AIDG
Appropriate Infrastructure Development Group

BUILD MANUAL: ARTI FLOATING DOME BIODIGESTOR

(www.eawag.ch)

Revision	Date	Author
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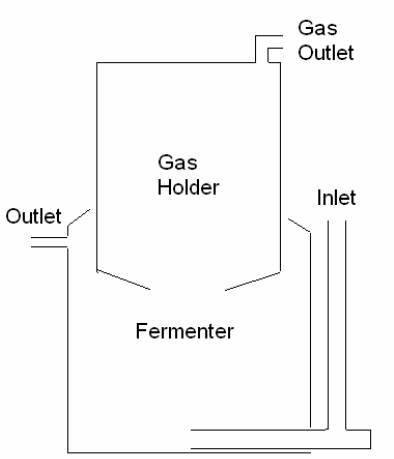
1. Introduction

The Appropriate Rural Technology Institute (ARTI) is an NGO based in Maharashtra, India. ARTI has developed a compact biogas plant which uses waste food rather than manure as feedstock, to supply biogas for cooking. The compact plants are made from cut-down high-density polythene (HDPE) water tanks, which are adapted using HDPE or PVC piping. The standard plant uses two tanks, with volumes of typically 0.75 m3 and 1 m3 (750l and 1000l). The smaller tank is the gas holder and is inverted over the larger one which holds the mixture of decomposing feedstock and water (slurry). An inlet is provided for adding feedstock, and an overflow for removing the digested effluent/ residue (www.eawag.ch)

The Appropriate Infrastructure Development Group (AIDG) helps individuals and communities to benefit from affordable and environmentally sound access to electricity, sanitation and clean water. AIDG's strategy focuses on business incubation, education and outreach and its projects are based in Guatemala and Haiti.



2. Materials List

1000l plastic water tank (*1100l tank used at AIDG*); 750l plastic water tank; 2m of x PVC pipe; PVC glue.
Feedstock Inlet: 2 x 4" PVC to male threaded fitting; 1 x 4" PVC to female threaded fitting; 1 x 4" PVC T; 1 x 4" female cap; scrap sheet metal (for funnel: 115cm x 35cm x 20cm long); 5 rivets.
Residue Outlet: 1 x 4" PVC to male threaded fitting; 1 x 4" PVC to female threaded fitting; 1 x 4" PVC elbow.
Small tank upper inlet 1 ½" female cap (assuming the inlet is male threaded. This is to seal the hole)
Seals 80 x 80 cm x 2mm thick rubber (like bike inner tube rubber); 25cm x 25cm x 6mm thick spongy rubber; silicone; PTFE (Teflon) tape.
Float Limiting Structure: 11m of 1" PVC; 4 1" PVC elbows; 0.5 x 6cm Bolts (4); 0.5cm Nuts (4); 0.5cm Washers (24); Flat iron (approx. 3.5m x 2cm x 2mm thick.)
Gas outlet 1 ½ " coupler; 1 ½ - ¾ " male to female reducer ; ¾- ½" male thread to female thread reducer; ½ " male threaded adaptor to flexible hose; ½ "flexible hose; ½ " hose clamp.
Gas Burner: ½ " hose clamp; 2 x ½ " metal nipple; ½ " shut off valve; 1.5cm Ø iron bar + 2.5cm Ø tubular iron iron bar to be welded into a stove frame *Note: this is for one of several stove options.*

3. Tools List

Jigsaw; Tape measure; Flat file; Marker pen; Two large pipe wrenches; Small adjustable spanner ; Welding machine (helps to make the float limiting structure); Scissors; Hammer; Chisel; Hacksaw; Drill; Rivet gun

4. Fit the small tank into the large tank.

A 1100l and a 750l tank were used to build a prototype at AIDG Guatemala: exterior diameters 120cm and 106cm.

ARTI Bio-digester built by AIDG Guatemala

4.1 Mark where to cut off the top of the big tank

Cut the top of the big tank (the fermenter) so that the small tank (the gas holder) will fit inside it (upside down.) The big tank is cut so that its opening is the size of the small tank.

Cut off the top of the small tank and place it, centered, on top of the big tank to mark its perimeter. Remark the cutting line so that the hole is 3" wider than this. Ensure that the line is level.

Alternatively:

- Mark the small tank circumference on a cord = ∏ x diameter (photo 3)
- Use the cord to mark the big tank so that the small one fits inside exactly (photo 2)
- Lay the cord in a circle. Check that distance to the tank edge is the same all round. Centre the small tank on top of the big one; check it's directly above the cord.

2.

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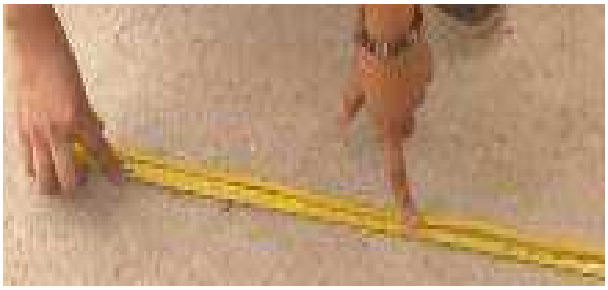

4.2 Cut the hole

5.

6.

- Penetrate with a hammer and chisel so that the jigsaw blade can pass through (chiseling is easier with another person pushing from the inside.) Then cut along the marked line with the jigsaw

Make the initial cut based on the hole you have marked → Check that it is large enough for the small tank→ Cut again until it is the right size.

The final hole should be approximately 8cm wider than the small tank diameter- there should be 4cm of space on each side of the small tank. This allows the small tank to float upwards when full. Make sure that there is enough space for the small tank to float past the female fitting on the inside of the outlet of the fermenter (see section 5.4 for details- it will be cut but the threading must be left.) Use a file so that the edge is left smooth.

5 Making the Inlets and Outlets

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8.

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Holes in the tank for the inlet and outlet are made using a jigsaw:

- Mark out the hole – 4" diameter
- Drill a small hole for the jigsaw blade to pass through.
- Cut with the jigsaw – lay the cutting surface horizontally if possible for accuracy
- Finish the hole to the line you have marked using a file.

Make the initial cut based on the hole you have marked → Check that it is large enough for the fitting → Cut again or file the hole bigger until it is the right size. *If you do not have a jigsaw, then drill small holes. Then cut through with a fine chisel using hammer blows.*

Ensure the 4" male fitting fits all the way into the hole. Screw it in with a large pipe wrench (photo 11). This is easier to do with two people. This wrench will later be used for tightening the male and female threaded fittings, either side of the inlet.

11.

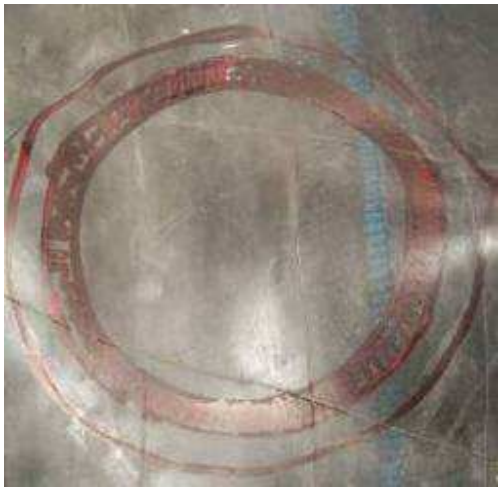
5.1 Making the rubber washers.

Rubber washers are used to seal the inlets each side of the tank wall. These are made in the following way:

1. Mark the inside and outside diameter of the washer on the rubber, drawing around the fitting.

12.

13.



2. Use scissors to cut a washer from the rubber

14.

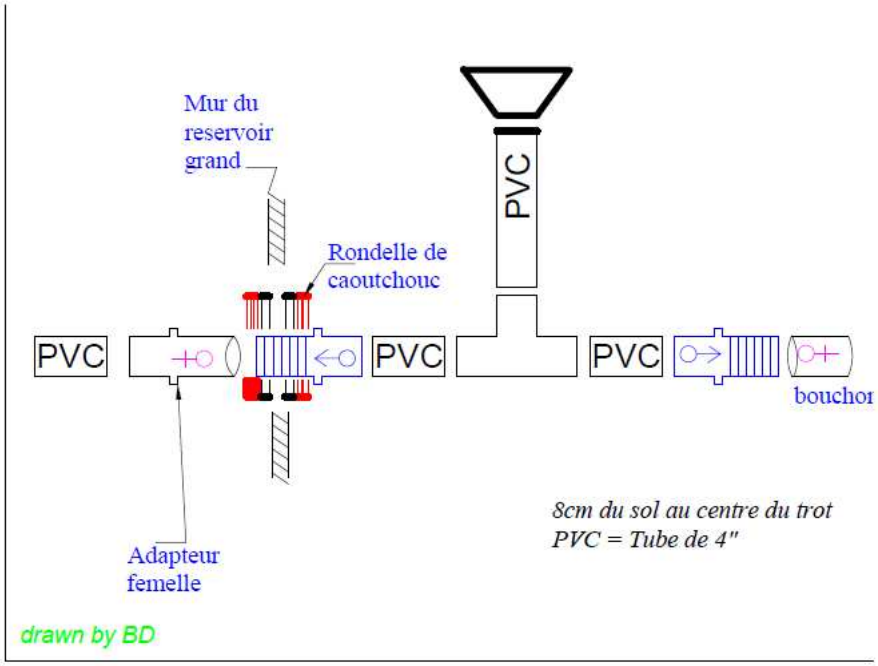
You will need 4 normal rubber washers and 2 thicker washers for the inlet, and one normal washer for the outlet. It is important for the Feedstock Inlet to be water tight. This should have two rubber washers on each side of the tank wall. A third washer made from a thicker, spongier rubber is also necessary (on both

sides, next to the tank wall). The Residue Outlet can be sealed with two normal washers and one thick washer on the inside, but only one rubber washer on the outside of the tank.

5.2 Feedstock Inlet

The existing inlet to the large tank can be used for the feedstock inlet (approximately 8cm from the floor to the centre of the hole.) However it must be widened to 4" (the method is explained in [5].)

D1 ARTI BIODIGESTOR – Entrée du Composter



Tank interior is on the left. There are two rubber washers and a thicker washer (black) on each side of the tank.

The pipes and fittings are connected to make the inlet and outlet as shown in Diagram D1.

15.

16.

Mark the 4" PVC pipe to size and cut it with a hacksaw. The lengths are shown in photo 17.
17.

The fittings should be pushed all the way onto the pipe (photo 20.) This may require tapping with a hammer (photo 21). Use plenty of PVC glue on both the pipe and the fitting to join them together (photo 18.)

18.

19

20.

21.

Threaded joints should be sealed using PTFE tape (teflon) (photo 22). The tape is wound over the male threading around 10 times in a clockwise direction.

22.

23.

As shown in photo 23 the inlet should be extended on the inside of the tank.
On the outside, the inlet is fitted with a cap on one side of the T to enable the pipe to be unblocked or the bio-digester to be drained if necessary. This is connected by screwing onto the male fitting (photo 24). Two large pipe wrenches are needed: one to tighten the cap and the other to prevent the male fitting from moving (photo 25.)

24.

25.

Rubber washers are installed ach side of the tank wall (5.3). Silicone should be applied between the rubber washers and the inlet/ outlet holes for extra sealing. Apply to all non-threaded joints between the pipe and fitting.

26.

27.

28. Feedstock Inlet

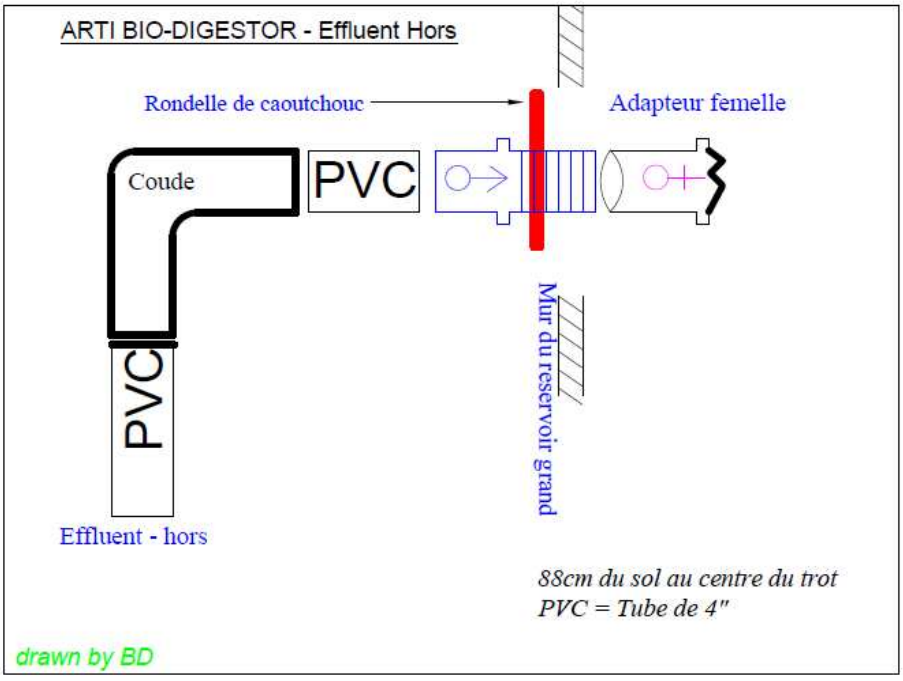
5.3 Feedstock Funnel

The inlet needs a wider mouth to make feeding easy. A funnel can be made from a sheet of scrap metal. Cut one horizontal side longer than the other (115 x 35cm); the other sides should be angled (20cm long). Bend over into a funnel shape and 5 drill holes which line up for riveting. Rivet together.

5.4 Residue Outlet

The existing inlet to the large tank can be used for the residue outlet (approximately 88cm from the floor to the centre of the hole.) However it must be widened to 4" (the method is explained in [5].)

D2



The female fitting used on the inside of the tank for the residue outlet must be cut short with a hacksaw. If it is not cut there will not be enough space for the gas holder to fit inside the fermentation tank.

29. 

30. The Residue Outlet

5.5 Gas outlet

The gas outlet is connected to the lower inlet to the smaller tank (this tank is upside down so it appears to be the higher inlet.) Connecting to this fitting means that there is a small space above the gas outlet from which gas cannot escape. An alternative is to make a new hole in the middle of the top of the gas holder and connect the gas outlet there. This option is more complicated for construction, as it requires making and sealing a new hole as well as sealing off the existing fitting. However, it does have the benefit of allowing all the gas to escape from the gas holder.

31. Connection of the gas outlet.

The fittings to be installed are as follows:
(Male inlet to tank) →1 ½ " coupler →1 ½ - ¾ " male to female reducer → ¾- ½" male to female reducer → ½ " adaptor to flexible hose → flexible hose (attached with a hose clamp)
Use silicone to seal the joint to the inlet

32. The gas burner with its iron stand

A stand for the gas burner can be welded from iron bar (1.5cm Ø + 2.5cm Ø tubular iron for the legs.) The fittings needed to attach the gas hose to the burner are as follows:
(Gas hose) →½ " metal nipple (hose attachment with a hose clamp) ½ " shut off valve →½ " metal nipple → gas burner

5.6 Sealing the higher outlet from the small tank

This should be sealed with a cap to prevent gas leakage.

6 Float Limiting Structure.

33.

To prevent the gas holder (the smaller tank) from rising too high, a structure is attached to the outer tank as shown in photo 33. Three lengths of 1"PVC pipe are connected together with 90° elbows to form inverted 'U' shapes (140cm→129cm→140cm.) This is built twice. The two structures are connected over the bio-digester in an 'X' formation.

A belt of thin iron is wrapped around the base of the bio-digester and connected together with bolts (photo 34.) Four metal lips are welded to the iron (photo 35), providing a surface that the PVC 'X' structure can be bolted to.

34.

35.

7 Further Information

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