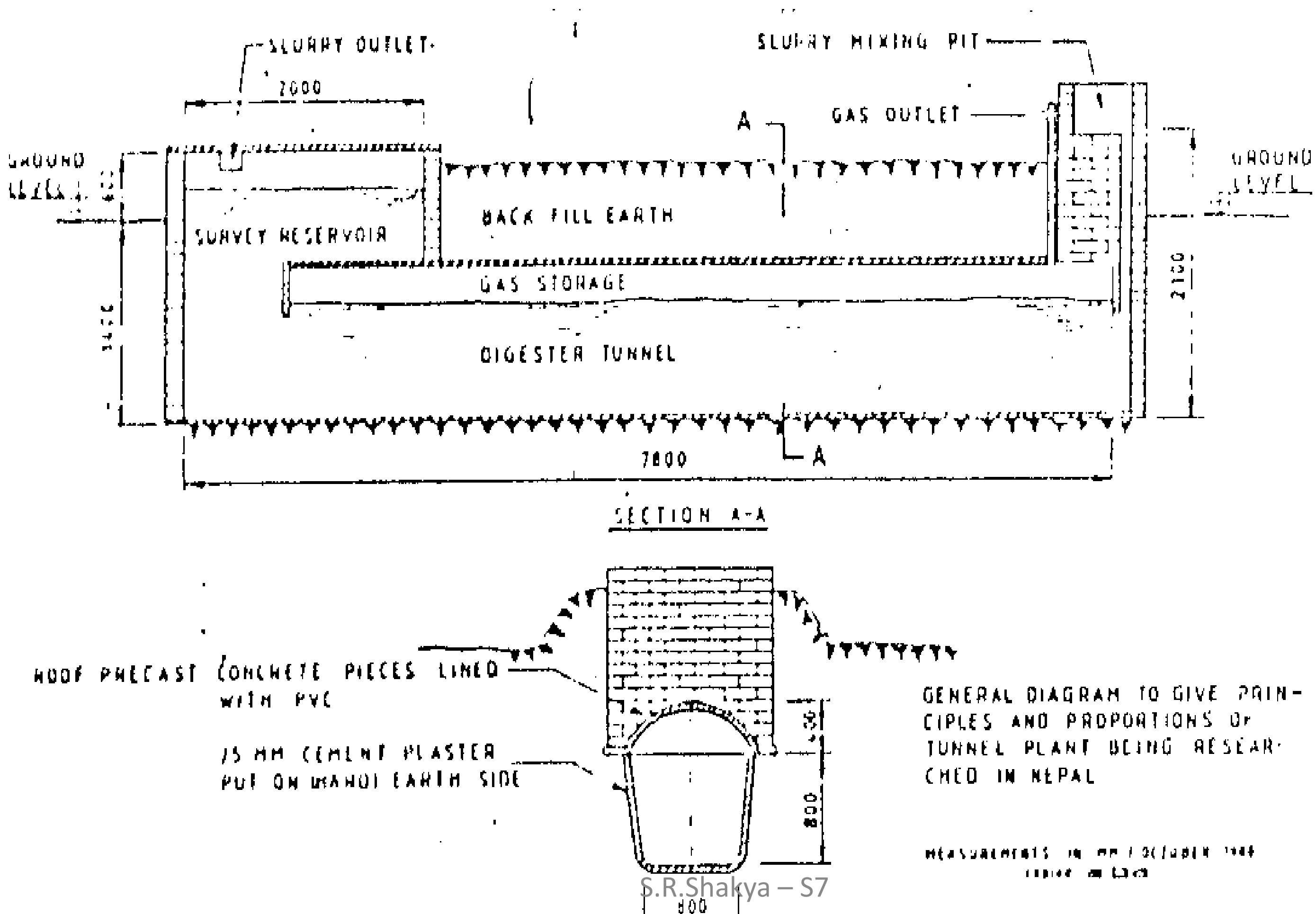
PVC Bag Digester Tested in Nepal



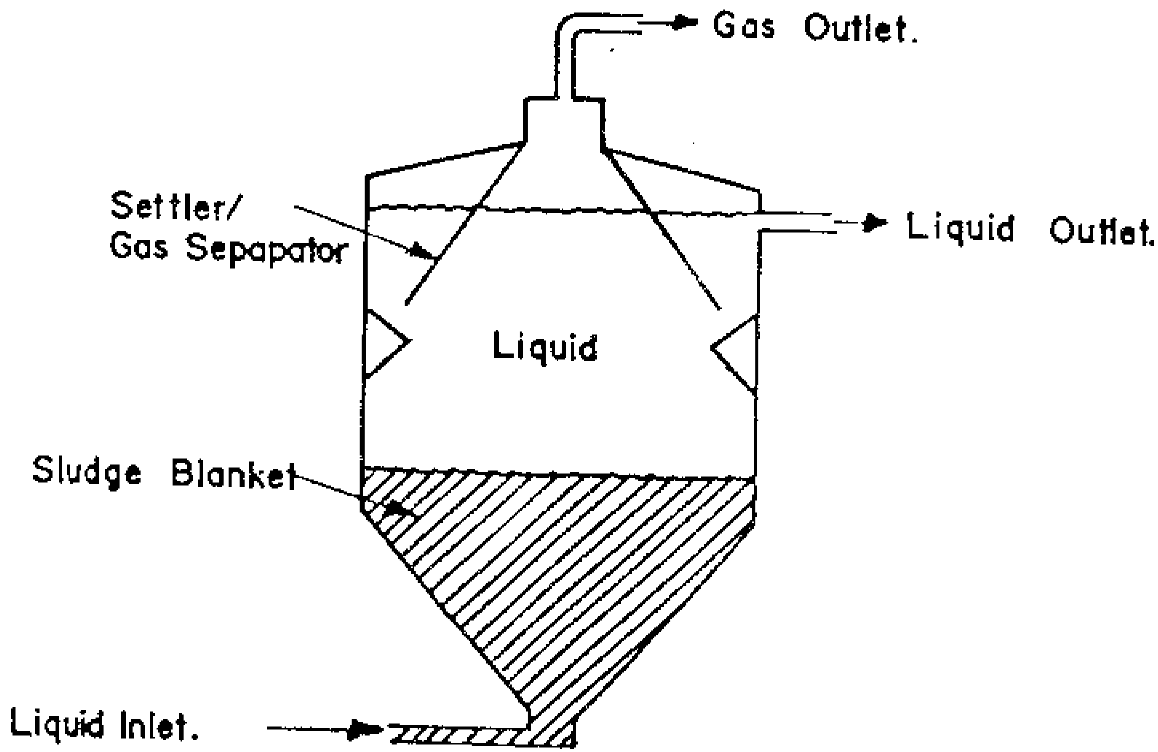
Plug Flow Digester



Tunnel Type Plant



Up flow Anaerobic Sludge Blanket (USAB)



TED Model Fixed Dome Bio-digester

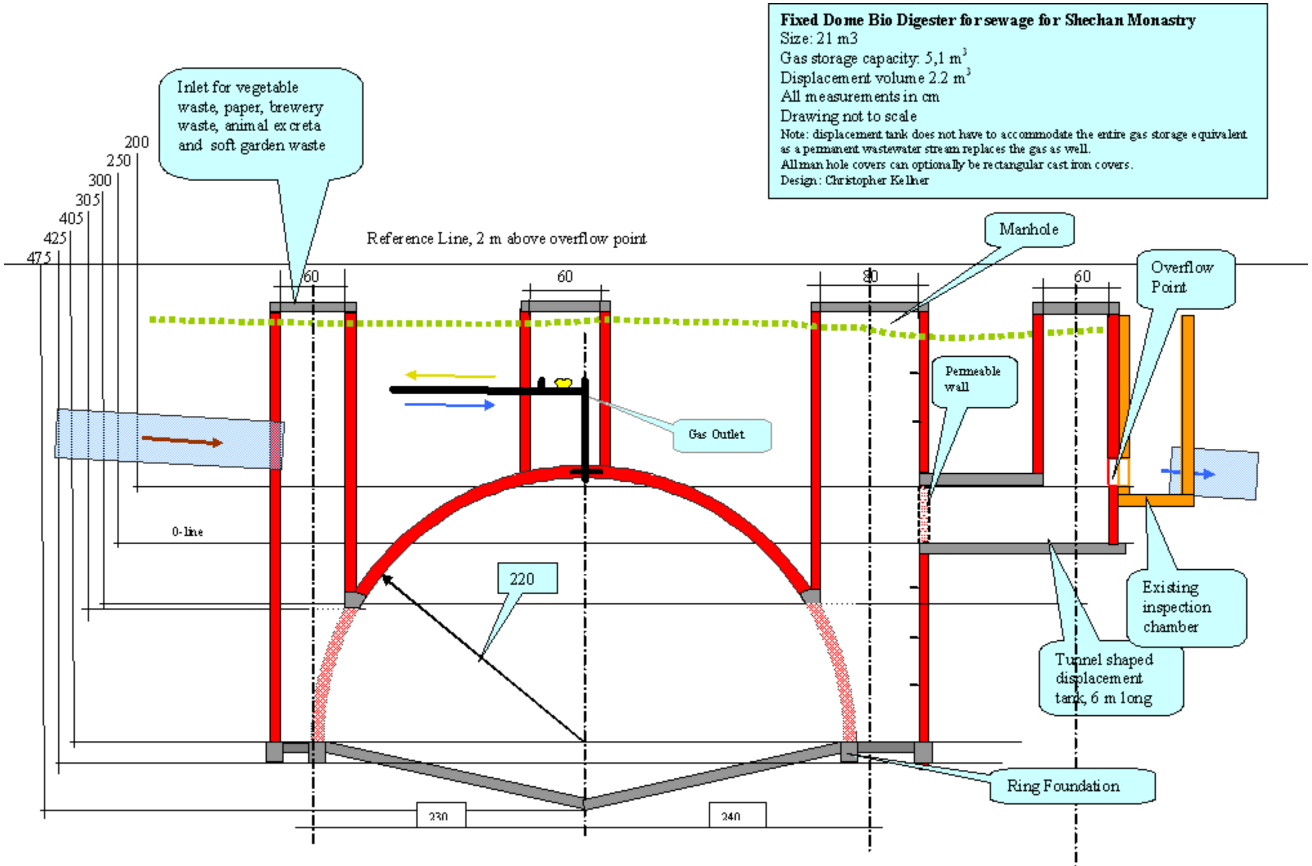
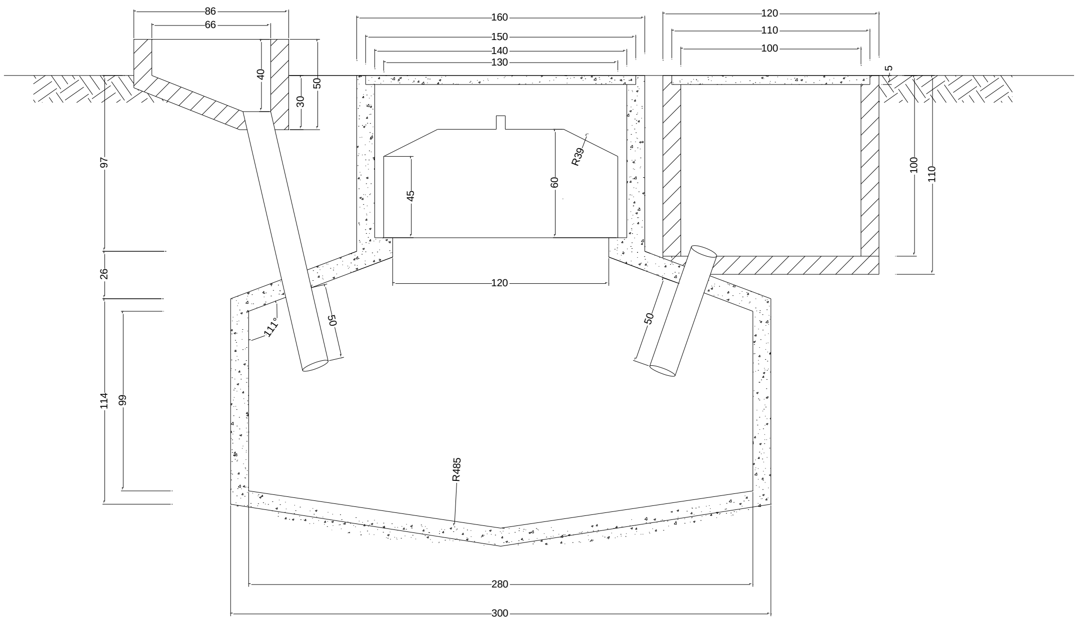
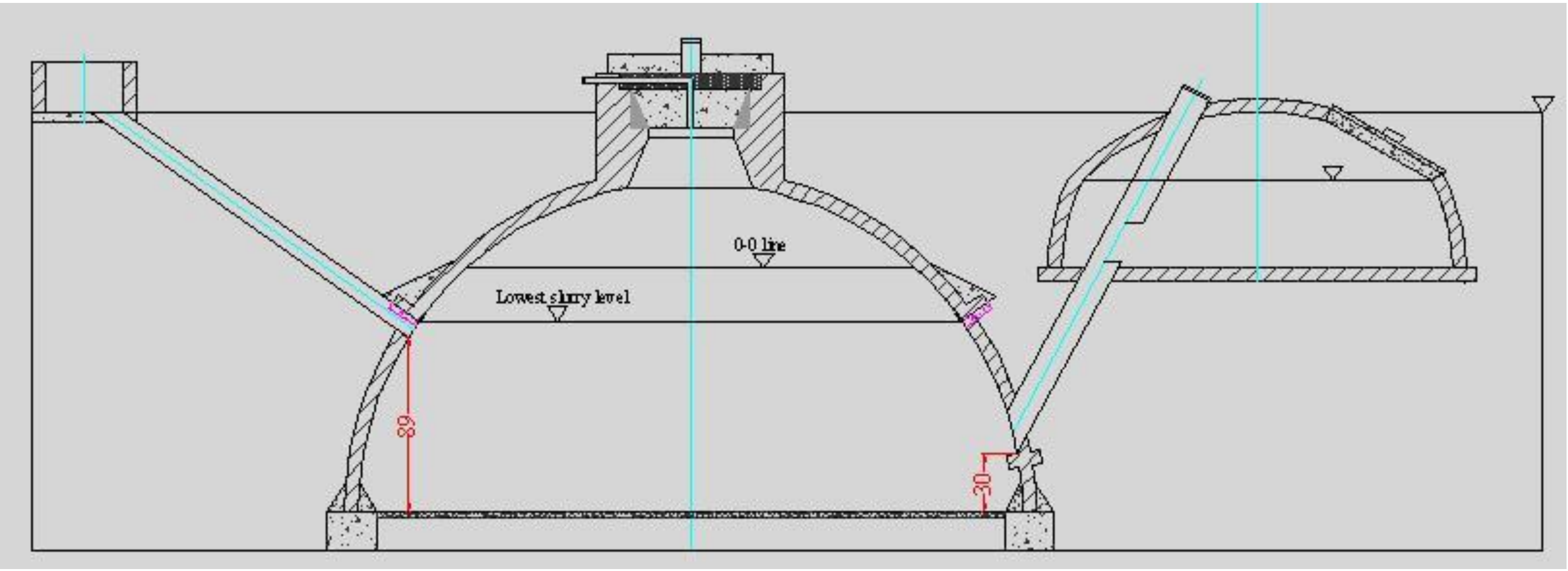


Figure : TED Model Fixed Dome Bio-digester

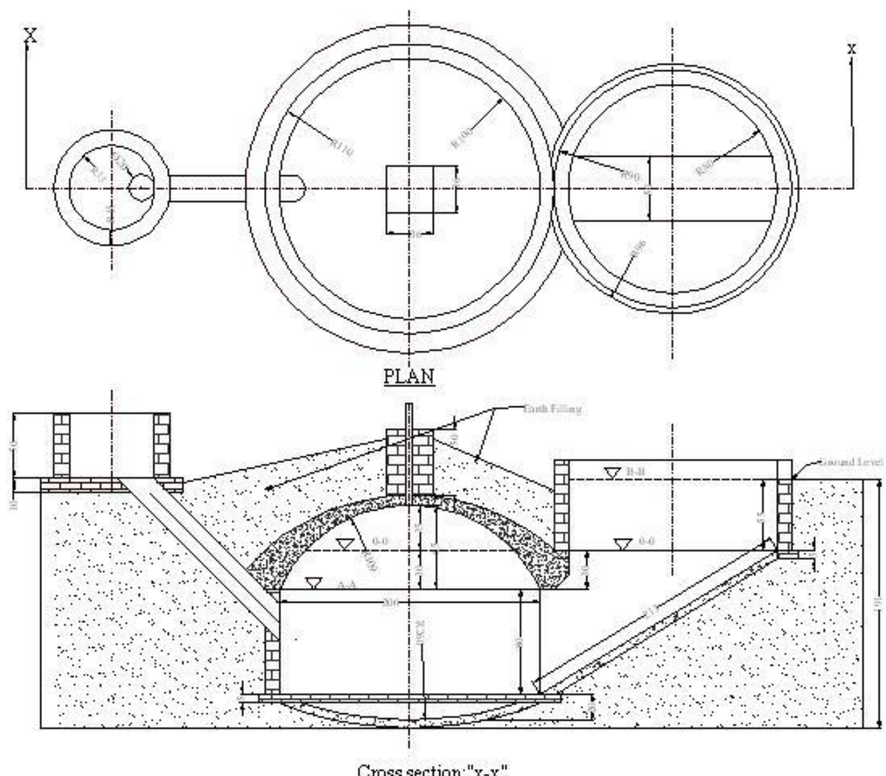
Puxin Model Bio-digester



CARMATEC



Modified GGC 2047 Model



Criteria for the Selection of an Ideal Biogas Model

- **It should be simple in terms of Construction and Operation.**
- **It should be Cost effective and durable.**
- **It should be efficient i.e the gas production should be optimum per unit volume of a gas Plant for given type and quantity of input.**
- **It should be possible to construct using of local materials as far as possible.**
- **Repair and maintenance requirement should be minimal.**
- **It should be convenient and user friendly.**

Site Selection (1)

- **A careful selection of the best site for the biogas plant must be made to ensure its sustainability.**
- **The factors that influences the decision are: Technical/Financial**
    - **Ideal location (sunny, south slope)**
    - **Distance of Kitchen and site**
    - **Distance of stable and Input site**
    - **Distance of site and effluent (Slurry)**
    - **Distance of water sources**
    - **Surrounding features (trees/ bamboos)**
    - **Ground water depth**
    - **Foundation Condition**
    - **Distance of available local construction materials**
- **Social Condition**
    - **Users does not want toilet attached biogas near by their front door.**

Site Selection (2)

- **A sunny site for right temperature of digester**
- **The site should be slightly higher than surroundings for no water logging**
- **Plant should be close to stable and water source**
- **Plant should be as close as possible to point of use**
- **Edge of the foundation of the plant at least 2 meters away from home**
- **Plant should be at least 10 m away from underground water source**
- **Sufficient space for compost pits**

Design Parameters for Sizing of Biogas Plants

S.N.	Parameter	Value
1	C/N Ratio	20 – 30
2	PH	6 – 7
3	Digestion temperature	20 – 35
4	Retention time (HRT)	40 –100 days
5	Biogas energy content	6 kWh/m^3
6	One cow yield	9 – 15 kg dung/day
7	Gas production per kg of cow dung	0.023 – 0.04 m^3
8	Gas production per kg of pig dung	0.04 – 0.059 m^3
9	Gas production per kg of chicken dung	0.065 – 0.116 m^3
10	Gas production per kg of human excreta	0.020 – 0.028 m^3
11	Gas requirement for cooking	0.2 – 0.3 m^3/person
12	Gas requirement for lighting one lamp	0.1 – 0.15 m^3/hr

Assessment of biogas requirements and available feedstock

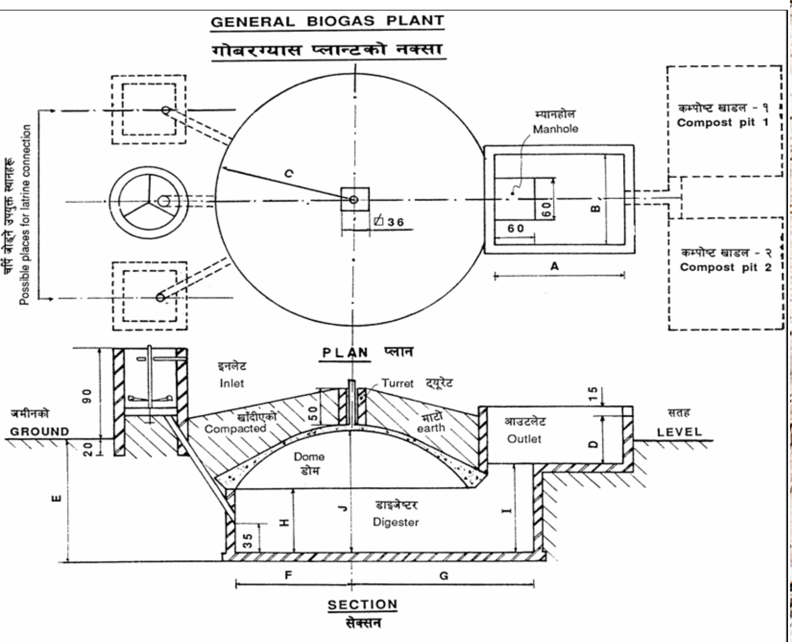
- Household fuel wood consumption=200 Kg/month
- If 1Kg=0.18m^3 of gas, comparable biogas volume=0.18x200=36m^3/month
- The required daily biogas vol=36/30=1.20m^3
- Therefore if daily gas production is 1.20m^3 all fuel requirement of this family is met.
- By thumb rule 1Kg dung produced 40 liters of gas thus to meet energy requirement 30 kg dung per day required.

THANK YOU !!!

Design of Biogas Plant

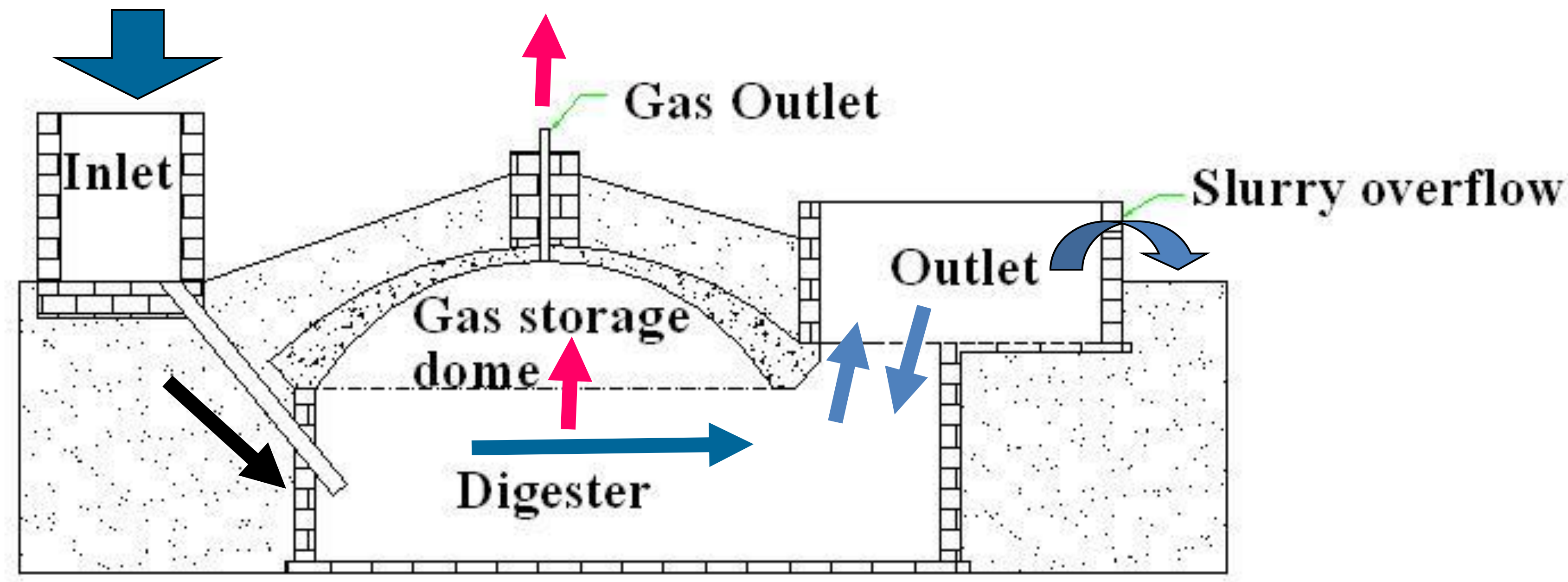
Biogas Plant Design in Nepal (1)

- **Biogas Plant (GGC 2047 Design)**

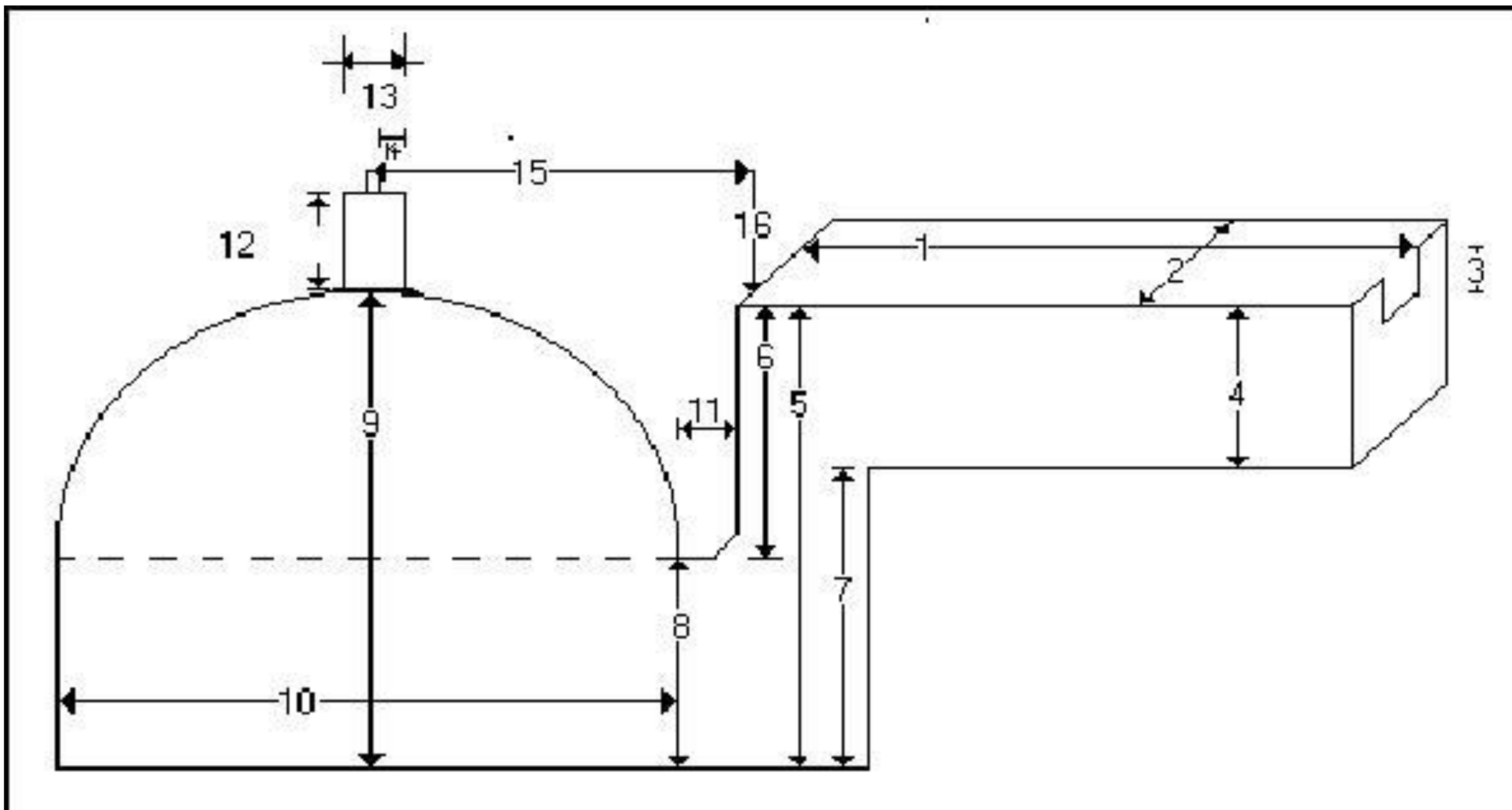


Biogas Plant Design in Nepal (2)

- **A Sectional View of Biogas Digester Showing Feed Inlet, Gas Outlet and Slurry Overflow.**



Design Calculation and Measurements of Different Size Biogas Plants



GGC Model 2047-Design Parameters (1)

- Design mainly depends upon:-

1. Energy consumption of particular families
2. Feeding materials available

GGC Model 2047-Design Parameters (2)

- **On the basis of feeding materials:-**

Suppose 36kg cow dung available daily (Dung:water)(1:1)

- **Total feeding daily=36+36=72Kg**
- **Retention time =60days**
- **Digester Volume =72*60=4320kg~4.32M^3**

- **Additional volume of digester to over come scum and gas bubbling=4.32+4.32*10%=4.75M^3**

Digester Sizing

<u>Calculation of H and D</u>

- Usually D/H=2~2.5
- Suppose H=1, then D=2.45 by Formula

Volume of digester $V=\pi/4*D^2*H$

Dome Sizing

- Usually dome volume=40~50% of digester Volume
- Therefore dome volume =40%of Digester volume

$$=0.4*4.75=1.9M^3$$

<u>Calculation of h and r</u>

- Now r=D/2=2.45/2=1.22 then by Formula

Volume of dome $V=\pi h/6(3r^2+h^2)$ by solving cubic equation h=0.68

Outlet Sizing

- Usually outlet volume=60~70% of dome volume
- Therefore outlet volume =60%of Dome volume

  $=0.6*1.90=1.14M^3$

<u>Calculation of L, B and h</u>

- Height of outlet chamber depend upon how much structure can take the pressure for safe side 0.80m-1.35m water gauge pressure taken for concrete work.
- Usually L=1.2~1.5B
- Therefore Outlet Volume=1.14=L*B*h

Inlet Sizing

- Daily feeding=72Kg~0.072M^3
- Additional space for to prevent spell out 10%

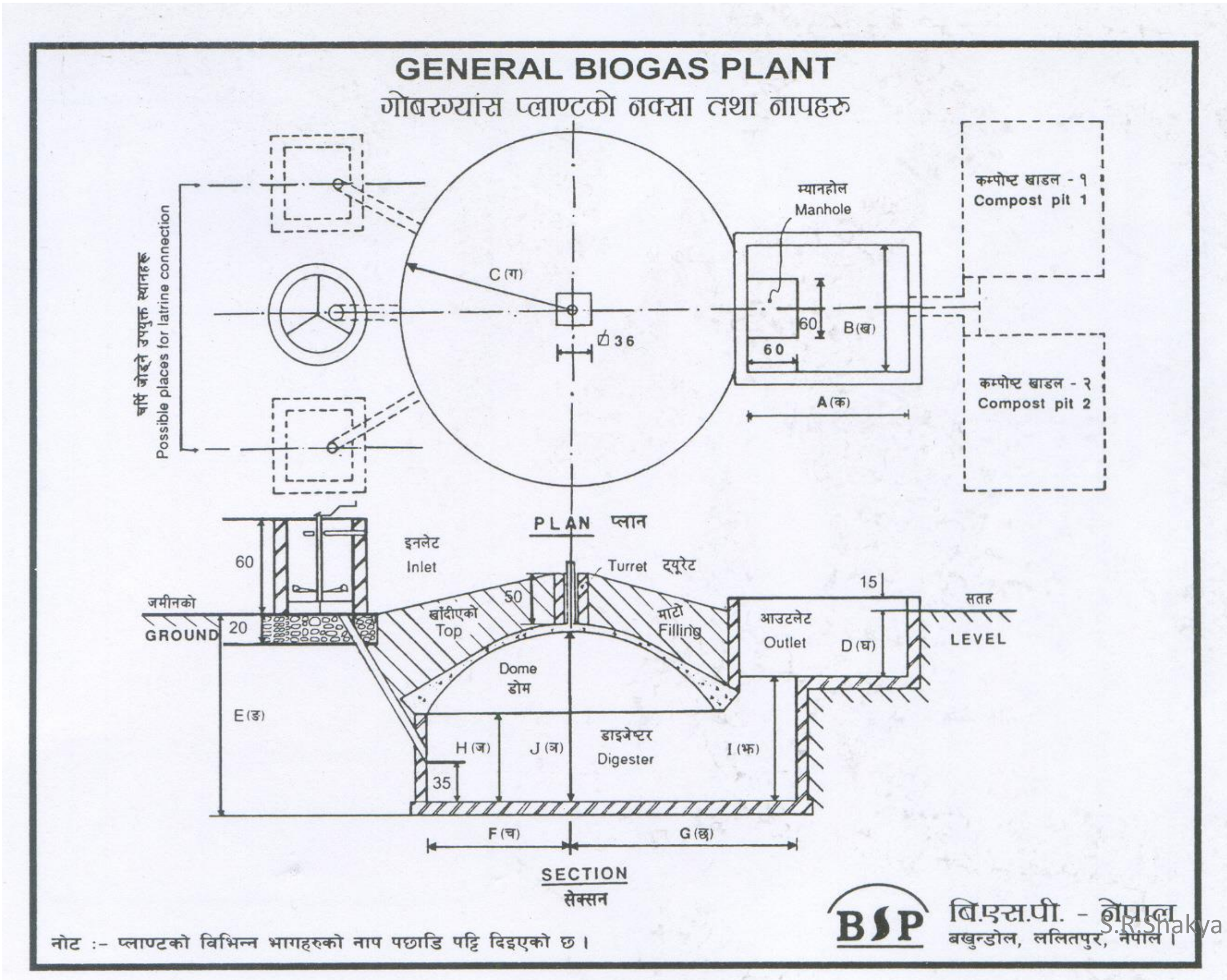
Therefore Inlet volume =0.072+10%0.072

=0.072M^3

<u>Calculation of D and h</u>

- For convenient height of inlet=0.5~0.6meter in height Therefore D can be calculated from Inlet Volume=$\pi/4*D^2*h$

Various Dimension of Biogas Plant (1)



Various Dimension of Biogas Plant (2)

Measurement of GGC 2047 Plant

Section	4m3	6m3	8m3	10m3	15m3	20m3
A	140	150	170	180	248	264
B	120	120	130	125	125	176
C	135	151	170	183	205	233
D	50	60	65	68	84	86
E	154	155	172	168	180	203
F	102	122	135	154	175	199
G	195	211	230	243	265	293
H	86	92	105	94	115	115
I	112	116	127	124	132	137
J	151	160	175	171	193	203

Construction Materials Required(1)

Plant Size M^3	Cement bags(@50Kg\ Bag	Stone,M^3(or Bricks in number)	Gravel in No. of C-Bags	Sand in No. of C-Bags	Paint in litres
4	11-12	3.5(1,200)	30	60	1
6	13-14	4.5(1,400)	35	70	1
8	16-16	6.5(1,700)	40	80	1.5
10	19-21	8.0(2,000)	50	90	2

Construction Materials Required (2)

- Iron Rod(8mm) =15-16Kg
- Mixer =1 piece
- Intel Pipe =4 metres
- Half Inch GI Pipe =4 metres
- HPDE Pipe(20mm) = 12 metres
- Dome Gas Pipe = 1 piece
- Main Gas Valve = 1 piece
- Water drain = 1 piece
- Gas Tap = 1 piece
- Rubber Hose Pipe = 1 metre
- Gas Stove = 1-2 pieces
- Lamps as necessary
- Nipple(1/2"X6") = 1 piece
- Socket(1/2") = 2 pieces
- Elbow(1/2") = 2 pieces
- Tee (1/2") = 1 piece
- Brass Union = 3 pieces
- Teflon Tape(10mm) =2 pieces

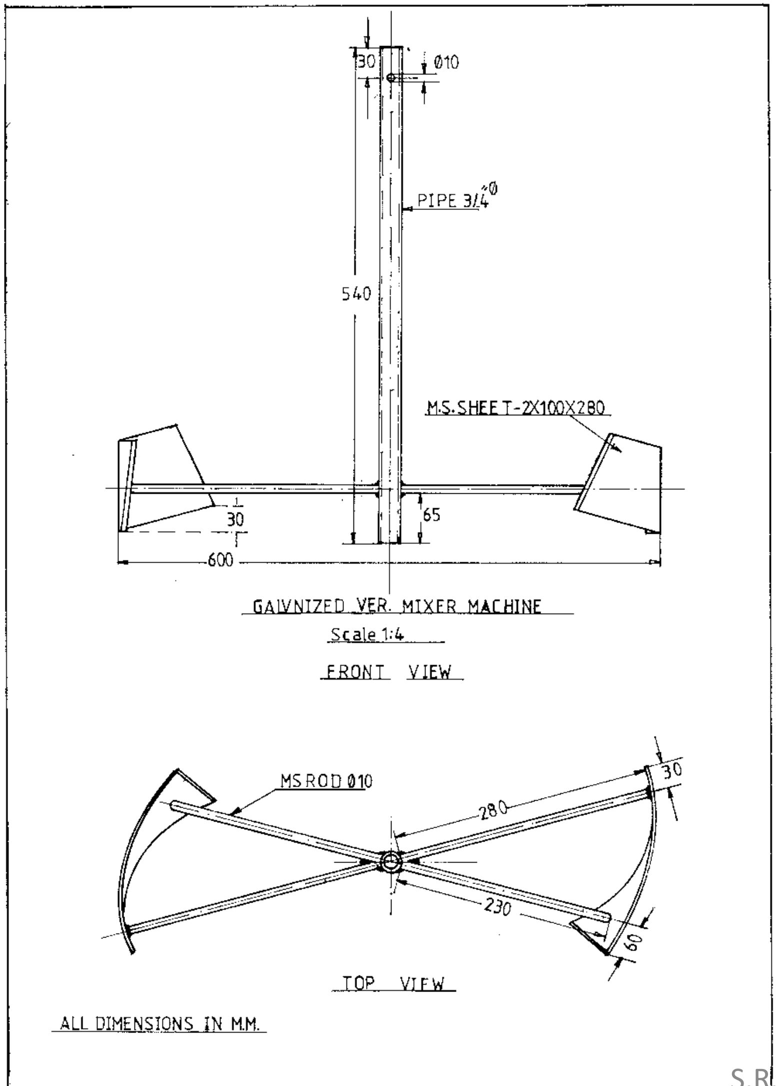
Operation and Maintenance(1)

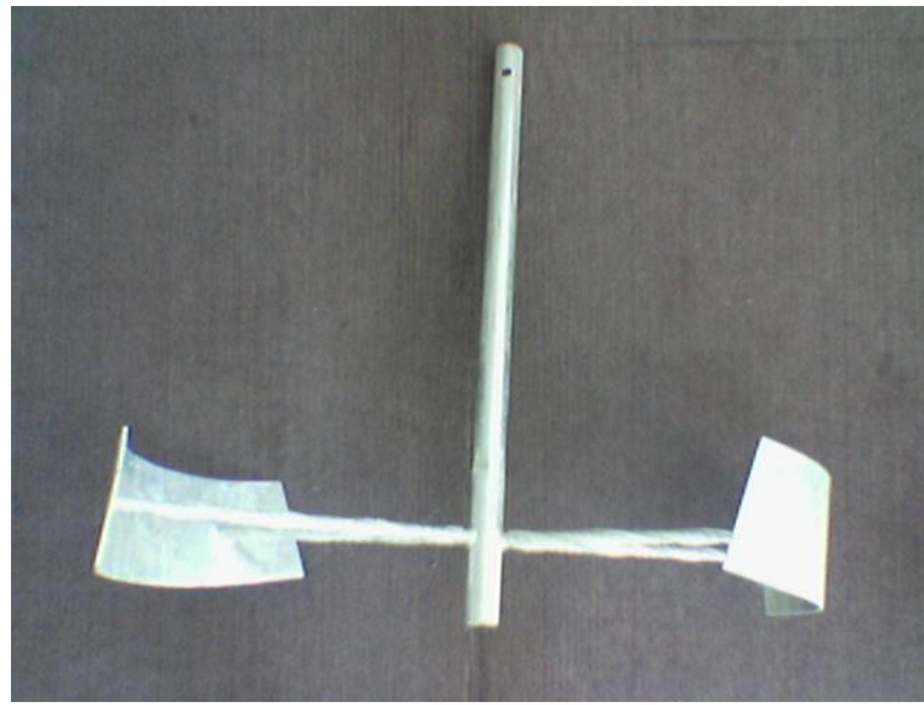
- This is one of the vital part of the technology
- Proper Operation only ensure the sustainability of the technology
- Proper Maintenance will ensure satisfaction of the users

Operation and Maintenance(2)

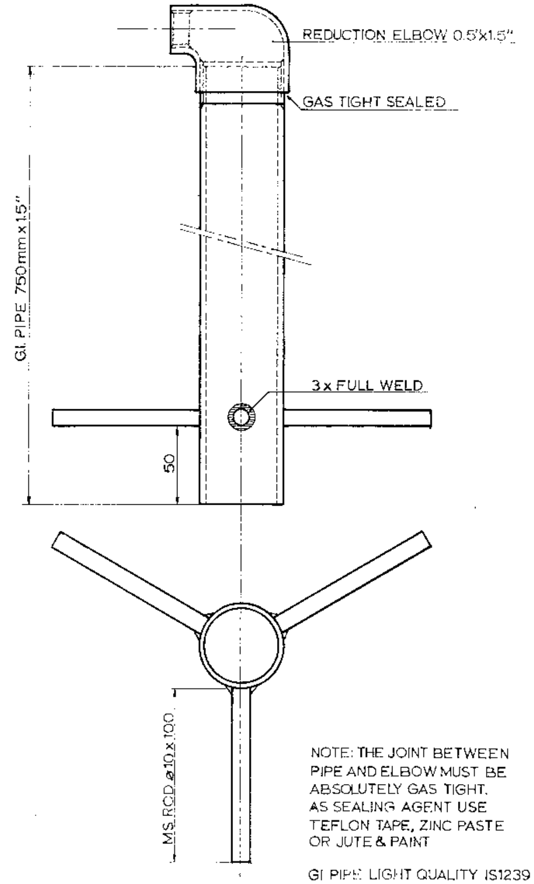
- Proper Feeding
- Overflow
- Operation of Main Gas Valve
- Operation of Water drain
- Operation of gas tap
- Operation of stove
- Operation of gas lamp
- Top Filling

Mixture Machine

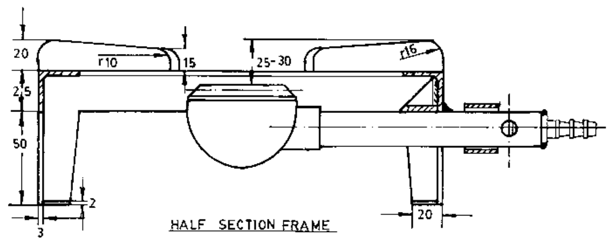


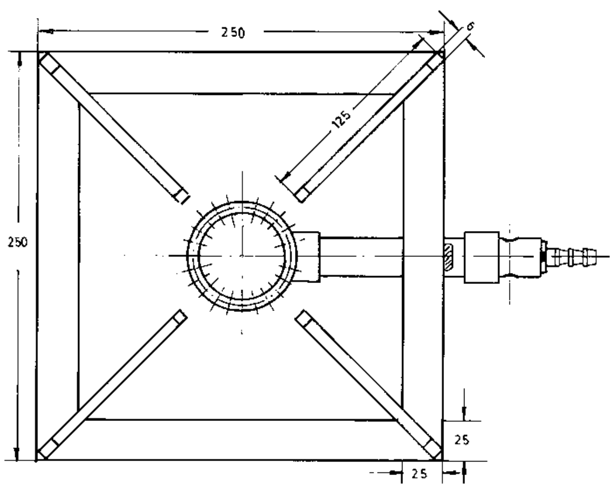


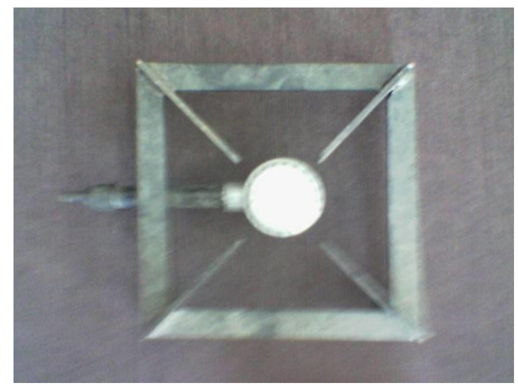
Dome Gas Pipe

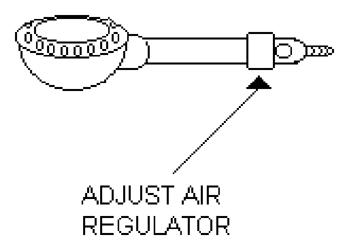


Biogas Stove

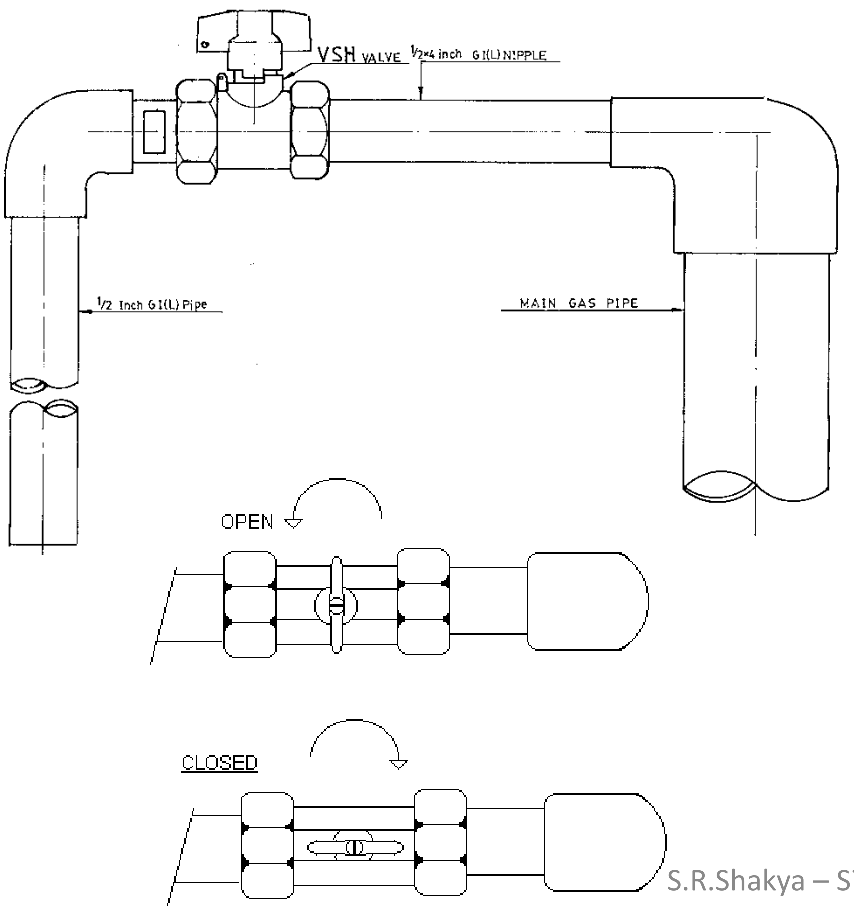




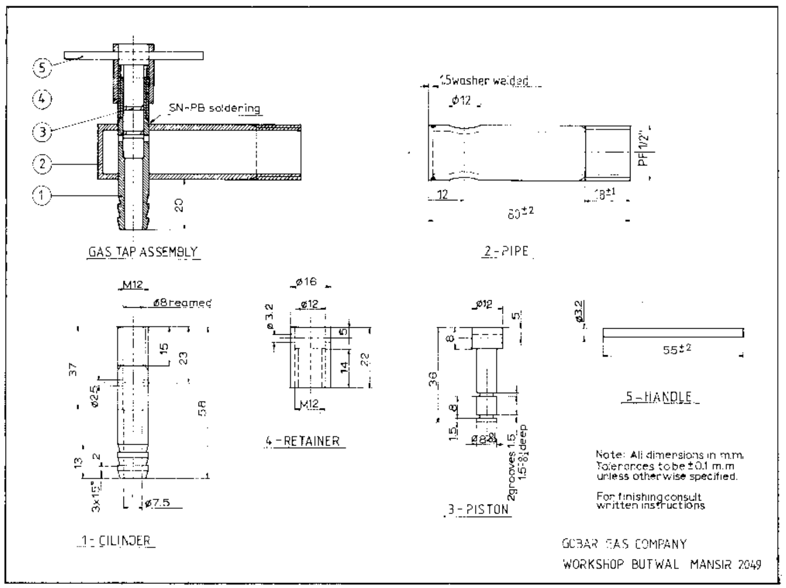


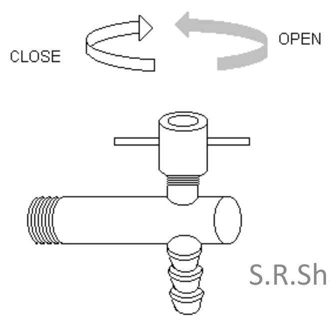


Main Gas Valve

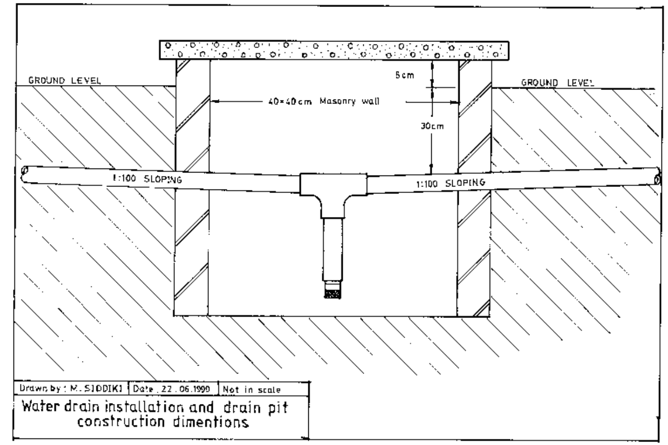


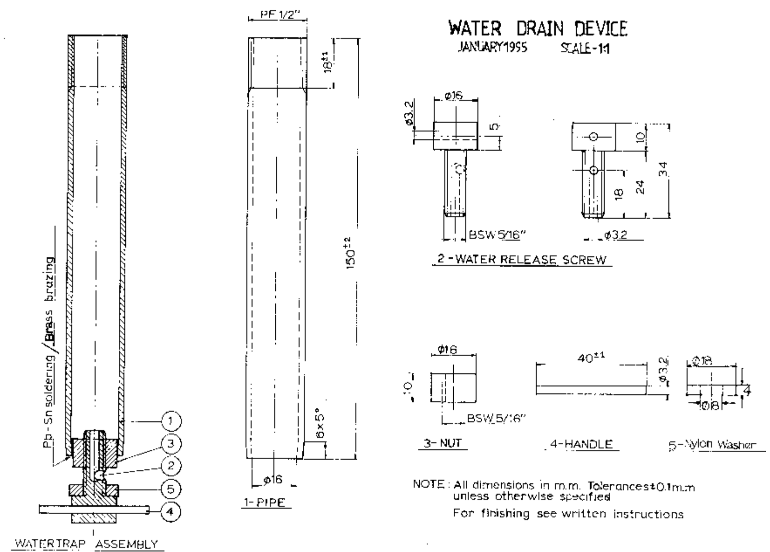
Gas Tap

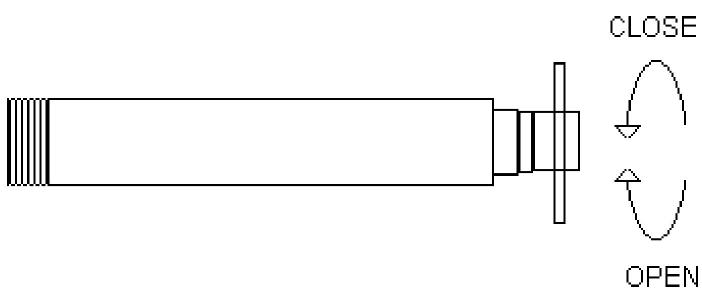

GAS TAP ASSEMBLY
SN-PB soldering
2-PIPE
1.5washer welded
PF1/2"
4-RETAINER
3-PISTON
5-HANDLE
1-CILINDER
Note: All dimensions in m.m.
Tolerances to be ±0.1 m.m
unless otherwise specified.
For finishing consult
written instructions
GOBAR GAS COMPANY
WORKSHOP BUTWAL MANSIR 2049


CLOSE
OPEN

Water Drain D







Problem Solving Techniques(1)

Problems	Causes	Remedies
Although there is enough gas in the dome, gas does not burn.	At the beginning, in newly filled plant, there is an mixture of different non-combustible gases, which do not burn.	Release all the stored gases from the dome. By opening gas taps and water drain plug. Repeat this process until the gas burns easily.
	Newly filled slurry do not produce methane gas instantly.	Wait for about a week because, it takes some time to produce methane.
	Main gas valve may not be opened.	Open Main gas valve.
	The hole of gas tap and stove jet hole might be obstructed	Clear all the ports in the gas tap, stove jet and burner cap.
	Water may have blocked the gas flow.	Open water drain and release all the water from the pipe line.
	Lack of methanogenic bacteria.	Add slurry from old operating plant.

Problem Solving Techniques(2)

Problems	Causes	Remedies
Gas production suddenly reduced or completely stop.	Quantity of slurry is decreased or increased suddenly then recommended.	Feed recommended amount of dung and water daily.
	Ratio of dung and water suddenly changes.	Mixture ratio should be corrected as to the recommended ratio. (1 kg dung :1 liter water)
	Decreased in the temperature inside the digester.	●leave the mixture in the sunlight for few hours before feeding inside the plant. ●Increase the top filling on dome by more than 40 cm.
	Chemicals such as soap water, detergent, phenyl and dung from the under treatment cattle may have been mixed.	●Avoid use of such contaminating chemicals and dung from under treatment cattle. ●Continue to feed the plant daily with the recommended amount of fresh dung and water until methanogenic bacteria develops fully.
	Plant not having enough sunlight on dome.	Manage enough sunlight on dome.
	●Gas leakage in the pipe joints. ●Cracks in the rubber hose due to poor quality.	●Check all the joints with soap foam, repair the leakage or call the company technicians as soon as possible. ●Replace with Neoprene rubber hose only.

Problem Solving Techniques(3)

Problems	Causes	Remedies
Flame is very weak or burns little with red flame.	Pressure of the combustible gas is weak.	Let the pressure rise by giving enough rest period.
	The hole of gas tap and stove jet hole might be obstructed.	Clear all the ports in the gas tap and stove jet.
	Water may have been collected in the pipe line.	●Open the water drain and release all the water from the pipe line.
	Slurry may have inter the pipe line.	●Open the union of the main gas valve, fill the pipe line with water and open the water drain so that the filled water may be release through the water drain. Continue this process until the pipe line is free from slurry. Same method should be applied through the gas tap to clean the other half of the pipe line.
	No slope, drain not placed at the lowest point or Incorrect sloping of the pipeline.	Maintain necessary slope so that water in the pipe line accumulate in the water drain from all side.

Problem Solving Techniques(4)

Problems	**Causes**	**Remedies**
Gas burns with weak and long flame far away from the stove burner cap.	Air hole and gas jet hole in the burner pipe my have been blocked.	●Position the air regulator ring so that the air hole is only half covered. ●Clean the jet hole as well as air hole free from foreign matters.

Problem Solving Techniques(5)

Problems	Causes	Remedies
Hard to operate gas tap, main gas valve and gas cock of the lamp.	Carbon deposits may have taken place.	●Frequently check the appliances for carbon deposits. Clean and lubricate it weekly.

Problem Solving Techniques(6)

Problems	Causes	Remedies
Slurry in the pipe line	Under fed plant.	Feed the plant with recommended amount of dung and water.
	In correct ratio of dung and water.	Maintain correct ratio of dung and water.
	Leakage	●Repair all leakage.
	Harmful Chemical in the mixture.	●Avoid using chemical in the toilet. ●Do not use dung from sick cattle.
	Low temperature.	●Maintain proper (40 cm) top filling on dome. ●Manage adequate sunlight on dome. ●Warm the mixture by sunlight for few hours before feeding.
	Little rest period and excessive use of gas	●Provide adequate rest period and economically use gas.

Loading of dung, Cattle Requirement and Gas Generation for different Plant Size

Plant Size, m^3	**Daily Dung Feed, kg *(@6-7.5 kg Dung/ m^3 Plant Size)****	**No. of Cow Required *(@12 kg Dung/Cow)***	**Daily Water Feed, (litres)**	**Daily Gas Produced, Litres *(@40 litres /kg Dung)***	**Daily Stove Burning Hours *(@400 Lit/Hr)***	***No. of Family***	***Initial dung feeding kg***
4	**24~30**	**2~3**	**24~30**	**960**	**2:40**	**4-6**	**2,025**
6	**36~45**	**3~4**	**36~45**	**1,440**	**3:60**	**6-8**	**2,900**
8	**48~60**	**4~5**	**48~60**	**1,920**	**4:80**	**8-10**	**3,930**
10	**60~75**	**5~6**	**60~75**	**2,400**	**6:00**	**10-15**	**4,490**

Calculation to Generate 1M^3 gas per day(1)

Calculate the amount of cow dung required to generate 1 m^3 of gas per day.

- 1 kg of cow dung produces 0.023 – 0.04 m^3 of gas
- Average value = (0.023 + 0.04)/2 = 0.032 m^3

-Or 0.032 m^3 of gas is produce from 1 kg of dung
-to produce 1 m^3 of gas: 1/0.032 kg of dung is required = 31.3 kg of dung

Calculation to Generate 1M^3 gas per day(2)

What is the appropriate plant size required for above Example ?

For loading rate of 31 kg of dung, the required plant size is 4 m^3 if the plant is located in Terai (30 kg) and 6 m^3 (36) for hills.

Calculation to Generate 1M^3 gas per day(3)

How many cows will the farmer need in the above examples (i.e. to produce 1 m^3 of gas)?

- 1 cow yields 9 – 15 kg of dung per gay (depending on whether it is stall fed or grazed)
    - Average value: (9 + 15)/2 = 12 kg/day assuming animals are partly grazed and partly stall-fed

    to produce 31.3 kg of dung he will need 31.3/12 = 2.6 ➔ 3 cows

In practice, a farmer has a fixed number of animals and wants to find out the plant size required and the gas produced to meet his energy demand. Also, farmers are advised to weigh the dung produced daily a few times to determine the appropriate plant size.

Calculation to Generate 1M^3 gas per day(4)

Suppose a farmer has:

2 cows each producing about 10 kg/day of dung

3 buffaloes, each producing 16 kg/day of dung

Can he meet the energy demand to cook for a family of 6 and light one lamp for 4 hours per day?

Total dung available: 2 x 10 + 3 x 16 = 68 kg/day

68 kg/day of dung produces: 0.032 m^3/kg x 68 kg/day = 2.2 m^3 of gas/day

From table, he will need a plant size of 8 m^3 to 10 m^3

Gas required for cooking: **Table 2.2**: 0.25 m^3/person (average)

For a family of 6: cooking requirements = 6 x 0.25 = 1.5 m^3

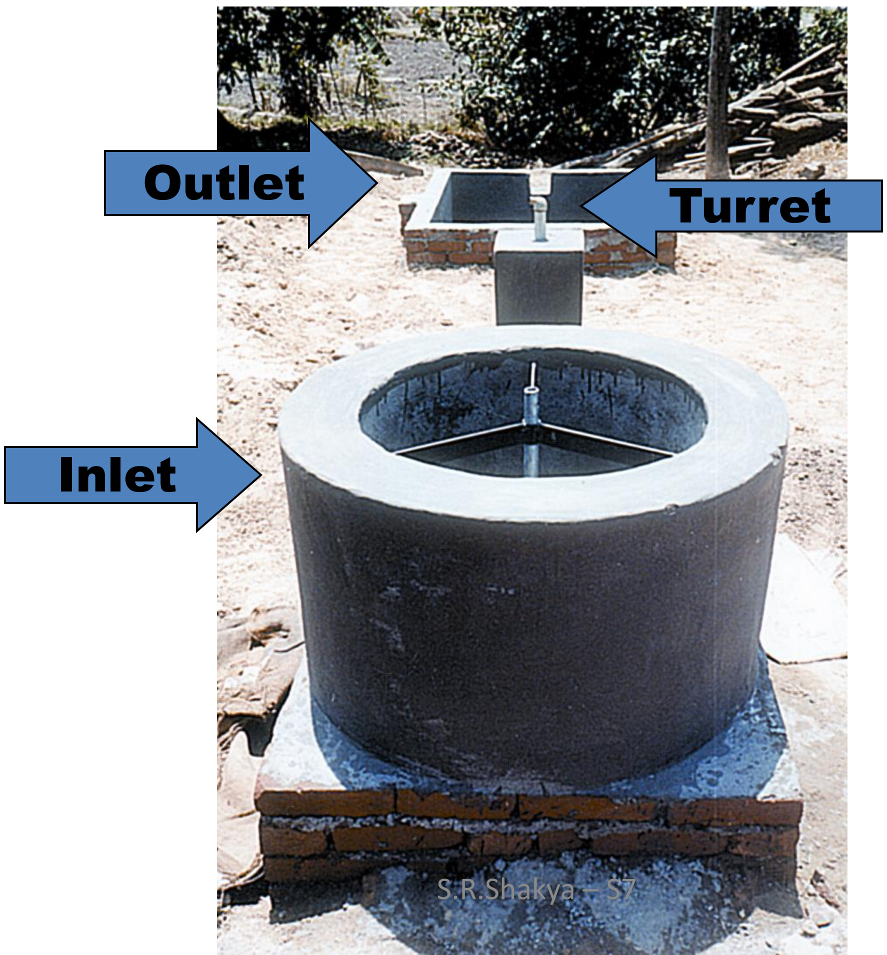
Gas required for lighting: **Table 2.2**: 0.125 m^3 (average)

Lighting requirements: 4 x 0.125 = 0.5 m^3

Total gas requirement = 1.5 + 0.5 = **2 m^3 /day**

Since his gas requirement (2 m^3/day) is slightly less than his gas production rate (2.2 m^3/day), yes, he can meet his energy demand.

Technical Features of Biogas Plant GGC 2047 Model



Presentation Overview

"A technology is appropriate if it gains acceptance"

- **Introduction of Biogas Technology**
  - **Introduction to biogas**
  - **Conditions for Anaerobic Digestion of Organic Wastes**
  - **Use of Low Cost Building Materials**
  - **GGC 2047 Model biogas plant and its Components**
  - **Biogas Plant Design**
  - **Working of GGC 2047 Biogas Plant**
- **New Design**
- **High Altitude Biogas Plant**

Introduction of Biogas Technology

- **Biogas is a combustible gas produced by anaerobic fermentation of organic materials by the action of methanogenic bacteria**
- **The gas is principally composed of methane and carbon dioxide**
- **Biogas is somewhat lighter than air and has an ignition temperature of around 700^{o}C**
- **If the methane content is considerably below 50%, biogas is no longer combustible**
- **The gas can be used as an energy source for any purpose from cooking to electricity generation.**

Average Composition of Biogas

Substance	Symbol	Percentage
Methane	CH_4	50 to 70
Carbon dioxide	CO_2	30 to 40
Hydrogen	H_2	5 to 10
Nitrogen	N_2	1 to 2
Water Vapour	H_2O	0.3
Hydrogen Sulphide	H_2S	Traces

Conditions for Anaerobic Digestion of Organic Waste (2)

- **pH of the fermentation slurry is indication of digestion and pH value should be between 6-8**
- **All feed material consists of organic solids, inorganic solids (minerals, metals), water**
- **Adding water or urine gives the substrate fluid properties and is good for operation of biogas plants**
- **Most commonly used cattle dung consists of 16-20% total solids (TS) of which 80-84% are volatile Solids (VS-organic materials in dung)**
- **Gas production is max between 7-9% TS**

Conditions for Anaerobic Digestion of Organic Waste (3)

- **Slurry with TS 5-10% is well suited for operation of continuous biogas plants.**
- **Fresh cattle manure is made of 16% TS and 84% water and if this dung is mixed with water in the ratio 1:1 the solid contents will be 8% (most suitable for BP)**
- **A high concentration of solids delays fermentation and the corresponding high viscosity prevents evolution of gas**
- **For GGC 2047 Model,**

  -Ave. Retention Time = 55~70 days (55days-Terai, 70days-hill)

  -Initial Waiting Time for Gas Production = ~ 15 Days.

  -Initial Dung Feed = ~ 410 kg/ m^3 plant size

Conditions for Anaerobic Digestion of Organic Waste (4)

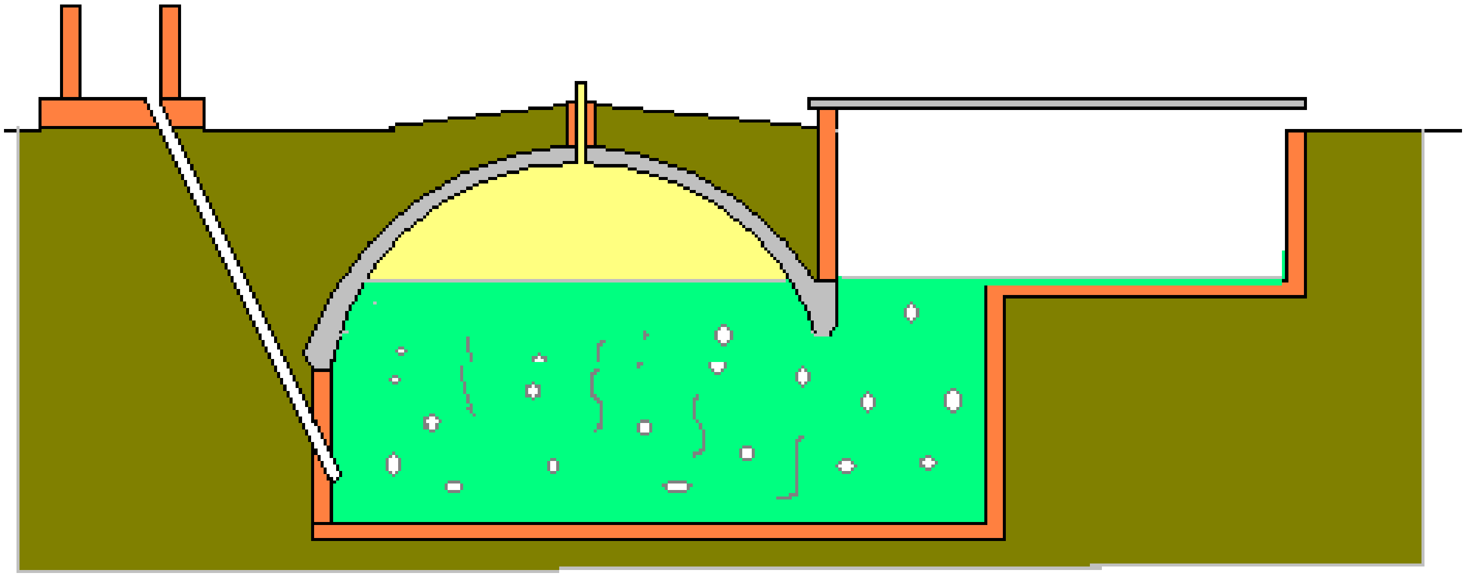
- Carbon-nitrogen (C:N) Ratio-all living organism need nitrogen for synthesis of protein
- A ratio of 20-30:1 is best for anaerobic digestion
- In high C/N ratio nitrogen consumption is high, rate of reaction will decrease
- In low C/N ratio nitrogen is liberated and accumulated as ammonia (toxic substance)

C/N Ratio of some Organic Materials

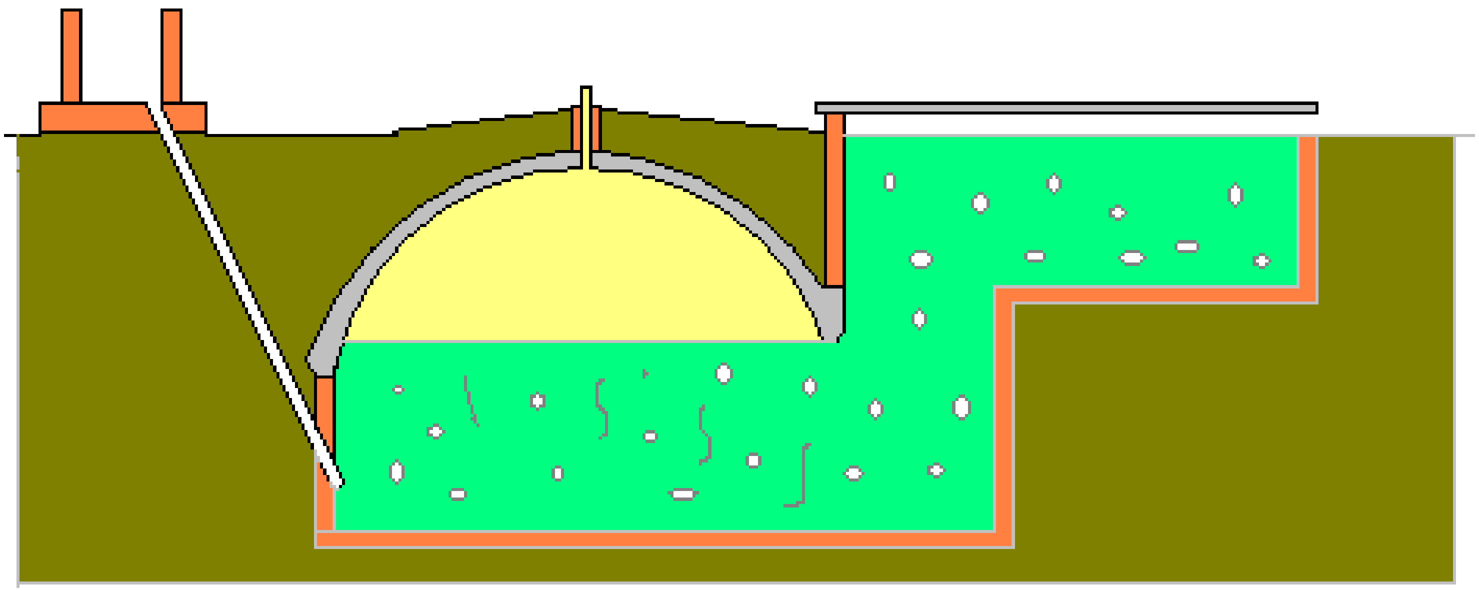
S N	Raw Materials	C/N Ration
1.	Duck dung	8
2.	Human excreta	8
3.	Chicken dung	10
4.	Goat dung	12
5.	Pig dung	18
6.	Sheep dung	19
7.	Cow dung/Buffalo dung	24
8.	Water hyacinth	25
9.	Elephant dung	43
10.	Straw (maize)	60
11.	Straw (rice)	70
12.	Straw (wheat)	90
13.	Saw dust	Above 200

Stages of Biogas Construction

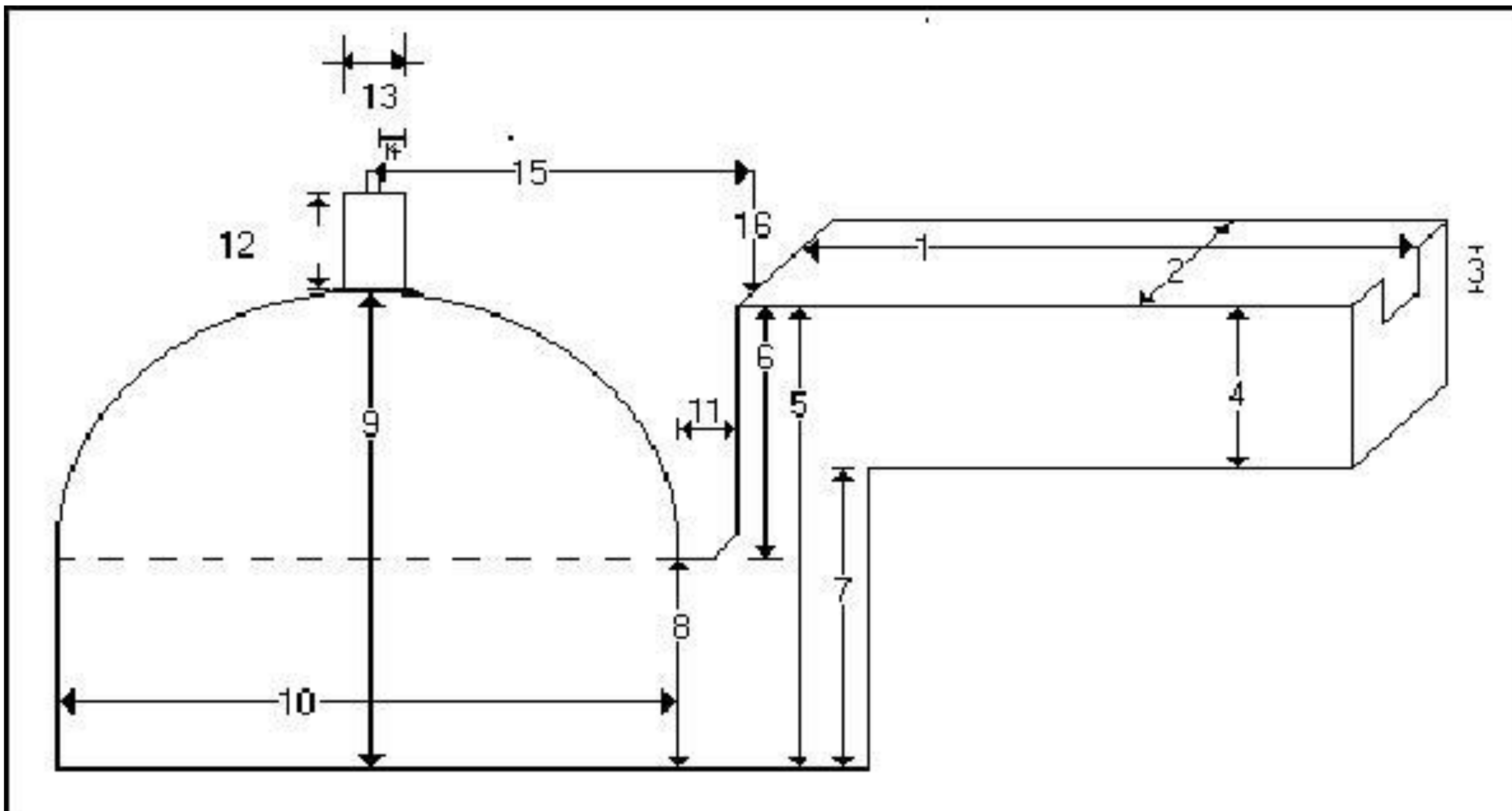
Functioning of a Biogas Plant



Functioning of Biogas Plant



Design Calculation and Measurements of Different Size Biogas Plants (1)



GGC Model 2047-Design Parameters (1)

- Household fuel wood consumption=200 Kg/month
- If 1Kg=0.18m^3 of gas, comparable biogas volume=0.18x200=36m^3/month
- The required daily biogas vol=36/30=1.20m^3
- Therefore if daily gas production is 1.20m^3 all fuel requirement of this family is met.

GGC Model 2047-Design Parameters (2)

- **Digester Loading-indicates how much organic material has to be digested**
- **Digester loading=Total organic matter (Kg) per cubic meter of digester volume per day**
- **Example: Digester volume Vd=4800l (4.8m^3)**

Retention time(Rt)=80 days, Daily slurry feeding (Sd)=60kg, Properties of organic matter=5%

Digester loading ®=5/100*60/4.8=0.625 Kg/m^3/day

- **In a simple biogas plant, 1.5 Kg(TS)/m^3/day is quite a high loading**

GGC Model 2047-Design Parameters (3)

- **Scaling of the digester-The size of the digester (digester volume Vd) is determined by the length of retention time (Rt) and the amount of slurry added daily (Sd)**
- **Vd (L)=Sd (L/day)xRt (days)**
- **Example: If Daily supply (Sd)=60 (L)**

  Retention time (Rt)=80 days

  Digester Volume (Vd)=60x80=4800 L

  =4.8 m^3
- **The length of retention time has the greatest effect on digester volume (Vd)**
- **The digester must be designed so that only fully digested slurry can leave it**

GGC Model 2047-Design Parameters (4)

- **Scaling of gas holder-The size of gas holder (gas holder volume Vg) depends on gas production and the volume of gas drawn off**
- **For calculation purpose, only the net digester volume or gas space is relevant**
- **The net gas space corresponds to the size of the compensation tank above the zero line**
- **The zero line is the filling limit**
- **Gas production depends on the nature of slurry, digester, temperature and retention time.**

GGC Model 2047-Design Parameters (5)

- Gas holder Capacity-It is ratio of gasholder volume (Vg) to daily gas production (G)
- Example: Gas holder volume (Vg)=1.5 m^3

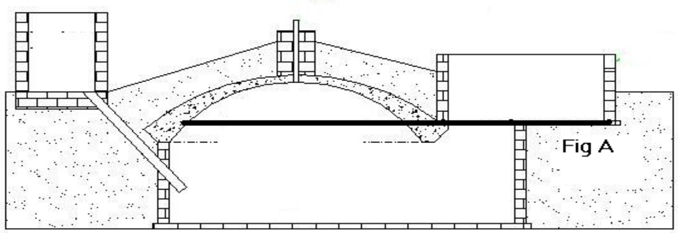
  Daily gas production (G)=2.4 m^3

  Gas holder capacity (C) =1.5/2.4=62.5%
- If gas holder capacity is insufficient part of gas produced is lost
- If it is too large, construction cost will be high
- Hemisphere shape (convex side) of dome=2r/h, is the best shape for the compressive load of the dome
- This hemisphere shape will not have any residual effect on the structure

Loading of dung, Cattle Requirement and Gas Generation

Plant Size, m^3	Daily Dung Feed, kg *(@6-7.5 kg Dung/* m^3 *Plant Size)**	No. of Cow Required *(@12 kg Dung/Cow)*	Daily Water Feed, (litres)	Daily Gas Produced, Litres *(@40 litres /kg Dung)*	Daily Stove Burning Hours *(@400 Lit/Hr)*
4	24~30	2~3	24~30	960	2:40
6	36~45	3~4	36~45	1,440	3:60
8	48~60	4~5	48~60	1,920	4:80
10	60~75	5~6	60~75	2,400	6:00

Working of GGC 2047 Model



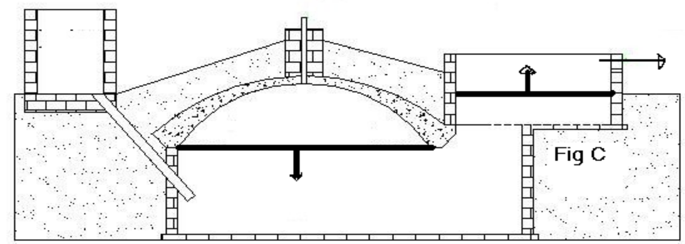


Fig C = Gas Being Produced

Note: The slurry level in the digester falls whereas in the outlet chamber it starts rising for discharging from the escape hole. Any gas produced after this point of time will escape through outlet tank unless the gas is used at this stage.

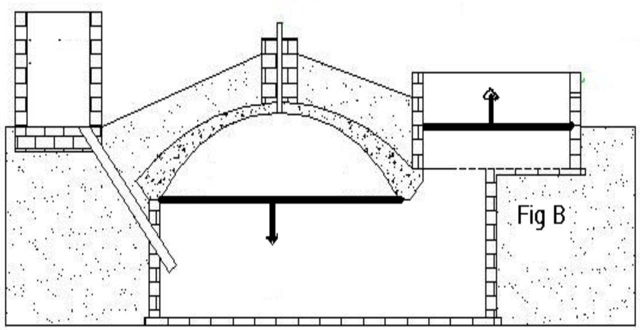


Fig B= Gas Being Produced

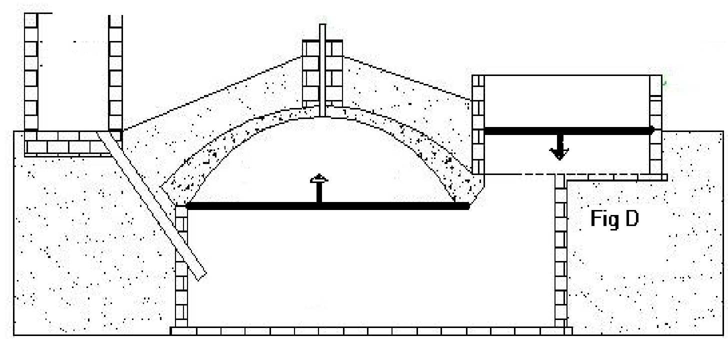


Fig D=Gas being Used

Thank you !

E-mail: shreerajshakya@ioe.edu.np
shreerajshakya@gmail.com