WATER TANK DIGESTER

for Domestic Biogas Production in Bangladesh

Do It Yourself Manual for
Assembly, Operation & Manteinance

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1 Foreword

Current world is most threatened and vulnerable issues are climate change, low practice for renewable energy, elevation of poverty, quality food production and distribution, waste management from different agricultural sub-sectors. To mitigate and adapt the current global and national issues, Bangladesh Agricultural University (BAU) has come forward by taken various initiative.

BAU is the top ranking agricultural education and research entities in the country. The main task of the university is to provide quality agricultural education and to produce top grade agricultural scientists and researchers for shouldering the responsibilities of agricultural development of the country. One of the major working missions of the university is to conduct basic and applied research in diverse sectors of agricultural problems faced by farmers, change-agents and agro-industrialists with a view to solve those problems by recommending possible measures against them.

As a pioneer institution, BAU was the first university to develop biogas technology in our nation back in 1974. Most recently BAU has entered into new developments for this technology aiming to the augmentation of biogas production by using different kinds of agricultural, livestock, poultry, kitchen and municipal waste and by testing different forms of biogas digester.

Today is an immense pleasure to share that BAU jointly with the University of Science and Technology Beijing (USTB) has developed a new water tank based biogas digester, under a project funded by The World Bank and the Infrastructure Development Company Limited (IDCOL).

Made of local production water tank, this digester is the results of months of academic research. The model is easily affordable, easy to handle and properly feeded it produces more gas compared to other existing digesters in the country. With this manual, we aim to disseminate the popularity of biogas production, to enhance the treatment of local waste and to promote the production of bio-fertilizer in Bangladesh.

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WATER TANK DIGESTER

2.1 Concept

A digester made with locally available materials oriented to small–scale biogas production.

A common water tank —available all over Bangladesh— is converted into functional biogas digester, by using only materials and tools obtainable at local hardware and plumbing stores.

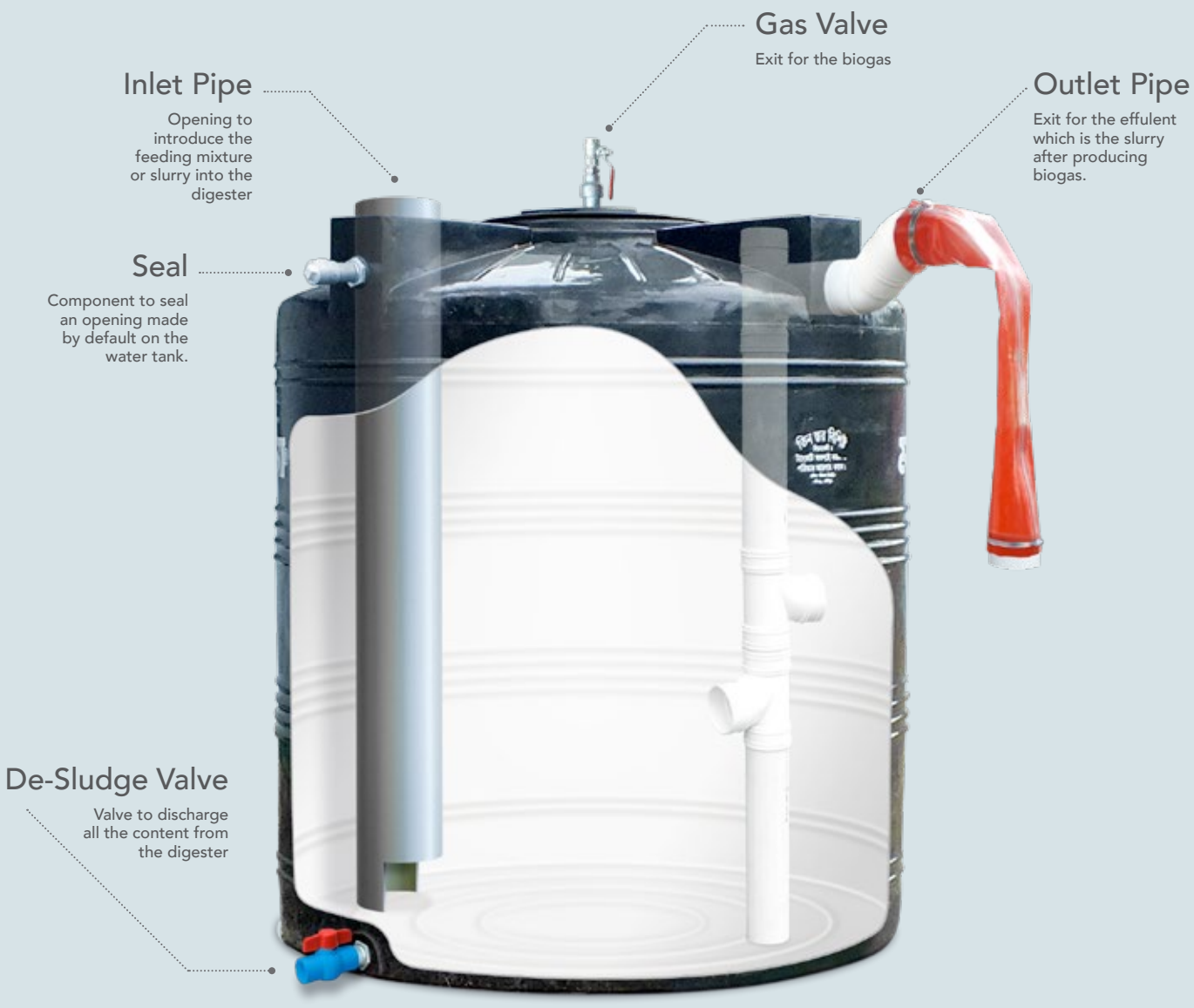
This micro-scale biogas digester is oriented to provide households owning one or two cows with biogas technology, a scope that until now had no access to the production of this renewable energy due to the small scale of their livestock.

In addition, this water tank digester can be implemented in areas with high ground water levels or affected by flooding, where other available biogas technologies would have their limitations.

WATER TANK DIGESTER

2.2 Overview

Components added to an average water tank to convert it into a biogas digester and their specific function are:



PLANNING

3.1 Requirements

Before making the decision to implement a biogas digester, it is advisable to verify first if certain requirements are met.

The water tank Digester presented in this publication is aimed at farmers and householders, who must check first if they posses all four fundamental requirements which will determine a good production of biogas:

Livestock

2 to 3 adult cows (producing daily 20–30 kg of manure) is the requirement to run a Digester based on a water tank of 3000L capacity, while 4 to 5 adult cows (producing daily 40–50 kg of manure) is the requirement to run a Digester based on a water tank of 5000L capacity.

Empty Space

Biogas needs a warm enviroment to be produced, ideally this empty space should be near the barn to make the feeding tasks easier. For a 3000L Digester, is required an area of 2.5m diameter (5m^2), while for a 5000L Digester, the area should be 3m diameter (7m^2).

Commitment

A strong commitment from the community to collect specific organic materials and perform short tasks every day should be confirmed before taking the decision of install a Digester. This requirement is as important as the others above: without this firm will, the gas production will not succeed.

LEARN MORE
About daily tasks in section "Operation" on page 37.

Capital

As a "do it yourself" technology, farmers and householders interested into implement biogas at home must count with a small amount of capital to purchase, transport and assembly materials and tools required, for both the Digester and its operation.

The investment and repair cost have been considered for 15 years. IDCOL is supposed to continue such WTD plant will be continued for 15 years.

The investment cost consist of the cost of water tank, pipes, fitting cost, gas valve, cooking stove, gas balloon. The tasks of collection, repair, stirring and feeding substrates into the biogas digester are mostly performed by household members due to it being an affordable task for a household.

The annual maintenance cost and depreciation cost are considered to be about 4% of the capital cost of the plant.

Investment & Maintainence Cost of 3000 L and 5000 L Digester

Cost Item	Amount (BDT)	
	WTD 3000 liter	WTD 5000 liter
Tank	20400	34000
Pipe	135	135
Fittings	2595	2805
Fitting for Gas Burner	1100	1100
Gas Pipe	500	500
Valve	500	500
Socket, Elbow, Threat Pipe	300	300
Gas Storage Bag	5000	10000
Cooking Stove	1100	1100
Total Investment Cost	**31630**	**50440**
Operation & Maintenance per Year	**1000**	**1500**

3.2 Orientation for Components

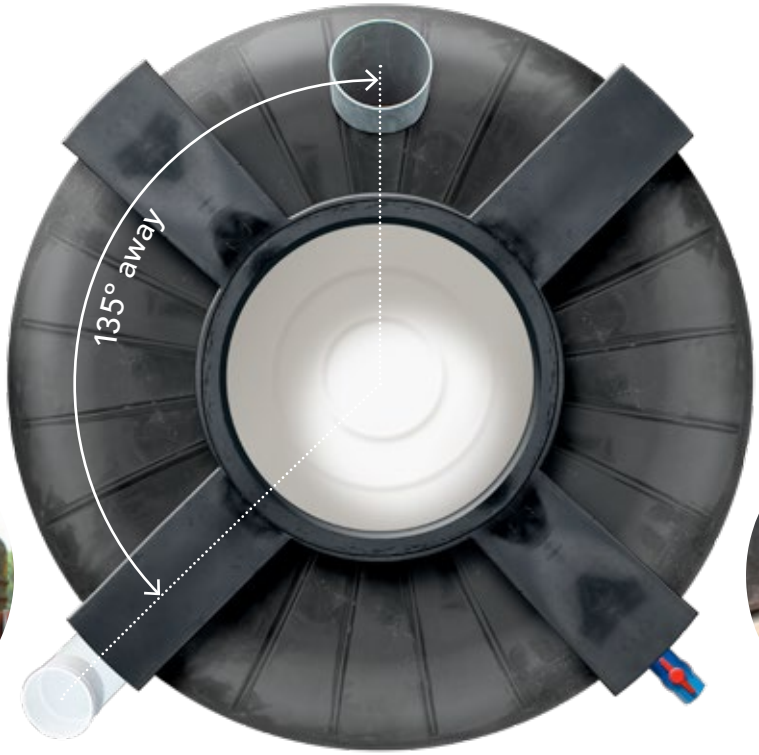
Planning the final location of the digester goes along with determining the orientation for its components, considering also the openings the water tank brings from the factory.

The position of the digester should be as close as possible to the cow barn, for an easy access to the source of feedstock materials.

Preferably, it should be a space with direct sunlight to ensure a warm temperature, which favors anaerobic digestion.

Inlet Pipe

This component needs to be placed in the middle of one of the quarters of the water tank surface; it should be directly facing the cow barn for an easy access to the collected cow manure.



Outlet Pipe

This component needs to be placed right over one of the two top openings the tank brings from the factory. It should be a positioned 135° away from the Inlet Pipe, in either direction.

De-Sludge Valve

This component needs to be placed in the bottom opening the tank brings from the factory, preferably away from the Inlet Pipe to protect the valve form accidental damage in daily activities.

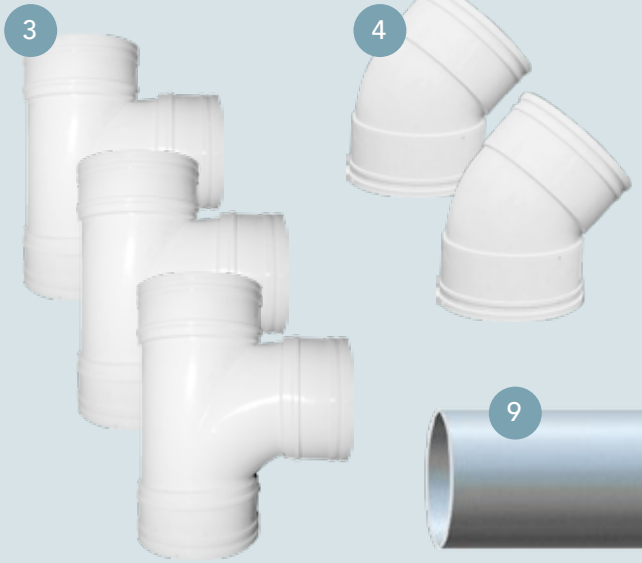
ASSEMBLY

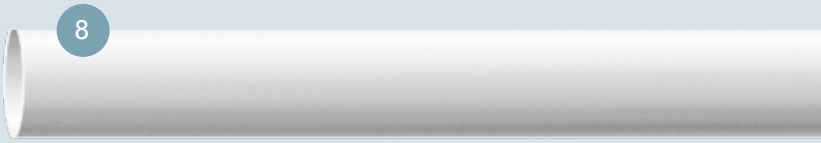
4.1 Materials

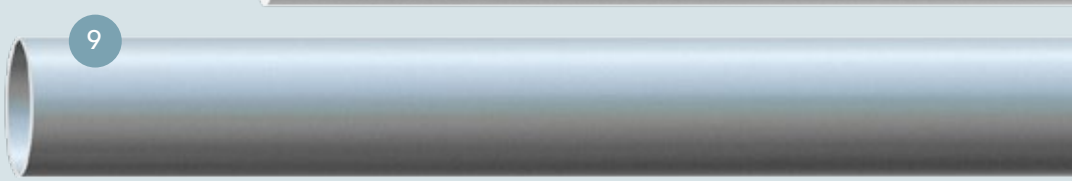
*HDPE & PVC

The High Density Polyethylene, also known as HDPE —the material of the water tank— and the Polyvinyl Chloride, also known as PVC —widely used for pipes— are two different types of plastic which are not compatible for being weld together. It is recommended for HDPE water tanks to use HDPE pipes.

Since the HDPE welding equipment is rather expensive along with the fact that HDPE pipes are rarely available, PVC pipes are an acceptable alternative to combine with HDPE water tanks. In this case, an adequate welding will not be possible and connections between a HDPE water tank and a PVC pipe will never be 100% tight. Within this manual, the word "**weld**" is actually "**melt**" HDPE plastic when joining the water tank with PVC pipes, to provide stability to the whole system by filling gaps. However, additional application of two components epoxy glue (M-Seal) is used to seal joining areas and prevent water or gas leakage.







1. 1 x water tank of 3000L or 5000L capacity
2. 1 x plastic drum with open top 250L capacity
3. 2 x 110mm PVC 45° elbows
4. 3 x 110mm PVC tee fittings
5. 1 x 110mm PVC pipe cap (as flat as possible)
6. 110mm PVC flexible hose:
   1 piece of 150cm length
7. 2 x 110mm hose clamps
8. 200mm PVC pipe:
   - For 3000L tank, 1 piece of 180cm length
   - For 5000L tank, 1 piece of 210cm length
9. 110mm PVC pipe:
   - For 3000L tank, 1 piece of 180cm length
   - For 5000L tank, 1 piece of 210cm length

10. 1 x 2" PVC ball valve threaded
11. 1 x 2" tank fitting
12. 2 x 1" tank fitting
13. 1 x 1" female joiner
14. 1 x ½" male joiner
15. 1 x 1" male end cap
16. 1 x 1" female reducer to ½"
17. 1 x ½" ball valve
18. 5 x 50gr of two components epoxy glue (M-Seal)
19. PVC cement
20. Plumbing tape
21. Alcohol or attenuation agent
22. Tissue, rag or fabric to clean

ASSEMBLY

4.2 Tools

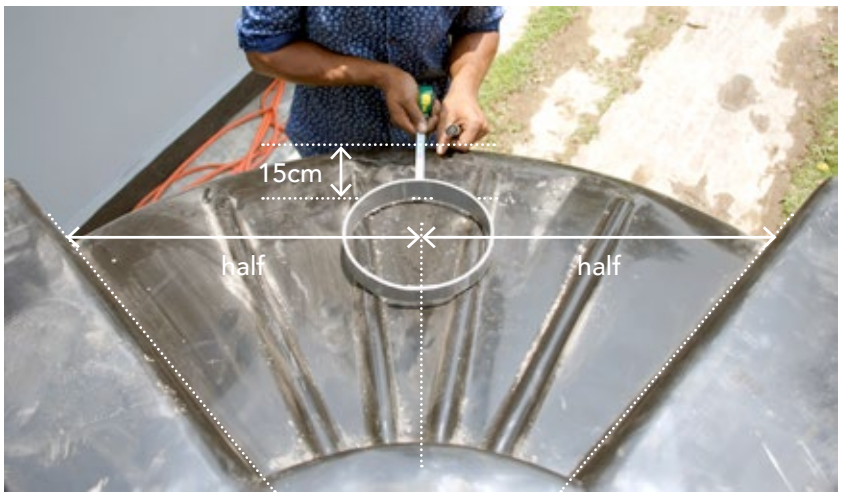
1. Measuring tape
2. Level
3. Sand paper
4. Saw
5. 2 Adjustable wrenches
6. 2 Plumber wrenches
7. Slotted screwdriver
8. Hammer
9. Chisel
10. Pliers
11. Marker
12. Cutter knife
13. Hot air gun
14. Extension cable

ASSEMBLY

4.3 Step by Step Instructions

Inlet Pipe

1. On the top of the water tank, measure and mark a rounded opening of 20cm diameter in the middle of one quarter at the surface, 15cm away from the border. A piece of 200mm pipe can be used as guide.



2. After double check measurements and position, cut the opening using the chisel and hammer, or driller if available.

3. Someone can help the cutting by holding a brick against the area from inside the tank.

4. On the 200mm pipe, measure and mark the length of the inlet pipe and cut the piece according the tank to be used:

a. For 3000L water tank:
   - 1 piece x 180cm.

b. For 5000L water tank:
   - 1 piece x 210cm.

5. Measure and mark the bottom opening on the inlet pipe of 15cm height and half of the diameter width. After double check measurements, cut the opening using the saw.

6. Prepare the surface of the inlet pipe for welding, at the same height as the opening of the water tank and also at the bottom border, by roughen the pipe with sandpaper. Clean up the dust by using tissue, rag or fabric with alcohol or another attenuation agent.

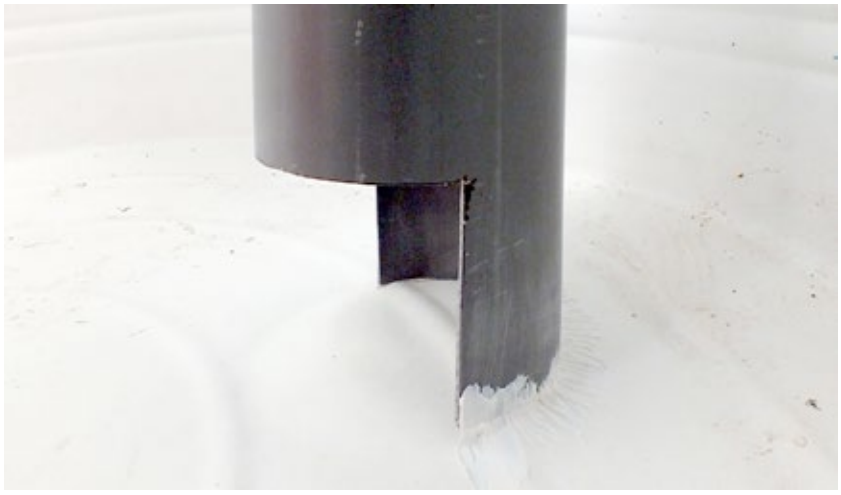
7. Try if the inlet pipe fits through the opening made on the top of the water tank. If not, adjust the edge carefully with the cutter knife and the saw until it fits.

8. Prepare the outside surface of the tank for welding by roughen the area with sandpaper. Clean up the dust as before.

9. Place the pipe on its final position. The opening at the bottom should face the center of the tank.

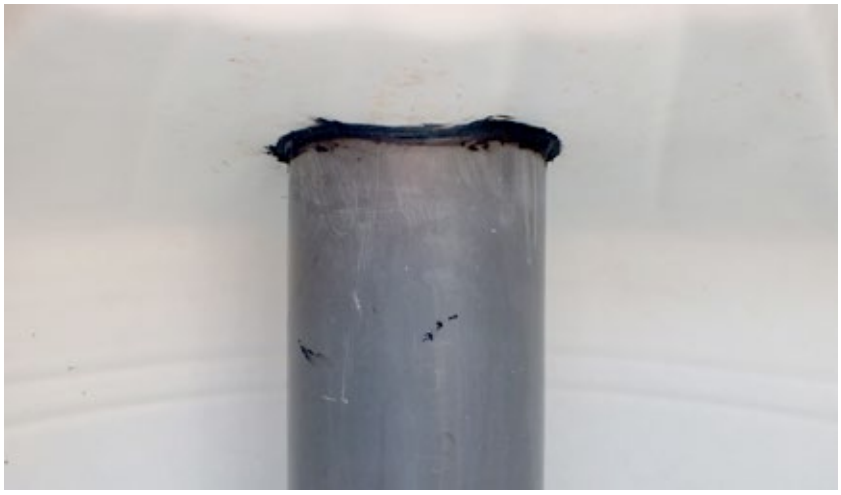
10. Prepare the bottom of the tank for welding by roughen the area with sandpaper in the area where the pipe will be based. Clean up the dust as before.

11. From inside the tank, use the hot air gun to weld the bottom of the inlet pipe to the bottom of the water tank.



12. From outside the tank, use the hot air gun to weld together the inlet pipe and water tank surface.

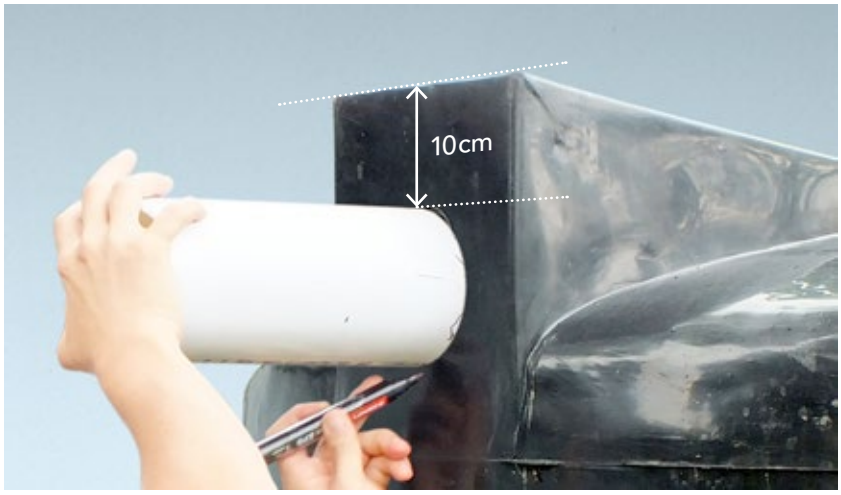
13. If using PVC pipe, then also from inside the tank use two components epoxy glue (M-Seal) to fill the gap around the inlet pipe and the wall of the water tank.



Outlet Pipe

1. On the chosen position for the outlet pipe, measure and mark a rounded opening of 11cm diameter, 10cm down from the top border of the side of the water tank. A piece of 110mm pipe can be used as guide.

Make sure the pre-made opening is completely inside the mark.



2. After double check measurements and position, cut the opening using the chisel and hammer, or driller if available.

Again, someone can help the cutting by holding a brick against the area from inside the tank.

3. Try with one piece of pipe if it fits through the opening made on the side of the water tank. If not, adjust the edge carefully with the cutter knife until its does.

4. On the 110mm PVC pipe, measure and mark five pieces for the outlet pipe and cut them according the tank used:

a. For 3000L water tank:
- 1 horizontal top piece x 25cm
- 1 vertical top piece x 57cm
- 1 vertical bottom piece x 54cm
- 3 connection pieces x 10cm

b. For 5000L water tank:
- 1 horizontal top piece x 25cm
- 1 vertical top piece x 71cm
- 1 vertical bottom piece x 67cm
- 3 connection pieces x 10cm

5. Prepare the three 110mm tee fittings, the two 110mm 45° elbows, the 110mm pipe cap and the five 110mm pipe pieces for gluing, by roughen the overlap areas with sandpaper: inside the fittings and outside the pipes.

Clean up the dust as before.

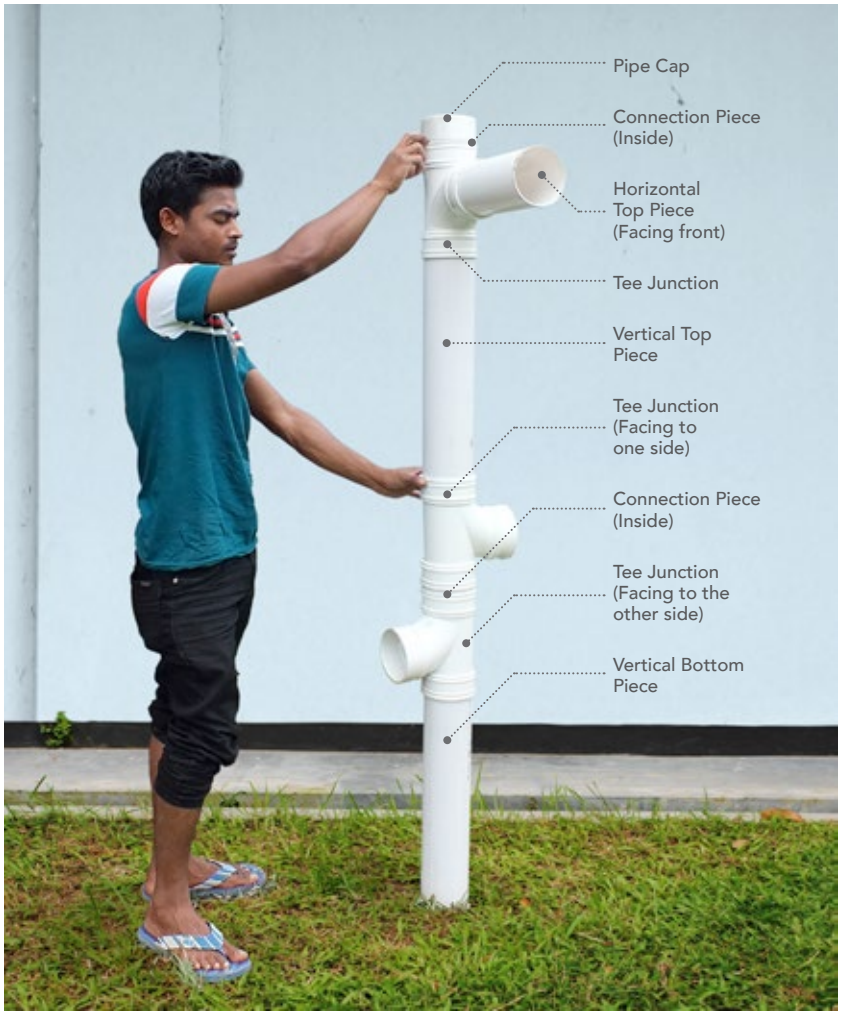
6. Assemble the parts together as explained here and try to fit the outlet pipe inside the tank, checking all angles and measurements are correct.

Note that some parts of the outlet pipe will be assemble after placing the digester on its final destination, therefore by the moment, please reserve aside:

- 1 x 110mm PVC 45° elbow
- 110mm PVC pipe:
  1 piece of 10cm length
- 110mm PVC flexible hose:
  1 piece of 150cm length
- 2 x 110mm hose clamps

LEARN MORE

About the assembly of these components in section "Finishing Assembly" on page 32.



7. Once it all fits correctly, paste the parts together. If using PVC pipe, use PVC cement to paste the parts together and wait until the cement is dry. If using HDPE pipe, the parts can be welded together.

8. Place the pipe on its final position, leaving 5cm of pipe outside the tank.

9. From outside the tank, paste one 45° elbow to the end of the pipe, with the open opening facing up. Make sure the 45° elbow touches the tank. If using PVC pipe, use PVC cement to paste the parts together and wait until the cement is dry. If using HDPE pipe, the parts can be welded together.

10. From outside the tank, weld together the 45° elbow and water tank side surface.

11. From inside the tank, check if the pipe is sitting firmly. If not, fix the top of the pipe to the ceiling of the tank using the two components epoxy glue (M-Seal).

12. Also from inside the tank, weld the bottom of the outlet pipe to the bottom of the water tank.

De-Sludge Valve

1. Wrap plumbing tape around the short thread of the 2″ tank fitting.

2. Attach the 2″ PVC ball valve to the fitting as tight as possible.

3. Install the piece at the pre-made opening located at the bottom of the tank, positioning the key up. The wall of the tank should be in between the two rubber rings of the fitting.

4. With the help of an additional person inside the tank, tighten the fitting firmly using the plumber wrenches. One person should be holding while the other is screwing the nut.

5. The valve should remain closed.

Seal

1. Wrap plumbing tape around the thread of the 1" male end cap.

2. Screw the piece to the 1" female joiner, using two adjustable or plumber wrenches.

3. Wrap plumbing tape around the thread of the 1" tank fitting and screw firmly to the other end of the 1" female joiner.

4. Install the assembled fitting at the pre-made opening located at the side of the tank. The wall of the tank should be in between the two rubber rings of the fitting.

5. With the help of an additional person inside the tank, tighten the fitting firmly using the two adjustable or plumber wrenches. One person should be holding while the other is screwing the nut.

Gas Valve

1. Wrap plumbing tape around the thread of the 1" tank fitting and screw firmly to the 1" female reducer to ½", using the two adjustable or plumber wrenches.

2. Wrap plumbing tape around both threads of the ½" male joiner and screw firmly to the 1" female reducer to ½", using the two adjustable or plumber wrenches.

3. Screw the ½" ball valve on the top thread of the ½" male joiner. The valve should remain closed.

4. On the lid of the water tank, mark at the very center of it a rounded opening for the gas valve. The remaning 1" tank fitting can be used as guide.

5. Heat up the free end of the fitting with fire for 5 to 10 minutes.

6. Turn of the fire and use thick fabric or pliers to carefully grab the hot fitting and press it against the lid, until melting opens the opening. An alternative procedure is to use a hole saw (lock saw) in combination with a driller.

7. Once the 1" tank fitting cooled down, remove any melted plastic away from the piece. Install the assembled fitting at the rounded opening located at the center of the tank lid. The lid should be in between the two rubber rings of the fitting. Tighten the fitting firmly using two adjustable or plumber wrenches. Close the tank with its lid.

Water Tank Lid

1. Weld the lid to the tank is the last step of the assembly, which it should be done only after transportation and placement of the Digester are concluded.

With the opening available:

a. Is easier to handle the digester, providing an area to grab the tank and lift it for placement.

b. There is still chance to go inside the tank and fix unforeseen problems, such us components damaged or loose during the transportation or placement.

LEARN MORE
About the excecution of this step in section "Finishing Assembly" on page 30.

2. For now, the assembly is finished and the digester can be moved or transported to its final destination.

PLACEMENT

5.1 Terrain Preparation & Digging

1. In the site selected as the permanent position of the digester, remove vegetation and objects from the surface and dig a rounded hole:

a. For 3000L water tank:
   - 100cm depth.

b. For 5000L water tank:
   - 130cm depth.

2. Once the hole is done, remove sharp objects, rocks or any solid material which could damage the digester or make it unestable.

Level the ground with the assistance of ropes and sticks. Flat the area inside the hole with the assistance of a plain object such as a piece of wood.

3. If working on muddy terrain and there is too much water, simply dry as necessary to identify and remove sharp objects and other solids.

PLACEMENT

5.2 Lift, Settle & Level

1. A minimum of four (4) people is required to lift the digester to unload it from transportation and place it on its permanent position.

Do not lift by grabbing welded areas or valves to avoid damage; the opening for lid and tank structure should be used as a grab area at all times.

2. Lift and move the digester with the help of ropes to load the weight from below. Pull the digester grabbing the lid opening.

3. Reach the permanent position and settle the digester according the plan.

During the movement, keep an eye on components that may be damage, such as the de-sludge valve.

4. Settle the digester on its permanent position as horizontal as possible is crucial to ensure an efficient gas production.

Once the digester is settled inside the hole, use a level to measure its inclination from every spot.

5. The Digester can be partially filled with water as required, to add stability by weight and to make the leveling easier.

6. To modify the inclination of the digester, push the digester from the side reaching a full horizontal position.

To make a spot lower, the digester can also be pushed down.

Remove soil if necessary.

7. To elevate an spot, add soil under the tank at that angle.

8. Once the digester is as horizontal as possible, fill the gap around the tank with soil, compacting the material down.

9. Leave a clear area to have access the de-sludge valve located at the bottom of the digester.

10. Double check the inclination from different angles with the level at all times while filling the gap around the digester.

Once finished, cut off the water supply.

11. The clear area for the de-sludge valve can be protected by covering the opening with wooden boards, which will provide easy and fast access to the valve in the future.

PLACEMENT

5.3 Finishing Assembly

Water Tank Lid

1. Before closing the digester, check if all the assembly work is in good condition.

Repare damage areas and tighten pieces if necessary.

2. Prepare the border of the tank opening and the outside border of the lid for welding, by roughen the area with sandpaper. Clean up the dust as before.

3. Place the lid on the opening and close the tank as firm as possible.

4. Weld together blending the gap between the lid and the border of the tank. Someone can help by pressing the border down with a stick.

5. Sealing the digester hermetically is an important factor to obtain an efficient gas preassure.

Double check the weld after finish it, confirming the seal has no gaps where the gas may escape in the future.

Outlet Pipe

1. From the reserved materials, attach the remaining 110mm PVC 45° elbow to the exit of the outlet pipe in the digester. The pieces should fit to be assemble together.

Direct the elbow opening away from the center, as shown here.

2. Next step is to prepare the flexible hose to have its end opening wide open at all times.

For that, the remaining 110mm PVC pipe piece of 10cm length is attached firmly to one opening of the flexible hose, using a 110 hose clamp.

2. Next step is to prepare the flexible hose to have its end opening wide open at all times.

For that, the remaining 110mm PVC pipe piece of 10cm length is attached firmly to one opening of the flexible hose, using a 110 hose clamp.

4. Attach firmly the opposite opening of the hose to the PVC 45° elbow in the digester using the second clamp.

5. Finally, place a container to collect the effluent discharged from the Digester and let the hose naturally fall down.

The container should be a either a concrete ring or a plastic pit; choose yours according your budget.

LEARN MORE
About how to manage this discharged material in section "Slurry Preparation" on page 40.

GAS LINE

6.1 Technical Specifications

Pipe Installation

To install pipes above the ground, uPVC pipes with UV protection is the best choice. For underground installations, also common PVC pipe without UV protection would be also suitable.

Avoid the use of hose (flexible) pipe for long distances, especially when the pipe is hanging above the ground: a hanging hose will sag and at its lowest point the accumulation of water will be inevitable causing frequent pipe clogging which requires frequent troubleshooting.

Main criteria for choosing appropriate diameter of the pipe are: the gas line lenght and maximum gas flow. The following table provides a reference to choose the minimum pipe diameter (in inches) depending on the gas line length and maximum gas flow, where the latter is determined by the capacity of biogas appliance. For example, a typical single household consumes around 0.4 m^3/h, at a distance of 10 meters between biogas digester and the stove, the pipe diameter of 0.75" will be sufficient.

		Gas Line Length				
		10m	20m	30m	40m	50m
Maximum Gas Flow	0.5 m^3/h	0.75"	1.00"	1.00"	1.00"	1.25"
	1.0 m^3/h	1.00"	1.25"	1.25"	1.50"	1.50"
	1.5 m^3/h	1.50"	1.50"	2.00"	2.00"	2.00"
	2.0 m^3/h	2.00"	2.00"	2.50"	2.50"	2.50"
		Optimum Pipe Diameter				

When planning the gas line, make sure that the gas line consists of few low points as possible, where condensed water can accumulate, but at least one. The lowest point should be equipped with condense water trap and all gas line should decline towards that point. If possible, set the lowest point at the digester itself; in this case, no additional condense water trap is required, hence all water will flow back to the digester.

In order to avoid any possible gas leaks, any junction or bend in the gas line should ideally be made using threated pipe fittings using the most appropriate tool, in combination with sufficient amount of plumbing tape around the thread.

If flexible hose is used, best is only for a short distance, for example to connect the gas line with the stove. In this case, always use hose clumps on both ends of the hose pipe.

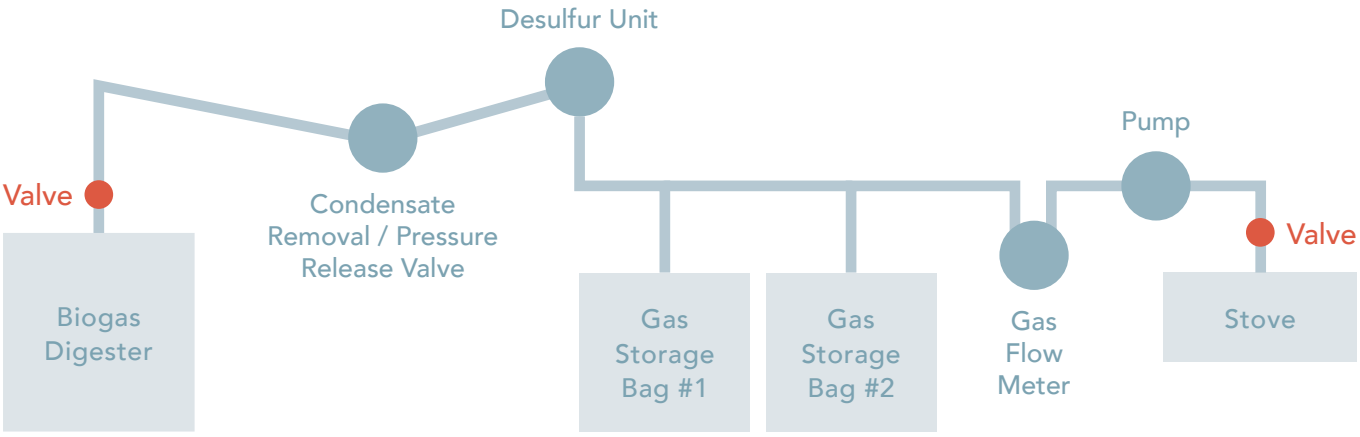
At least one valve (ball valve) should be placed in the gas system, ideally two valves one on the digester side, another on end used side.

GAS LINE

6.2 Flow Diagram

Once the assembly is finished, it is time to build the gas line which will connect the Digester with the stove at the kitchen.

The follow diagram explains the position of necessary elements to be included in the gas flow for the system to work properly.



6.3 Elements Description

Condensate Removal / Pressure Release Valve

Pressure release valve liberates the pressure when the gas is not used for a while and pressure is building up in the biogas system. It is added into the gas line to avoid damage of the digester itself and can be easily made in combination with condensate removal. It should be installed at the lowest point of the gas system.

Desulfur Unit

Because of the water concentration present in the biogas, the gas should be treated to avoid corrosion of metal components in the biogas system, for example stove. It can be achieved by leading the gas through an airtight container, filled with iron shaving and iron oxide pallets, hence iron will react with water, cleaning the gas. The iron shaving and iron oxide pallets, should be replaced or regenerated on the regular basis. The volume of the container depends on the maximum gas flow, where for household biogas systems using one or two stoves, two liters container will be sufficient.

Gas Storage

In order to store generated biogas, an external biogas storage system is required. In order to provide sufficient storage capacity for 3000L digester, 1500–2000L biogas storage bag is required; for 5000L digester, 2500–3000L bag. Gas storage bags can be made of different materials, usually PVC or PE. The PVC or PE sheets are sealed on side and can be achieved by folding and sewing the edges, so it is airtight. Bags should have one sealed fitting where hose or pipe can be connected. To prevent damage of the gas storage bag, the PVC bag can be made of two layers, one for actual gas storage and second to protect the inner layer from the damage.

Gas Flow Meter (Optional)

In order to know and monitor the biogas production of a system, a gas flow meter installed into gas line is the most straightforward way. Gas flow meter used to measure natural gas and available at the market can also be used for biogas system. The appropriate gas flow meter for a biogas system is determined by the minimum and maximum gas flow rate, for example, a G2.5 have 25/h and 4000L/h respectively is usually enough for small scale biogas systems.

Pump

To be able to extract biogas from gas storage bag, a gas pump is required. It can also be replaced with extra weight on top of the gas bags, which will push the gas out.

LEARN MORE
About how to replace this pump by a pressuring device made out of wood in section "Low Cost Pump" on page 38.

Stove

Cooking is the most common use for biogas. Plenty biogas stoves are available at local markets in Bangladesh, in various sizes from 0.5m^3/h to >4m^3/h. For any digester size, small biogas stove is recommended. Note that despite the appearance similarities between LPG and biogas stoves, there are specific differences between them as well, for example mixing ratio of primary air and operational pressure.

GAS LINE

6.4 Setting Gas Storage

The system should be provided with two gas storage bags: one connected to the Digestor to collect the daily production of biogas, plus a second bag connected to the pump and the stove to cook with it.

Setting the system with two bags ensures permanent production and use of biogas.

To avoid loosing stored gas, use the valves properly while connecting and disconnecting the bags.

GAS LINE

6.5 Low Cost Pump

If the budget do not allow to afford the cost of an electric pump, this one can be replaced by a self-made device as here explained.

1. With the help of a local carpenter, build a wooden device consisting of four pilars, a rectangular base and a mobile platform able to go up and down framed by the pilars, just like the example in the picture.

The dimension for the device will depend on the size of the gas storage bag which it can be measured taking its biggest size by pumping the air inside of it until its fully expanded. The storage bag should fit between the basis and the mobile platform.

2. Place a storage bag in between the basis and the mobile platform.

Connect the bag with the gas line that goes to the stove in the kitchen.

3. Let the mobile platform to lay on the top of the bag. When gas needs to be extracted, put heavy objects on the top of the platform: this example uses a 10L container full of water and the pressure is pushing the biogas out the bag.

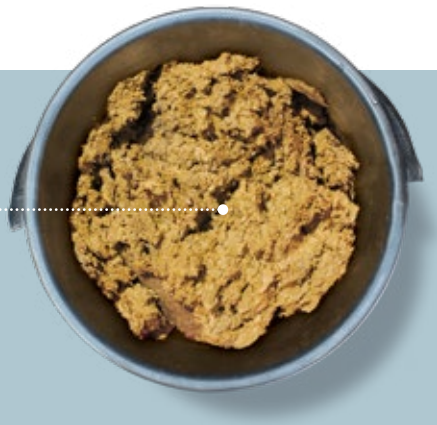
Open and close the valve to release gas to the stove and to cook as required. The flow of gas is proven to work better if the stove is at the same level as the wooden device, or even lower.

After the cooking, the weight from the bag should be removed.

OPERATION

7.1 Feeding Materials

The mixture to feed the Digester every day is composed of organic materials which needs to be collected with the committed contribution of the whole community.



Cow Manure (CM)

To run a Digester of 3000L capacity is required to collect daily 20–30kg of manure, while for a Digester of 5000L capacity the manure required is 40–50kg daily.

Organic Waste (OW)

Fruit and vegatables peals, leftovers, spoiled meals.

Fresh grass cutting, fallen leaves, taro leaves.

Clean paper, paper napkins from meals, newspaper.

PROHIBITED MATERIALS:

Bones | Big Seeds | Egg Shells | Branches | Sanitary Pads | Plastic, Metal & Glass

OPERATION

7.2 Start Up

After settle the digester on its final position, it will contain already the water used to level it. Now is the time to fill the Digester up with slurry for the first time. There are two options for this:

Option 1

Fill the digester about 50% with water, and then start feeding with the standard daily mixture using only cow dung.

Option 2

Fill up the digester with a preparation disolving 1kg of cow dung in 10L of water until the digester is full.

Following only one of these options until the Digester is full and leave it stand for two weeks. After that time, standard daily mixture can start and the first burnable biogas will be generated two to three weeks later.

LEARN MORE
About how to prepare standard daily mixture in section "Slurry Preparation" on page 43.

OPERATION

7.3 Mixing & Feeding

Tools & Equipment

1. Buckets to collect and mix
2. Clean jug for water
3. Blender or grinder
4. Measuring scale
5. Sickle or knife to chop organic materials
6. Protective globes
7. Stick or piece of pipe to mix

Slurry Preparation

1. With an empty bucket mounted on the scale, reset the scale kilograms to zero in order to measure accurately the collected organic waste and the cow manure.

2. If there are large materials in the organic waste, cut them first into smaller pieces.

Remove any prohibited material.

3. Put the collected the organic waste in the bucket and measure the weight.

Remember the amount of kilograms; the organic waste need to be mixed with cow manure according certain proportions.

4. Blend the organic waste with a bit of water. Collect the blended mixture in another bucket.

5. Check within these tables how much cow manure is required according the organic waste measured in step 3.

Standard daily mixture for digester of 3000 L capacity

APR — SEP (High Temperature)			NOV — MAR (Low Temperature)		
Organic Waste (kg)	Cow Manure (kg)	Effluent (L)	Organic Waste (kg)	Cow Manure (kg)	Effluent (L)
4.0	20.0		–	–	
3.5	21.5		3.5	19.0	
3.0	22.0		3.0	19.5	
2.5	22.5		2.5	20.0	
2.0	23.0	61.0	2.0	20.5	41.0
1.5	23.5		1.5	21.0	
1.0	24.0		1.0	21.5	
0.5	24.5		0.5	22.0	
0.0	25.0		0.0	22.5	

Standard daily mixture for digester of 5000 L capacity

APR — SEP (High Temperature)			NOV — MAR (Low Temperature)		
Organic Waste (kg)	Cow Manure (kg)	Effluent (L)	Organic Waste (kg)	Cow Manure (kg)	Effluent (L)
7.0	32.5		–	–	
6.5	33.0		–	–	
6.0	33.5		6.0	26.0	
5.5	34.0		5.5	26.5	
5.0	34.5		5.0	27.0	
4.5	36.0		4.5	27.5	
4.0	36.5		4.0	28.0	
3.5	37.0	97.0	3.5	28.5	73.0
3.0	37.5		3.0	29.0	
2.5	38.0		2.5	29.5	
2.0	38.5		2.0	30.0	
1.5	39.0		1.5	30.5	
1.0	39.5		1.0	31.0	
0.5	40.0		0.5	31.5	
0.0	40.5		0.0	32.0	

6. Measure the specific amount of cow manure for the amount of collected organic waste, according the table in step 5.

7. Using the protective rubber globes, collect in a bucket the required amount of effluent to dilute the cow manure.

8. Blend the cow manure with the effluent inside the bucket, mixing with a stick or a piece of pipe, to make the slurry as homogenic as possible.

9. Feed the Digester with the prepared slurry mixtures, both cow manure and organic waste.

Feeding must be once a day, every day at the same time.

8 Maintenance

As the time passes by, these simple maintenance tasks will help not only to achieve a sustained biogas production but also to protect the equipment and the resources already invested.

Tasks each 3 months

1. Check for visible holes or any damage around digester surface. Spray mixture of soap and water around the welded areas, if bubbles grow big it means there is a leak and it needs to be fixed.
2. Check for any visible damage of the pipe. Verify all connections with mixture of soap and water. Best to check the gas line systematically, starting with pipe connection to digester and follow the gas line until last connection or piece of pipe is checked.
3. If the water release valve is installed, open the valve to release water from the gas line.
4. Check the stove, especially the gas holes. Make sure the gas holes are not clogged and the stove is clean

Task each year

1. Lubricate the gas tap with a little oil.

Task each 5 years

1. It is recommended to empty the digester all five years, to discharge settled sludge and break the scum layer.

   Then, flush it with water and restart the feeding from zero again.

9 Troubleshooting

Strong gas smell

POSSIBLE REASON	SOLUTION
Leakage on the digester Biogas is escaping digester through a hole.	**Search for holes** Look for gas smell. Check for visible holes. Do "The bubble test" to identify holes: spray mixture of soap and water around the digester surface on welded areas; bubbles will grow bigger where there is a leak.
	Fix the holes Clean the area around the hole. Dry the surface. Seal the hole with epoxy glue.
Leakage on the gas line Biogas is escaping through a broken pipe or through an open connection.	**Check pipes** There may be a damaged pipe. Check for visible damage pipe. Do "The bubble test" to identify holes and fix them.
	Tighten connections A pipe connection may be loose, tighten and repeat "The bubble test" until sealing is confirmed.
	Replace damaged pipe If a pipe is damaged, replace the section with a new pipe.
Leakage on gas storage Biogas is escaping gas storage through a hole.	**Search for holes** Look for gas smell. Check for visible holes. Do "The bubble test" to identify holes.
	Fix the holes Clean the area around the hole. Dry the surface. Fix gas storage according the materials.

Clogged inlet pipe

POSSIBLE REASON	SOLUTION
Cow dung is blocking the pipe Blocks of cow dung are clogging the entrance of feeding mixture into the digester.	**Use a stick to unplug the pipe** Insert a long bamboo stick into the inlet pipe. Move the stick up and down as well as in circles, until entrance is clear.
	Prepare homogenic feeding mixtures Make sure dilution of cow dung in effluent is well done, preparing an homogenic fluid substance before feeding the digester.

Low Gas Production

POSSIBLE REASON	SOLUTION
Low temperature Ideal temperature to produce biogas is between 25–37°C. If the temperature drops below 15°C, then the gas production will stop.	**Nothing to do**
Underfeeding Amount of daily feeding is not enough to produce biogas.	**Feed the digester properly every day** Check if all instrucions from chapter "Operation" in page 36 are being followed every day.
Clogged gas line Condensed water is blocking the pipes.	**Check the slope of the gas pipes** Check if the pipes have an inclination down towards the release valve. If not, adjust accordingly.
	Shake gently the gas pipe Move softly the gas pipes to direct excess of water towards the release valve and unclog the pipe.
	Use the release valve Open the release valve to remove the water. Leave the valve closed after.
Overfeeding Excess of feed causes acidity, turning digester sour which kills the bacteria required for biogas production.	**Change the pH of the digester** Add some lime or backing soda inside digester to make it alkaline.
	Postpone feeding Stop feeding the digester for 2–3 days, and re-take the feeding following strictly the tables described in section "Slurry Proportions" in page 40.
Chemicals in feeding The slurry contains detergents, pesticides or antibiotics.	**Stop feeding with chemical elements** Make sure the feeding do not cointain any laundry water, pesticides or antibiotics.
Leackage	**See solutions for "Strong gas smell" in page 43**
Scum Layer On top of the slurry, a solid layer was formed with floating materials which is now obstructing the gas flow.	**Empty the digester and restart feeding** If none of the previous solutions worked out, as last resource the digester should be emptied through the de-sludge valve and the feeding should be restarted.

Gas smells bad and does not burn

POSSIBLE REASON	SOLUTION
Digester is on Start Up phase During the start up phase it is normal that not burnable CO_2 will be produced.	**Nothing to worry about** wait and observe until the biogas burns.
Overfeeding	**See solutions for "Low gas production" above**

10 Organizations

The World Bank

The World Bank is an international financial institution that provides loans to countries of the world for capital projects. It comprises two institutions: the International Bank for Reconstruction and Development (IBRD), and the International Development Association (IDA). The World Bank is a component of the World Bank Group. The World Bank's stated goal is the reduction of poverty which its Articles of Agreement define as commitments to the promotion of foreign investment and international trade and to the facilitation of capital investment.

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+1 202 473 1000

http://www.worldbank.org

IDCOL

Infrastructure Development Company Limited (IDCOL) was established on 14 May 1997 by the Government of Bangladesh. The Company was licensed by the Bangladesh Bank as a non-bank financial institution (NBFI) on 5 January 1998. Since its inception, IDCOL is playing a major role in bridging the financing gap for developing medium to large-scale infrastructure and renewable energy projects in Bangladesh. The company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh.

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http://idcol.org/

BAU

Bangladesh Agricultural University or BAU was established as the only university of its kind in Bangladesh in 1961. It started functioning with the College of Animal Husbandry and Veterinary Science at Mymensingh as its nucleus. The university has six faculties and 43 departments covering all aspects of agricultural education and research. BAU was the second highest budgeted public university in Bangladesh for the year 2013–2014. It is ranked number one university of Bangladesh according to the webomrtrix university ranking 2017.

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info@bau.edu.bd

https://www.bau.edu.bd

USTB

The University of Science and Technology Beijing (USTB) was founded in 1952 following the amalgamation of the best departments in related fields of five eminent universities as a result of a nationwide reorganization of the higher education system. Over half a century of remarkable growth, it has developed into one of the most influential key national universities sponsored by the Chinese Ministry of Education. USTB is renowned for its study of metallurgy and materials science. Its main focus is on engineering while it also maintains a balanced programme of science, management, humanities, economics and law.

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http://en.ustb.edu.cn

CSES

The Center for Sustainable Environmental Sanitation (CSES), integrated in the School of Environmental Engineering at the University of Science and Technology Beijing (USTB) was created in 2007 with the objective to build capacity among young professionals in the interrelated sectors of sustainable environmental sanitation, food security, bioenergy and climate protection.

CSES
环境可持续排水技术研究中心
Centre for Sustainable Environmental Sanitation

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12 Notes



Water Tank Digester for Domestic Biogas Production in Bangladesh

Do It Yourself Manual for Assembly, Operation & Manteinance

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