



Biogas Bag Installation Manual

For small bag-type plug flow digesters

Version 1.1



Author: Bart Frederiks, MSc.

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1 INTRODUCTION

1.1 Background

This manual has been prepared to support practitioners with the installation of small bag digesters for the production of biogas. Together with its partners, FACT Foundation has developed a sturdy but low-cost digester that can be easily installed by individuals with little or no background in biogas technology. It is intended for application in developing countries, in households or institutional setting. The digester bag is made from fibre-reinforced PVC; it can be installed using materials that can usually be sourced in developing countries (e.g. PVC pipes, connectors, hose, valves).

A first batch of the digester bags was manufactured in November 2010; the first installation was implemented at the site of Mali Biocarburant in Koulikoro, Mali, in December. For a short video on the installation of the digester, please visit www.fact-foundation.com.

1.2 System description

The biogas system that was developed is of the plug-flow type. It consists of a bag with an elongated shape, with a length : width ratio of about 5 : 1, although for reasons of efficient manufacturing, ratios may differ. The wet feedstock goes in the one side of the bag, and the digested material ("digestate") comes out the other; it is mounted inside a shallow ditch which supports the sludge contained within. The produced biogas escapes from the sludge and is stored in the upper part of the bag. The gas is taken from the bag through a gas connection on top, and from there it is taken to the user through a system of pipes and hoses. In its least complex form, there are no systems for heating or stirring the contents, although in larger configurations (not described in this manual) either can be considered.

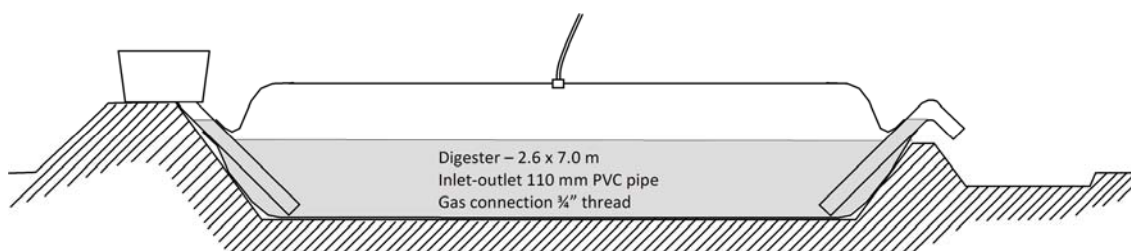


Figure 1 Cross-section of a plug-flow bag digester

The system is typically used for the digestion of animal manure and possible other organic matter. Any mixture should have a dry matter content below 15% in order to flow through. For some feedstocks (e.g. dry manure, dry biomass residues) this means that certain amounts of water should be added to the mixture. The liquid contents take up approximately 60-70% of the bag content; the remaining space is for gas storage (typically 1 day). At average ambient temperatures of 25-30 degrees, typical retention times are in the order of 50 days; this means that the daily material input in litres should be $1/50^{\text{th}}$ of the wet volume of the digester in litres. For example, a 12 m^3 digester with a wet content of 8 m^3 (8000 litres) should typically be fed with 160 litres of feedstock.

Digester feedstocks should preferably contain a certain amount of animal manure, in order to provide nutrients to the micro-organisms inside the digester, and to provide a buffer for acids produced and broken down in the different stages of decomposition.

Biogas systems intended to supply gas to engines should be fitted with a system supplying a small amount of air to the gas storage in order to allow for biological removal of sulphur compounds from the gas. This can either be an electrical aquarium pump or an alternative system that manages to provide a continuous air flow to the digester. In addition, it is advisable to add a condense trap and a pressure relief system in the gas piping system.

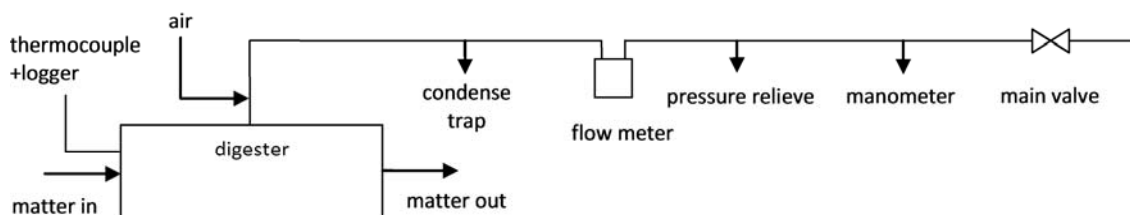


Figure 2 Schematic representation of the biogas system constructed in Koulikoro (Mali) in December 2010.

1.3 For whom

This manual is primarily meant for the person(s) intending to install a bag-type plug flow digester; it is meant to be provided along with the digester bag. However, it may prove useful to biogas practitioners wishing to develop their own system, or as a background document for other interested parties. Please do not hesitate to send us your comments, or the results of your own work in the field of biogas.

2 SELECTING THE APPROPRIATE SIZE

Although this manual is intended as guide for installation rather than a complete biogas reference, some indication with respect to selecting the appropriate digester size are provided in this chapter. The required biogas digester volume is basically determined by either the demand for biogas or the amount of biogas feedstock. For typical small scale systems however, biogas demand is usually the main criterion, and feedstock availability is a condition. Therefore, this situation will be used as a reference.

2.1 Determining gas requirements

Most small biogas systems produce gas for meeting household energy demands (cooking and lighting), although the use of the gas for power production (electricity or mechanical power) is starting to develop. Both will be briefly discussed below.

1. Household energy

Household energy that can be provided by biogas concerns mainly fuel for cooking and lighting. For both purposes, the existing energy use should be taken as a reference.

Biogas requirements for cooking can be estimated on the basis of the current fuel type, fuel consumption, and stove equipment used. For different combination, approximate fuel-to-biogas replacement values can be found in Table 1 below. For example, if a household currently uses 8 kg of woodfuel per day, cooking on 3 stones, the daily biogas need would be $8 \times 0.21 = 1.7 \text{ m}^3$ of biogas per day.

Table 1 Approximate cooking fuel replacement values

Fuel / stove	Fuel NCV	stove efficiency	replacement
Wood 3-stone	15 MJ/kg	10%	0.21 m ³ /kg
Wood improved	15 MJ/kg	20%	0.43 m ³ /kg
Charcoal	25 MJ/kg	30%	1.07 m ³ /kg
Kerosene	38 MJ/l	40%	2.17 m ³ /l
Butane gas	45 MJ/kg	45%	2.89 m ³ /kg

Biogas requirements for lighting can be estimated using the number of lights and the number of hours of lighting needed. Biogas lamps come in various sizes but an average consumption rate is some 100 litres (0.1 m³) of biogas per hour, so for one lamp used for 4 hours per day the gas requirements would be $1 \times 3 \times 0.1 = 0.3 \text{ m}^3$ per day.

2. Power production

For using biogas for the production of power (mechanical or electric), there are essentially two options: using a gas genset (similar to gasoline engine, i.e. with spark plugs) or a diesel genset.

Gas engines run on gas only, so the full electricity demand should be covered by biogas. The gas requirements should be calculated directly from the electricity demand, using a conversion factor of about 0.8 m³/kWh. So a daily electricity demand of 3 kWh/day would require $3 \times 0.8 = 2.4 \text{ m}^3$ biogas per day.

Note that gas gensets are available from about 1 kWe upward, and running such engines at very low loads results in low efficiency and more frequent engine failure. For individual households, such engines are often too large.

For use of biogas in diesel gensets, it should be understood that some amount of diesel (at least 20%) is always required. Biogas can thus replace a large amount of diesel consumption but cannot fully replace it. Assuming that there is an existing diesel set in operation, one can estimate the biogas consumption from the current diesel consumption, using a maximum replacement of 75% of the diesel and a replacement value of about 2 m³/l diesel. So when daily diesel consumption is 5 litres, the biogas requirements would be $5 \times 75\% \times 2 = 7.5 \text{ m}^3/\text{day}$.

2.2 Determining feedstock requirements

There are many different types of biomass that can be used for biogas production, but also many that are less suitable or downright unsuitable. Determining the suitability of certain (mixes of) biomass for digestion requires a more detailed assessment; in this chapter we briefly look at cow dung only, and a mixture of cow dung and jatropha presscake.

In the case of cow dung, one can use a biogas yield of approx 40 litres (0.04 m³) per kg of fresh dung. So at a daily gas requirement of 2 m³ gas per day, some 50 kg of fresh dung is required. Note that the dung needs to be thoroughly mixed with water (typically 1 litre per kg of fresh dung) in order to arrive at a suitable slurry, in this case 50 litres per day.

If available, other organic substances can be added which can increase gas production tremendously, for example jatropha presscake. The gas yield per kg cake depends on the amount of oil still inside, but for first estimates one can use 400 litres (0.4 m³) of gas per kg cake. For a stable process it is highly recommended to use it in combination with animal dung, e.g. replacing half the dung with press cake. For 2 m³ of biogas per day one would then need 25 kg of dung (producing half of the gas) plus 2.5 kg of press cake. Note that the water requirements are slightly different: the presscake is very dry and each kg requires some 7 litres of water. In this case, some 43 litres of water are required per day.

2.3 Selection of digester size

The eventual digester size can be determined as follows:

1. The volume required for the digesting slurry is at least 50 times the daily input (where one kg of input is usually taken as 1 litre). So for 2 m³ biogas per day, in case of the dung-only digester, the slurry requires at least $50 \times 100 = 5000$ litres (5 m³) if volume; in case of the dung-and-cake mix, at least $50 \times 70 = 3500$ litres (3.5 m³) is required.
2. For biogas storage (inside the bag), a typical volume of one day of biogas production is reserved. So in both the described cases, 2 m³ of volume would be required for gas storage.

When using dung only, the minimum digester size would thus be $5 + 2 = 7 \text{ m}^3$, and a 12 m³ system would be recommended. When using dung and press cake, $3.5 + 2 = 5.5 \text{ m}^3$ would be required, and a 6 m³ system would be recommended.

3 PARTS LIST

3.1 Main components

Table 2 Main components

Item	Description
Digester bag	Fibre-reinforced PVC, 1.15 kg/m ² (normal) or 0.85 kg/m ² (thin). Standard flat dimensions: 4.5 x 2.6 m (6 m ³), 7.5 x 2.6 m (12 m ³), 13 x 2.6 (24 m ³). Gas connection 1" thread.
Digester bag reinforcements	Ø 80 mm wooden or hard plastic discs (8pcs) with M8 bolts (4pcs), nuts (4pcs) and washers (8pcs) for mounting.
In- and outlet pipe	Ø 110 mm PVC pipe (2x1.5m)
Fastening materials	Small hose clamps (½", 10pcs), large hose clamps (120mm, 2pcs), 30mm rubber strip from car inner tube (4m)
Inlet bucket	90 litre cement bucket, cement (25kgs)
Garden hose	½" hose (10m)
Gas connections and valves	Connector for ½" hose (3pc), T-pieces (3pcs), main valve (1pc), Teflon tape (1 m)

3.2 Secondary components

Table 3 Secondary components

Item	Description
Pressure relief system	1.5 l water bottle
Condense trap	1.5 l water bottle (with cap)
Roofing	Wooden poles, wire and thatch sheets
Sand bags	Sandbags (5pcs), rope (50m)
Pressure meter (optional)	Aquarium hose (1/8", 1m)
Air supply system (optional)	Small aquarium pump, aquarium hose (1/8", 5m), power supply
Gas counter (optional)	2.5 m ³ /h gas counter

3.3 Tools

Table 4 Tools

Item	Description
Shovels	For ground work
Rope and pegs	Thin rope (50m) and pegs for marking ground works
Measuring tape	For measuring excavation works etc.
Propane burner	Small propane burner for heating PVC pipe
Sand paper	For rounding off inlet- and outlet pipes
Saw	For cutting PVC pipes
Pressure testing	Air compressor, spray bottle



Figure 3 Overview of materials, as used in Koulikoro, Mali



Figure 4 Hose clamps



Figure 5 Digester bag reinforcements



Figure 6 Hose connectors and gas meter



Figure 7 Rubber strips

4 GROUND WORKS

4.1 Site selection

First step in the installation procedure is the selection of a site. The site should be large enough for the digester bag, the in- and outlet of the digester, and some additional space in order to walk around the installation. It should be as close as possible to the place where the gas is going to be used, in order to avoid large gas lines. The ground should be flat, and must be fit to excavate (e.g. no rocky underground).

As an indication, the following minimum space requirements can be used:

Table 5 Digester space requirements

Digester size	6 m ³	12 m ³	25 m ³
Space length	9 m	14 m	24 m
Space width	5 m	5 m	5 m

4.2 Measuring, marking and excavation

After selection of a suitable location, a ditch will need to be excavated in which to place the digester bag. The sand from the ditch should be put around the ditch to create a low wall thus increasing the effective depth of the ditch. A sketch of the ditch is provided in Figure 9 below; measures for the different digester sizes are provided in Table 6 below.

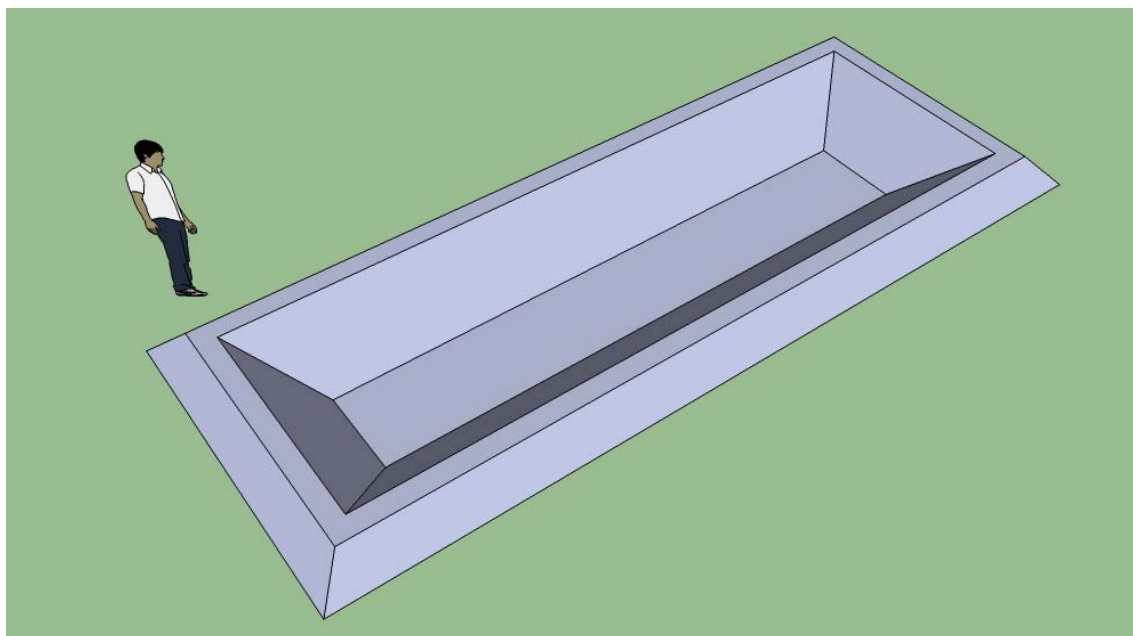


Figure 8 Basic layout for digester ditch (12 m³)

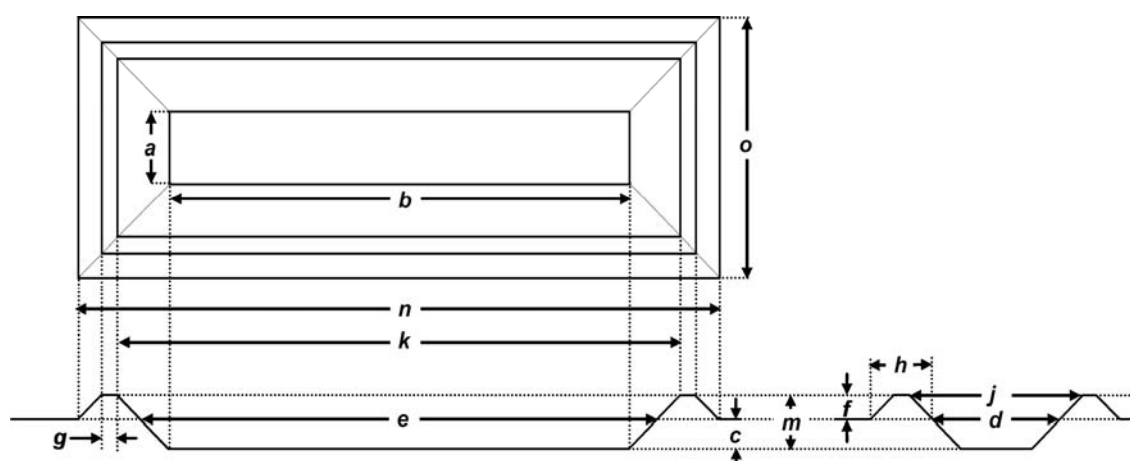


Figure 9 Measures of digester ditch

Table 6 Measures for digester ditch (in metres)

Digester size	6 m ³	12 m ³	25 m ³
a. ditch base width	0.90	0.90	0.90
b. ditch base length	2.20	6.00	14.70
c. ditch base depth from ground level	0.35	0.35	0.35
d. full ditch width at ground level	1.60	1.60	1.60
e. full ditch length at ground level	2.90	6.70	15.40
f. wall height from ground level	0.30	0.30	0.30
g. wall top width	0.20	0.20	0.20
h. wall total width	0.80	0.80	0.80
j. ditch width at top level	2.20	2.20	2.20
k. ditch length at top level	3.50	7.30	16.00
m. ditch depth from top level	0.65	0.65	0.65
n. total width	3.20	3.20	3.20
o. total length	4.50	8.30	17.00

In placing the ditch, please remember to leave space for inlet and outlet before and after the digester (both approx 2 metres).

The ditch should be dug in two phases:

1. First, a ditch with vertical walls should be dug, with the dimensions of the bottom of the ditch. Start with marking the corners and sides of the ditch with pegs and rope. Then the ditch can be dug, putting the sand from the ditch far enough from the edge of the ditch, i.e. there where the walls will be made. Regularly measure the depth of the depth in several places, in order to prevent digging too deep.
2. After that, the sides of the ditch should be scraped off diagonally, arriving at the eventual dimensions of the ditch. The angle should be approx 45 degrees in order to prevent caving in.



Figure 10 Excavation of a 12 m³ digester ditch

Care should be taken that the bottom and sides of the ditch do not have pointy rocks sticking out. Any rocks that could potentially damage the digester bag should be removed. If this is impossible, e.g. when it concerns large rocks that cannot be practically removed, counter measures should be taken:

- Rocks in the bottom of the ditch could be covered with a thin layer of fine sand, insulation material (e.g. rice husk)
- Rocks sticking out from the sides should be blanketed by a sturdy cover (e.g. rice bags or equivalent) before placing the digester bag in the ditch

When the ditch is complete, the bag can be placed inside. Make sure that the gas connection is on top! When the inlet pipe is being placed (see section 5.1), it may be necessary to remove additional sand from the top edge of the ditch to allow the pipe to be placed at the required angle.

5 CONNECTIONS AND TESTING

5.1 Inlet and outlet

Placement of reinforcements

In order to prevent tearing of specific bag welds at elevated pressure, the bag needs to be reinforced in four places (see Figure 11). Each reinforcement consists of two discs, a bolt, nut and 2 washers. Each reinforcement should be assembled by placing on the bolt 1) a washer, 2) the two discs, 3) the second washer, and 4) the nut. Tighten the nut so that approx 1cm of space is left between the discs. Push the reinforcements in place, with the bag material between the two discs, and tighten the nuts.



Figure 11 Top view of digester bag, with spots requiring reinforcements



Figure 12 Placing the reinforcement parts

Digester inlet

The digester inlet pipe is made of standard 110mm PVC pipe (1.5 m length) and needs three modifications prior to being fit:

1. On one side of the pipe, the edge should be bent outward, creating a collar of about 1 cm. This end will improve the connection with the inlet bucket. In order to do this, the edge should be slowly heated with a gas burner (constantly turn the pipe during heating to prevent the material to catch fire). When the edge material is sufficiently softened, carefully push the heated end on a flat surface, making sure that the edge bends outward all around the pipe. If it is well shaped, cool off the material with water while keeping the pipe in place. If the result is insufficient, saw off the deformed end of the pipe and try again.
2. A bend of 45-60 degrees should be made at approx 30 cm from the collar. Prior to heating the pipe, it should be filled with sand (both sides closed off) in order to prevent the pipe to collapse during bending. The pipe should then be slowly heated while rotating; when the pipe wall is sufficiently softened, carefully bend the pipe. If the result is satisfactory, cool off the bend with water.
3. The edge of the pipe going into the digester bag should be rounded off with a piece of sand paper, in order to prevent it from damaging the bag from the inside.



Figure 13 Preparing the inlet pipe

The inlet bucket should preferably be a standard 90 litre cement bucket. A hole with 110 mm diameter should be made in the bottom, as far away from the centre as possible. The inlet pipe should be inserted in the hole, from the inside of the bucket, all the way to the collar. NB the bend will have created a widening of the pipe so some force will need to be applied to pass the bend through the hole. Be careful with the collar: this is the most fragile part of the pipe!

Put a large hose clamp on the other end of the inlet pipe, and insert the pipe into the digester inlet sleeve (80 cm). Wrap rubber band tightly around the connection (see Figure 14), starting on the sleeve (5cm from the end), all the way onto the pipe (5cm from the bag) and back. Fasten the hose clamp on the rubber band, on the sleeve part.



Figure 14 Placing the inlet pipe and bucket

Digester outlet

The digester outlet is made of the same 110mm PVC pipe. The end of the pipe going into the bag should be rounded off with sand paper. Place this end into the digester outlet sleeve (80 cm), wrap it with rubber band and fasten with hose clamp like the inlet pipe. The outlet pipe may be sawn off in a later stage, when the digester bag is fully filled with substrate (see section 6.2).

5.2 Gas connections

Bag connection

First step in the gas connection is mounting the gas connector on the digester bag. Wrap the ½" thread of the connector in Teflon tape and screw it into the hole in the bag. Screw the hose connector on the bag connector and connect the hose.

Condensate trap

In the lowest point of the gas tubing, condensate may build up over time, which should be trapped in order to prevent it from blocking the pipe. At this point, a T-piece should be put in the tube, with one of the legs pointing downwards. This leg should be connected to an empty water through a short piece of hose – make sure that all connections are gas tight!

Other

Prepare the remainder of the gas tubing all the way to the location where the gas is to be used. Make sure that all connections are gas-tight, e.g. use hose clamps and short pieces of PVC pipe to connect hoses – not glue. On the end of the pipe, several equipment can or must be installed:

1. A gas meter (optional), using hose connectors and clamps
2. A pressure meter (optional), using a t-piece and hose clamps, and a u-shaped piece of transparent hose filled with water (see Figure 15). The U of the hose should have a height of at least 30 cm, and the water level should be approx 10-15 cm from the bottom. As

pressure builds up, the water level in one of the two legs will drop, and in the other it will increase. The pressure (in millibar or cm water) is equal to the height difference.

3. A pressure relief system (critical), consisting of a 1.5 litre water- bottle with a gas tube inserted, emerged in water for about 10-12 cm (see Figure 16). At elevated gas pressures, the gas can escape through the hose and the water into the atmosphere. ***This system should be placed in a well-ventilated area only!*** It should be connected to the gas piping system using a T-piece and hose clamps.
4. A main gas valve, from where the gas appliances can be connected.

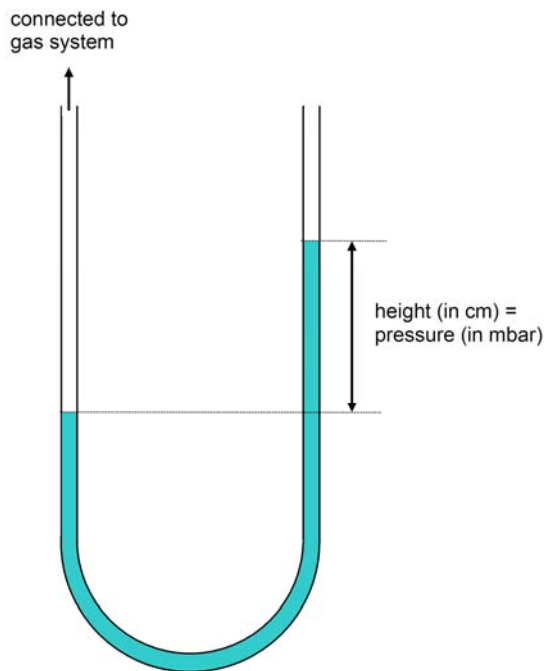


Figure 15 Pressure meter

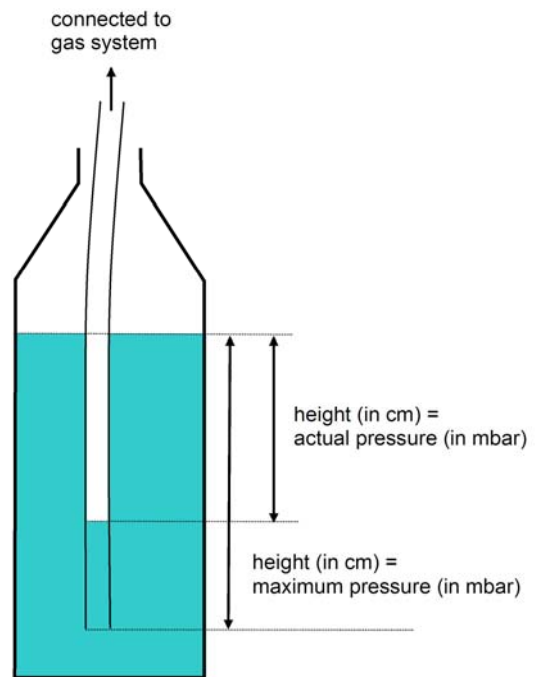


Figure 16 Pressure relief system

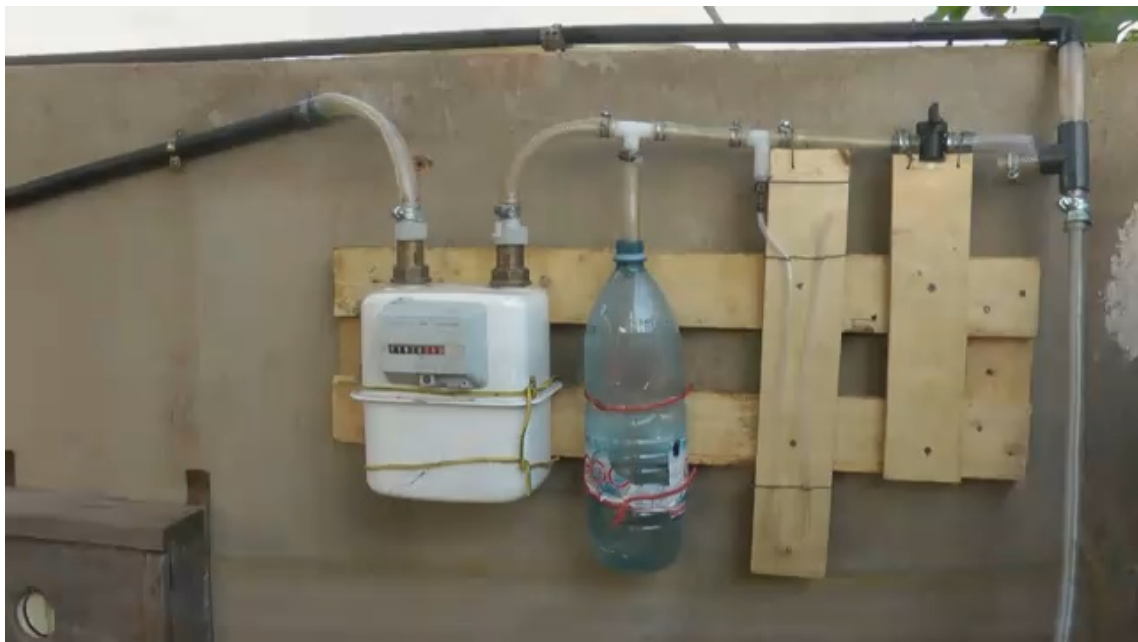


Figure 17 Gas meter, gas pressure meter, pressure relief and main valve

5.3 Pressure testing (optional)

When all connections have been made, an (optional) pressure test can be done to assure gas tightness of all connections. The digester inlet and outlets should be solidly blocked, e.g. with plastic bottles and plastic bags. The main valve should be closed; the pressure relief bottle should be filled such that the hose is emerged in at least 15cm of water. Also, the water level in the pressure meter should be verified.

Then, a compressor should be connected to the system, e.g. to the condense trap T-piece. The digester bag will be filled with air; after that the pressure will quickly build up. At the maximum pressure, the gas relieve system will start to kick in, and air bubbles will escape through the hose inside the bottle. The pressure meter will show a pressure of 15 cm water. At this point the compressor can be turned off. All connections (including the gas system and the in-and outlet connections to the digester bag) should be sprayed with a soap-water mixture from a spray bottle. Any gas leaks will cause bubbles, and should be repaired.

After the pressure test, the in- and outlet should be de-blocked, allowing all the air to escape from the bag (don't forget to reinstall the condensate trap!). Filling of the bag with dung and water can start as soon as the bag is completely empty.



Figure 18 Pressure testing in progress. The bottle provides a protection against over pressure.

6 FINALISATION, STARTUP AND OPERATION

6.1 Finalisation

Roofing

Prior to filling the digester, it is recommended to construct a simple roof over the digester bag, e.g. made from wooden poles and thatch. Such a roof limits the exposure of the bag to direct sunlight and will extend its lifetime. Also, it may reduce temperature fluctuations of the bag contents.

Outlet pit (optional)

An outlet pit can be created to catch the digester effluent, leave it to dry, and collect it after drying. The pit should be shallow (approx 10 cm), and have an area such that the daily effluent covers it to a maximum of a few cm. So when daily input (and thus output) is about 100 litres, and the max layer of digestate is 5 cm, the area should be at least 2 m². It should have a base in cement, in order to facilitate collection of the digestate.



Figure 19 Outlet pit

Air input (optional)

In case the biogas is going to be used to fuel a gas or diesel engine, it is strongly recommended to take measures against H₂S in the gas, which will in time cause damage to engine parts. There are different options for H₂S removal, but it is recommended here to use biological treatment. This requires the continuous supply of a small amount of air to the digester gas storage, at a rate of approx 3-5% of the biogas production. So a digester producing 5 m³ of biogas per day would require approx 200 litres of air per day, or 8 litres per hour.

The air supply is typically established using an electric aquarium pump; alternatively, an air cushion with weights – to be manually inflated each day – could be conceptualised, thus omitting the need for a continuous energy source to power the pump. In either case, the air

should be supplied to the biogas bag through an aquarium hose, inserted into the digester through the gas connection. A small valve should be added in the hose to set the air flow to the correct rate.



Figure 20 A small aquarium pump supplying air to a digester. The pump (4W) is fed with a small PV system

Adding weight

After the system has been started up (see section 6.2 below) and the gas storage is starting to become inflated, some sand bags should be placed on top of the digester, to increase the gas pressure inside the gas storage. It is recommended to place several sand bags, evenly spread over the digester bag, if necessary tied together with rope to avoid them from falling off. The recommended pressure is about 5-8 cm water. If no pressure meter has been installed, the pressure relieve system can be used to find the right pressure: if the hose inside the bottle is emerged in 5-8 cm of water, it will start to release the gas at that pressure. Do not forget to refill the bottle to 15 cm afterward!

6.2 System startup

For the startup of a digester, different methods exist¹. A proven method is to fill the digester to **half** the required level with a mixture of animal dung (cow or pig) and water, in a ratio of 1 kg of dung with 5-10 litres of water. This batch should be left for approx 2 weeks for the process to have started, after which the feeding of daily mixtures can start.

Alternatively, the digester can be started by filling it up with water to **half** the required level and start feeding it with the standard daily mixture. This method is considered safer but also takes more time.

Note that at lower temperatures, acid forming bacteria may outgrow methane producing bacteria, increasing the possibility of the digester to turn sour. In such a case, it is recommended to use more water (e.g. 10-20 litres per kg of dung) or revert to the water-only method.

¹ See for example http://www.appropedia.org/Biogas_start_up

In either case, it is recommended to use only dung for startup, and to wait with adding other substrates until the digester is producing a stable amount of gas. Even then, it is recommended to slowly increase the amount of co-substrate, adding 20% of the eventual amount for at least one week, then increasing it to 40% in the week after that, until the full 100% is reached.

Initially, mainly CO₂ is produced, so any gas produced in the first weeks will not burn. If after one month the gas still does not burn, it is recommended to (partly) deflate the gas storage. The methane content of the gas inside the storage will then increase much faster.



Figure 21 Digester filling

When the digester has been started up with half the amount of water and/or dung, it will take 25 days of feeding before it is filled with to the required level. At this moment, sufficient gas will have built up to pressurise the gas storage with sand bags (see section 6.1). At this point, the outlet pipe can be cut to the required length. Use a stick to gauge the level of digester effluent inside the outlet pipe, and saw off the pipe at that level. NB if the pipe that doesn't reach the outlet basin, a prefab 45 degree bend can be added to the outlet pipe to extend its length.

6.3 System operation

Typical daily operations activities include preparing and adding the daily mixture, daily checkup of the system, and managing the digester effluent. For reference: normal operation of a 12 m³ digester takes approximately 1 hour each day.

Preparing and adding the daily mixture

The digester should be fed once every day. Easiest is to mix inside the inlet bucket. Close the inlet pipe, e.g. with a plastic bottle and plastic bag. Make sure that neither goes into the inlet, as they might cause blockages. In case the needed amount is more than fits into the bucket, feed in two or three equal parts.

Measure the correct amount of dung, co-substrate (if applicable), and water. Co-substrate should be as fine as possible: when using e.g. kitchen wastes, it should be cut in small pieces

before adding it to the mix. Water should have the ambient temperature, in order to prevent temperature shocks when adding the mix to the digester. It may be best to fill a container of water each day, for use in the next day's mixture. The ingredients should be put in the inlet bucket, allow to soak for 15-30 minutes, and then mixed thoroughly by hand. Any dry lumps (e.g. from the animal dung) should be broken and soaked thoroughly. When the mixture is a uniform slurry, pull the plug from the inlet to let the mixture flow into the digester.



Figure 22 Daily feeding

Daily check-up

Each day, the whole biogas system should be checked for irregularities (tears or cracks in bag or hoses, tightness of hose clamps,). The water level inside the pressure relieve system should be checked (hose to be emerged in 15 cm water). The pressure should be checked (5-8 cm water), and the amount of water in the pressure meter. Check the level of water in the condense trap, and empty the bottle if necessary. Check the state of the roofing. Clean the system regularly.

Every three months, all of the connections in the system should be checked for gas-tightness. Use a spray-bottle with soap and water to spray all connections (including digester in- and outlet, and all gas connections upto the main valve.

Managing digester effluent

While adding the daily mixture, a similar amount of digester effluent will flow out of the digester outlet. The effluent is a potent fertiliser, containing all the nutrients present in the original inputs, and can be used in fields and gardens. The main drawback is the high water content (>90%) which makes it impractical to transport over large distances. This issue can be partially resolved by leaving the effluent in the open, so that part of the water can evaporate during the day. As such, it is best to first remove the effluent of the day before, and then feed the digester, to prevent the fresh (wet) effluent to mix with the partially dried effluent from the day before.

NB. work is ongoing to upgrade the effluent, e.g. by separating it into a solid fraction containing most of the undigested biomass, the phosphorous (P) and part of the nitrogen (N), and a liquid fraction with the potassium (K) and the remaining nitrogen (N). This may facilitate application and/or commercialisation of the effluent. Please check regularly on www.fact-foundation.com for further information.

6.4 Troubleshooting

After startup procedure, there is no gas production

- The digester may have gone sour. Flush out the digester bag with a large amount of water (twice the digester contents) and start it again, this time use water only during the startup (see section 6.2).

There is gas after startup, but it doesn't burn

- The gas that is produced in the first weeks after startup is mainly carbon dioxide (CO₂) and it takes a while for the methane content to rise to a level that can sustain a flame. Let most of the gas inside the digester escape; after a few days the methane content of the gas will have sufficiently increased to arrive at a sufficiently quality biogas.

There was gas after startup, but it stopped

- The bacteria inside the digester may have died due to high acidity, antibiotics, or poison. Flush out the digester bag with a large amount of water (twice the digester contents) and start it again.

There is gas, but it flows very slowly

- There may be too little weight on the digester bag. Check the pressure of the gas and add sand bags if necessary.
- Check the gas pipe system for blockages.

There is gas, but it is much too little to supply my daily energy needs

- Do you feed it enough? Gas production can be increased by adding co-substrate. Please discuss with an expert which types may be appropriate for you.
- Was the digester size properly assessed? If not, you may need a larger system.

Never use any sharp objects in an attempt to remove blockages in the in- and outlets, as this can easily lead to punctures in the bottom of the bag!