



An OLD idea whose TIME has come.

Among ALL alternative and renewable fuels, biogas is the easiest & cheapest to produce. It is very abundant and may be the most eco-friendly.

Biogas is popular again not only for its excellent fuel & energy value but as a potent greenhouse gas (GHG) that must be prevented from escaping into the atmosphere as it worsens Global Warming.

Make and collect biogas in an efficient digester and get a fuel that can be used for cooking and for running engines to produce mechanical & electrical power and to help reduce Global Warming.

Biogas is very EASY and very SIMPLE to produce. Animal manure submerged in water will emit biogas in the form of bubbles in just a few days.

The HBS (Home Biogas System) is a simple digester that can produce high rates of biogas and collect it efficiently. It was developed for tropical (year-round warm) countries like the Philippines. It can be built at low costs by anyone as a Do-It-Yourself (DIY) project. It is very simple & easy to operate.

Popular Biogas Systems

Biogas systems like the 6+ million CFDs (China Fixed Dome) and the 2.9+ million IFCs (India Floating Cover) digesters use complicated designs for specific reasons like:

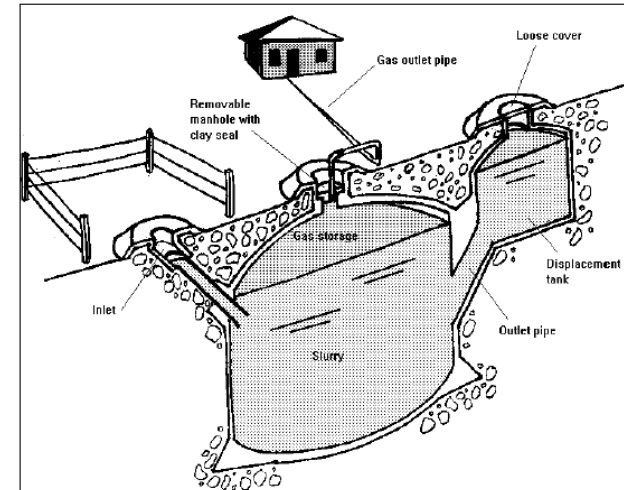
1. China has extreme cold weather that requires digesters to be built below ground (below the frost line) so that they will not freeze.
2. In India, pork is not a staple food for religious reasons. Their digesters are designed primarily for "gobar" or cow-dung.

We do not have to use these designs but we can learn from them. The HBS adapts many excellent features of the CFD & IFC.

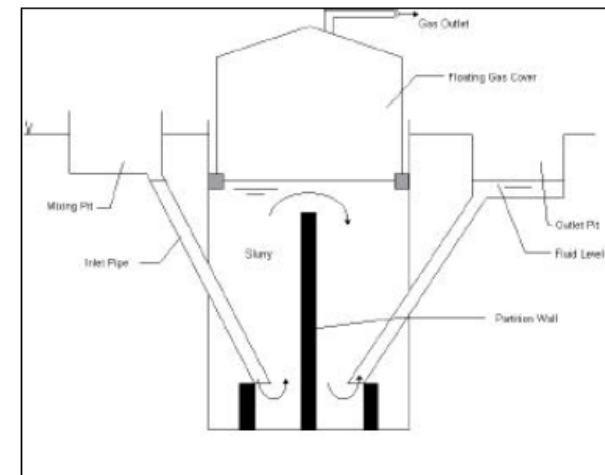
Anaerobic Digestion & Digester Science

The principles of anaerobic digestion & digester operation are not covered in this manual. Research them separately or inquire about our tutorials before building.

For best results, build the HBS exactly as indicated in this manual. Consult the author before making any alterations.



CFD (6+ Million IN-USE)



IFC (2.9+ Million IN-USE)

The Philippines year-round warm weather and many animal farms makes it ideal for biogas. Dr. Felix Maramba (a Filipino scientist) also recognized this. He pioneered biogas in the 1970's and is known internationally for it.

Study the enclosed plans & instructions. Build the HBS as a Do-It-Yourself (DIY) project for maximum savings. Avail of tutorial lessons to understand the science of Anaerobic Digestion and Digester Operation; see an online video of an actual construction; and, to know popular problems to avoid and minimize errors.

This manual is for a 5 m³ (cubic meter) HBS. It can use all kinds of animal manure but it works best with fresh pig, chicken* & cow manure. Biogas output can be estimated as follows:

- 10L (liters) of manure per day will produce biogas to cook 1 meal/day.
30L/day of manure is needed to cook 3 meals/day.
- The HBS can handle up to 50L/day of manure. Always mix manure with water at 1:1 ratio. Do not feed the HBS more than 100L/day of mixture.
50L/day of manure can save 20 pesos/day or P600/month in LPG costs.

Other advantages of the HBS

1. It has no concrete dome that is difficult to build, expensive and prone to leaks.
2. It has no floating cover that corrodes, is expensive and difficult to operate.
3. It has no stirring system that corrodes, is laborious and prone to leakage.
4. It has a simple sediment removal process.
5. The HBS can be situated near the kitchen (or away from the pigfarm) for additional convenience and to minimize piping problems.

* Layer chicken manure must be pre-mixed (dissolved) in separate containers to separate & remove sand-like particles that settle & can clog the HBS.



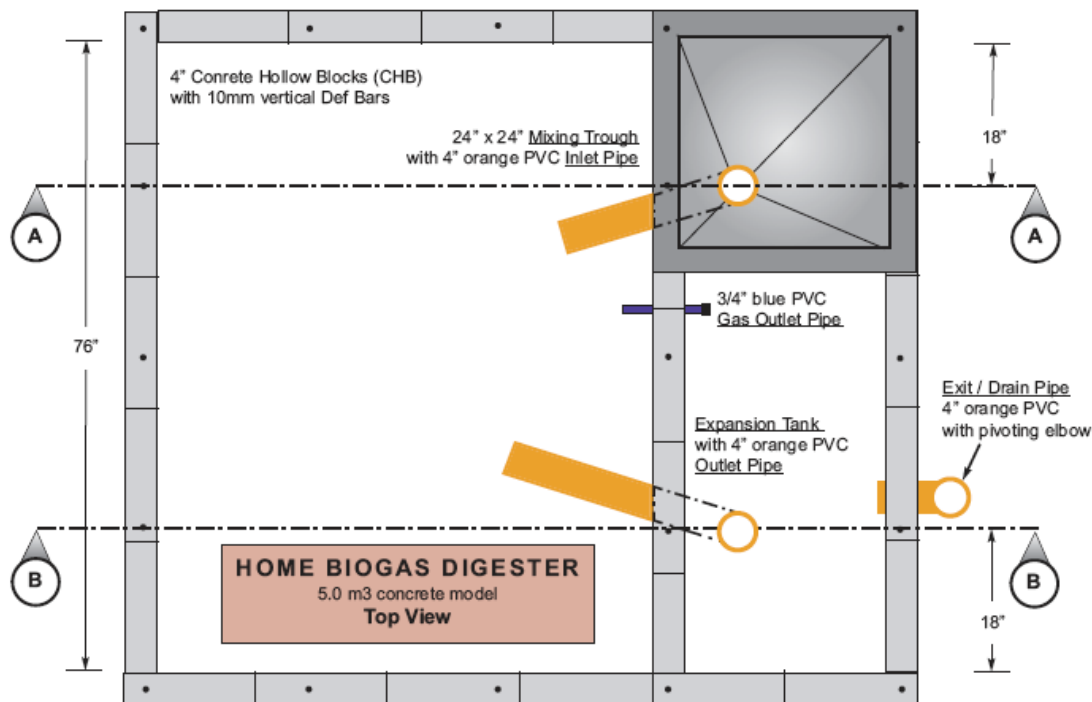
Use larger inlet piping to overcome low biogas pressures & corrosion. Biogas is corrosive. Avoid regular LPG burners as they can leak easily.



This digester shows that gas pressure can support the weight of a man. Since its HDPE cover is expensive & not-readily available, cheaper & common materials are used in this manual.

INSTRUCTIONS:

1. Select a location for the HBS close to where the gas will be used. (Sweep the manure from pig pens & bring it to the HBS. This will allow the HBS to be situated close to where the biogas will be used.)
2. Choose a sunny location away from trees. A sunny place makes the HBS work better & roots can break the digester walls.
3. Dig the compartments for the different sections of the HBS.

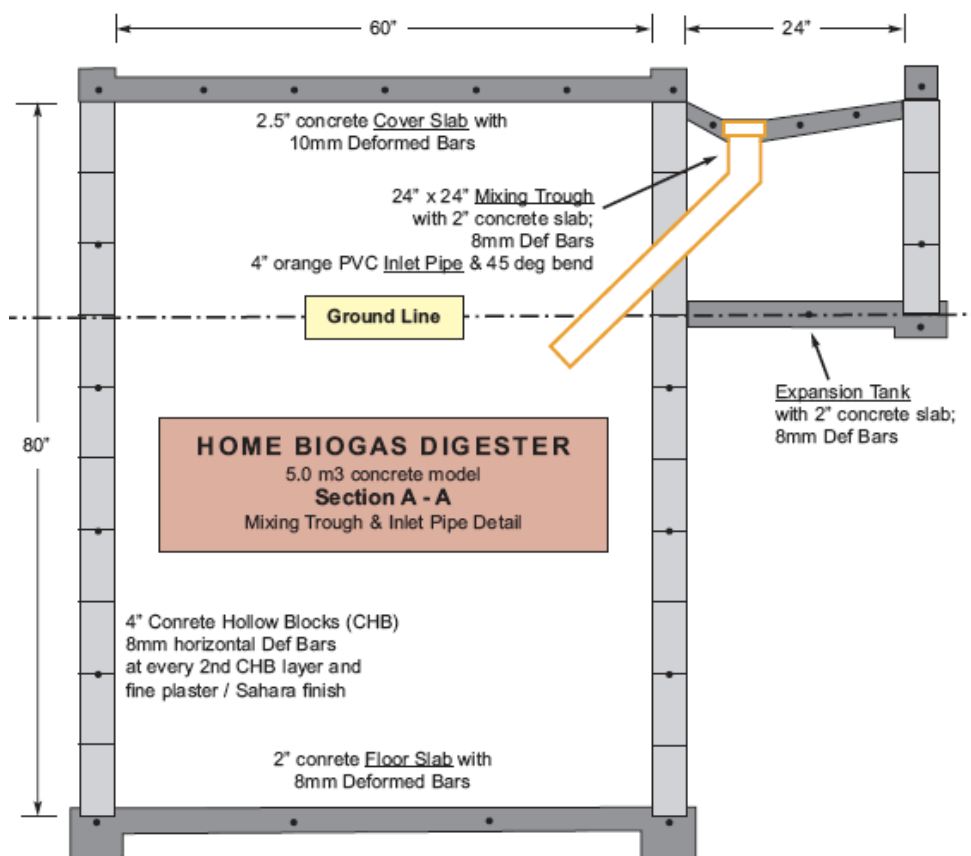


4. Build the footings and concrete floor slab. **ENSURE** there is no water seepage that will hamper construction and prevent the building of a watertight digester.
5. **IMPORTANT:** Create an opening (or man-hole) on one of the walls by not installing a few CHB's. See Instruction no: 10 for explanation & details.
6. Build the CHB walls. Upon reaching ground level, layout CHB walls for the Expansion Tank. Maintain CHB and Deformed Bar interlocks.
7. Install the Inlet & Outlet Pipes. **NOTE:** The Inlet & Outlet Pipes are positioned at different heights. These are necessary to make the digester work properly and to expedite sediment removal.
8. Build the concrete slab for the Expansion Tank.
9. Build formwork for the Cover Slab and Mixing Trough then pour cement mixture.
10. The man-hole in Instruction No: 6 is needed to allow the entry of a person inside the digester so that the upper inside walls & ceiling can be plaster finished & sealed. The upper-inside surfaces must be more than leak proof. They must be gas-tight. Apply at least one (1) coat of ThoroSeal or similar sealant. If possible, apply also one (1) coat of glossy exterior latex paint.

INSTRUCTIONS (continuation)

11. Smooth finish all inside surfaces with a plaster (containing a sealer like Sahara) & install piping work. Contact the author for the biogas piping layout.

12. The man-hole has to be covered & sealed after all work inside the digester is done. It is located below ground so that if it leaks only liquids inside the HBS – not biogas can leak through.

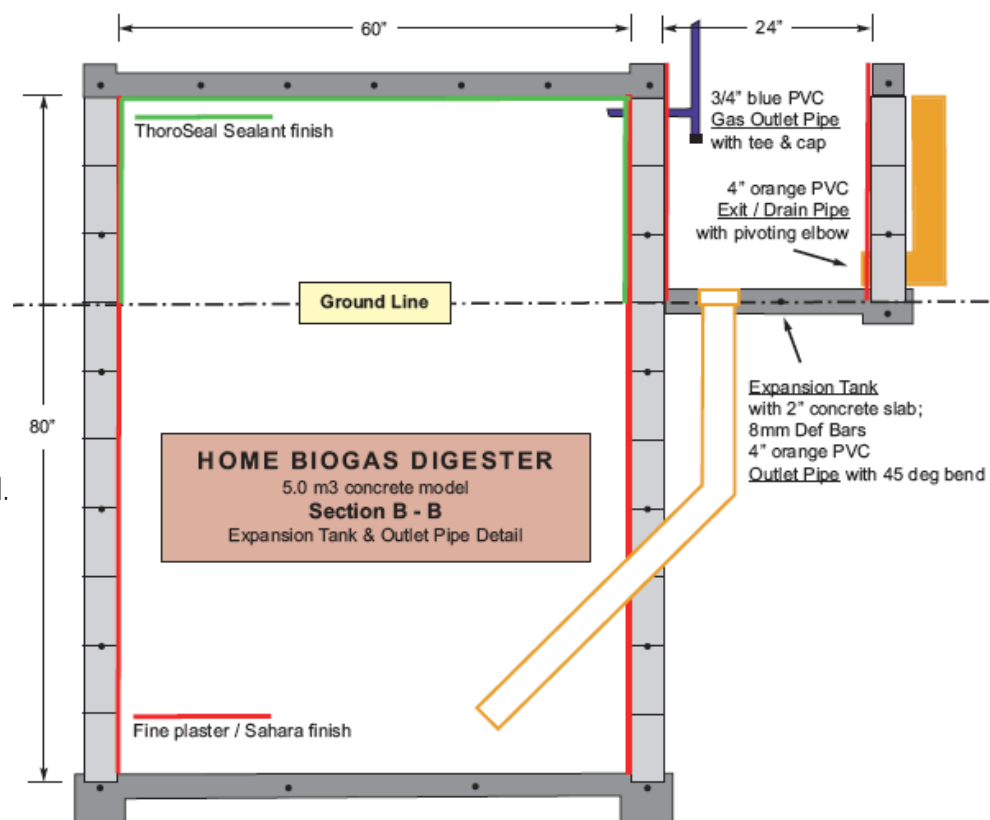


BILL OF MATERIALS (in Philippine Pesos @ 45.00 Pesos/US\$)

Qty.	Description	Unit Pr.	Amount
210 pcs	4" Concrete Hollow Blocks	7.50	1,575.00
8 pcs	8 mm Deformed Bar	75.00	600.00
6 pcs	10mm Deformed Bar	140.00	840.00
0.5 m3	Sand	500.00	250.00
0.25 m3	Gravel	800.00	200.00
12 bags	Cement	175.00	2,100.00
1 pc	Plywood 1/4x4x8	280.00	280.00
1 lot	Lumber, nails, etc.		500.00
10 packs	(Sahara) Water Sealer	30.00	300.00
1 gal	(Thoroseal) Sealer	450.00	450.00
1 pcs	4" orange PVC pipe	450.00	450.00
2 pcs	4" orange 45 deg el	70.00	140.00
1 pc	4" orange 90 deg el	70.00	70.00
1 pc	3/4" blue PVC pipe (sch 40)	75.00	75.00
1 lot	3/4" & 1/2" blue PVC fittings		100.00
1 pc	1/2" ball valve	150.00	150.00
	contingency		820.00
Total Materials			8,900.00
	Labor (6x400p/d + 6x300p/d)		4,200.00
TOTAL COST			13,100.00

Digester Start-Up:

1. Inoculants Preparation: Three weeks before construction, place 40L of manure in a 200L drum. Mix thoroughly with 40L of water. Leave alone to ferment. After 1 week, add 40L manure & 40L water again and mix. Make 2 or more drums, if possible. Do not overfill as froth and bubbles may form and overflow.
 2. When the HBS is completed, open the gas outlet valve & pour inoculants into the HBS. Collect stagnant fluids from lagoons & pour these into the HBS also until water appears (begins to exit) in the Expansion Tank (ET).
 3. With the gas outlet valve still open, add manure daily (thoroughly dissolved 1:1 ratio with water) into the HBS until water in the ET rises by 1 inch then close the gas outlet. Water in the ET should rise overnight -- indicating gas is being formed & is being collected.
 4. As water rises in the ET, set/rotate the Exit/Drain Pipe so that excess fluids flow-out & water is maintained at a halfway mark. Or, feed the HBS less. You may be over-feeding it.
 5. The water in the ET should rise by itself overnight (with nothing being added.) Open the gas valve & let out gases in the digester. Doing so lowers the water level. Close the valve, repeat for 2 to 3 days & then try to ignite the gas.
- BE CAREFUL, the flame may be invisible.** If it doesn't ignite, release the gases again (which could be CO₂), close the valve & try igniting the biogas again next day.



Digester Operation & Maintenance:

1. Biogas Production is a very slow process. Biogas has to be accumulated before it can be used. Gas produced overnight can be used to cook breakfast. Left-over biogas from breakfast plus gas produced in the morning can be used to cook lunch. Left-over biogas from lunch plus gas produced in the afternoon can be used to cook dinner.
2. Feeding the HBS with more manure & water at 1:1 ratio will produce more biogas but manage the Expansion Tank (or set the Exit/Drain pipe) properly so that excess water is expelled while digestate flows IN & OUT of the HBS as biogas is produced & is used.

Set Exit Pipe to expel effluent equivalent to the quantity of manure & water fed to the tank daily as follows: (1) With the Expansion Tank at the 1/4" mark, (2) close the gas outlet valve, (2) let manure mixture into the HBS and (3) set/rotate the pivoting Exit Pipe at an angle that lets an equivalent effluent quantity flow out.

A correct Exit Pipe setting will keep the HBS working properly & keep the Expansion Tank from filling up.

If you have excess biogas, share it with a neighbor or keep a burner lighted all the time. There is no-danger of over-pressure as liquids will simply overflow from the Expansion Tank when this happens.

3. Unclogging: Digestate & effluent flowing through the Outlet and Exit Pipes of the Expansion Tank are thick mud and sediments. Unclog them by inserting a flexible tubing IN & OUT of the pipes as needed.

The gas pipes or tubings may also clog with trapped water & condensate. These pipes should be at a small constant incline (that allows condensate to flow back into the digester, the burner or the condensate traps.) Vent or purge these pipes & traps regularly.

4. Sediment Removal: The Expansion Tank collects and accumulates mud & sediments from the HBS. To clean the Expansion Tank and expel sediments within the HBS: (1) Close the gas outlet with HBS full of gas (2) rotate the pivoting Exit Pipe to a horizontal position and to empty the Expansion Tank.

Pour new (manure+ water) mixtures into the HBS to force sediments out. Unclog the Outlet & Exit Pipes as needed. Shovel sediments from the Expansion Tank as needed. Use the sediments as organic fertilizer. (You may use the HBS cover slab for sun-drying.)



Biogas Piping , Burners & Others:

1. Biogas can be delivered from the HBS to the burner with ½" or larger PVC pipes or tubings. Small diameters should be avoided as they restrict flow.
Biogas Pressure is very low. Blowing a balloon or whistling creates higher pressures.
Progressive Incline: Biogas piping must be installed at a progressive incline (like sanitary pipes) so that liquids forming in the pipes would flow (back into the HBS, to the burner and to condensate traps.)
2. This manual is designed as a DIY (Do-It-Yourself) project for building low-cost HBS digesters in backyard farms. Consult the author before using it for large farms & specific circumstances.

Consultation and Design for larger & customized digesters are now available for a nominal fee in addition to the following:

- Demonstration videos: On line video of actual construction, start-up, operation & maintenance and animations of digester operating principles.
- Biogas burners & accessories: Ready & custom-made HBS appliances & accessories (Burners, Inflatable containers, Lamps, Condensate traps, etc.)
- Special Applications: The HBS is designed for backyards & for cooking only. Consultancy is available for larger applications, biogas-to-electricity systems, CDM project planning & documentation & carbon trading.

Tutorials, videos, consultations & updates

Inquire about these options at biofuels.work@gmail.com



Make the HBS gastight from within after it is covered. Create a manhole for access. Water should not seep-in. It will cause problems.



The Inlet & Outlet pipes have different heights & positions.