



Anaerobic Digestion Plant (5m³) Operation Manual

AAI ENTERPRISE PTY LTD

BEL OMBRE

TEL: 2510600

www.aaienterprise.com

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1. About Anaerobic Digestion (AD)

Anaerobic Digestion is a process whereby organic matter is decomposed by bacteria to produce a flammable gas called biogas. Biogas is composed of the flammable gas methane and non-flammable carbon dioxide gas. It also contains trace gasses such as hydrogen sulphide that is corrosive to metals. The anaerobic digestion process rely on a specific type of bacteria that live in the dark and in the absence of oxygen also known as anaerobic condition. For successful operation of an anaerobic digestion plant, it is important that the bacteria is kept alive by not introducing air and providing a constant supply of food also known as organic matter.

2. Knowing your AD plant

The AD PLANT is composed of three components, namely 1.) The BIODIGESTER, 2) BIOGAS COLLECTOR and 3) BIOGAS EQUIPMENT.

Below we will detail each component and give its function and how it is to be used.

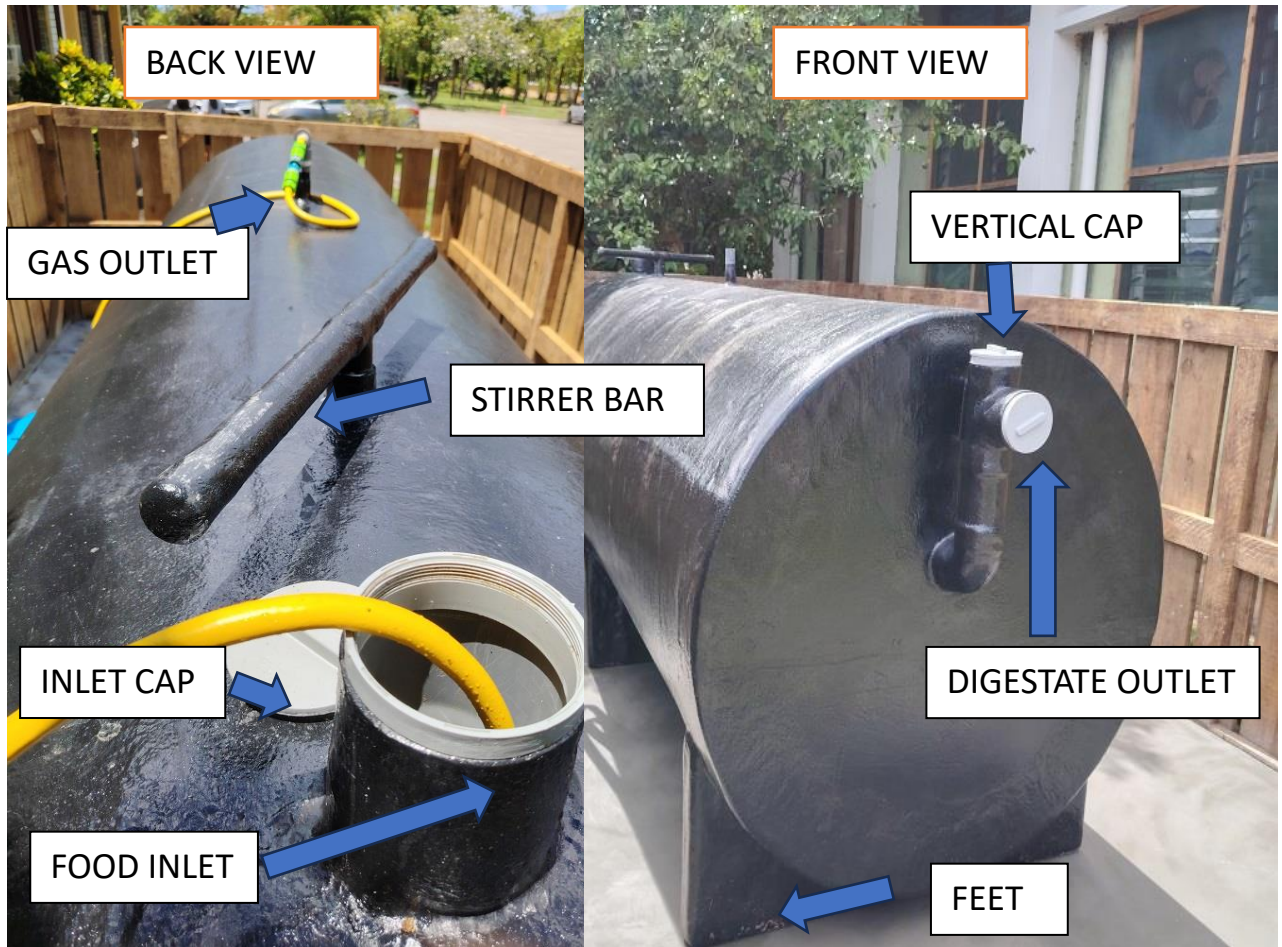
2.1 BIODIGESTER

The BIODIGESTER is the main component of the AD Plant and is where decomposition of food and its conversion to biogas happen. The BIODIGESTER is a cylindrical fibreglass tank. It has the following parts

- ❖ **FOOD INLET:** This is where food is administered. It is located at the beginning of the BIODIGESTER and is composed of a 4 inch vertical pipe. The INLET is where you administer food into the PLANT. The INLET has been designed to prevent biogas from coming out and is capped to prevent flies and other vermins.
- ❖ **DIGESTATE OUTLET:** This is where treated wastewater also known as DIGESTATE is removed from the BIODIGESTER. The volume of DIGESTATE removed should be the same as the volume of food slurry that is fed into the FOOD INLET.
- ❖ **BIOGAS OUTLET:** This is an outlet located at the at the top of the tank for extracting biogas. The GAS OUTLET is a 40mm PVC elbow and is much smaller in diameter compared to the INLET and the OUTLET.
- ❖ **STIRRER BAR:** The STIRRER BAR is a mechanical paddle that allow the mixing of the food inside the digester. The food items will after a while settle to the bottom of the tank and will not be as available to floating bacteria. Intermittent stirring causes agitation which creates better contact of bacteria with the food. The STIRRER BAR is designed so that it is not possible for large amounts of gas to escape.

On the next page you can see the various parts of the BIODIGESTER

PARTS OF THE 5m³ ANAEROBIC BIODIGESTER



NOTE: The DIGESTATE OUTLET have two caps one located vertically and the other horizontally. The vertical cap is there to prevent siphoning of water from the tank as the digestate is exiting. Only the horizontal cap is to be removed for Digestate removal from the tank.

In the photo above, the BIODIGESTER is being filled with water at the INLET.

2.2 BIOGAS COLLECTOR

The BIOGAS COLLECTOR is where BIOGAS is stored for later use. It is simply a 1m³ blue plastic bag which contain the BIOGAS and prevent escape into the atmosphere.



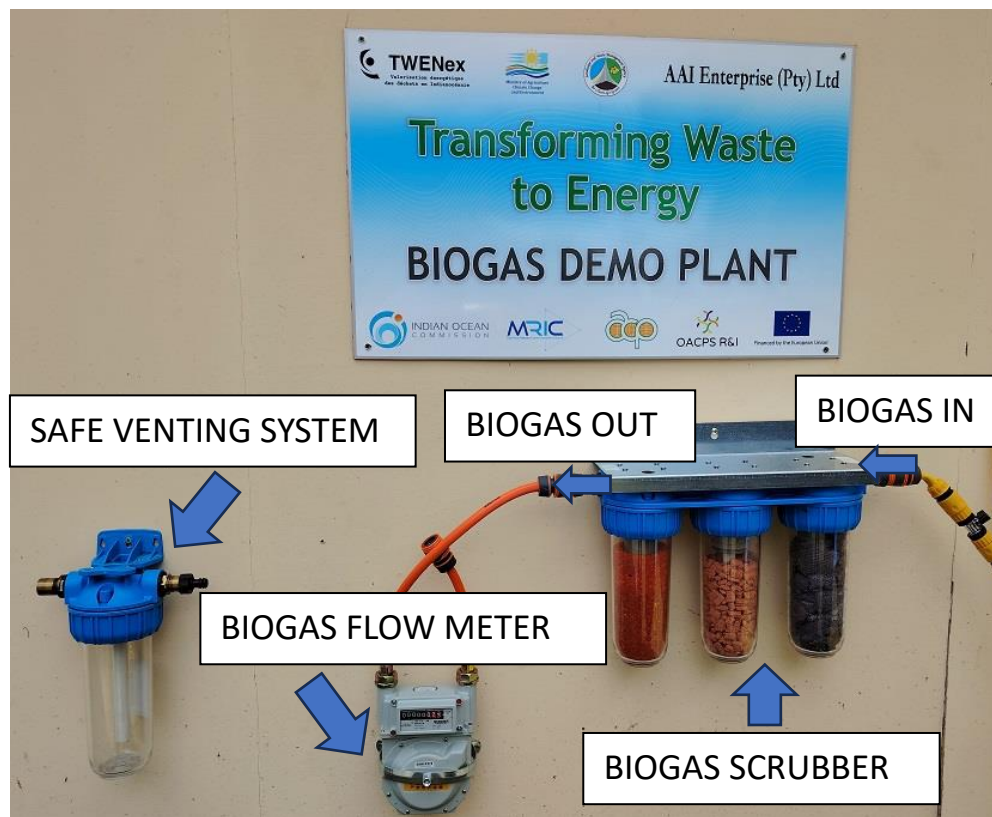
2.3 BIOGAS EQUIPMENT

The BIOGAS EQUIPMENT are items that is required for using the bigas effectively. This includes the

- ❖ **BIOGAS SCRUBBER:** The biogas scrubber is a three-chamber device which cleans the biogas (scrubbed) from contaminating gasses.
- ❖ **BIOGAS PUMP:** The gas pump is an electrical device which provides suction and pressure for the biogas to move from the GAS COLLECTOR to where it is required.
- ❖ **BIOGAS METER:** This function like a water meter but instead measure the flow of biogas so that we can know how much is generated.
- ❖ **BIOGAS COOKER:** A biogas cooker is a special cooker that can use biogas for cooking purposes
- ❖ **SAFE VENTING SYSTEM:** Is a device to allow you to release excess biogas from the system. The safe venting system is also used when the BIOGAS PLANT is to remain unattended for long period of time e.g. if you are going on a holiday. For this the valve to the BIOGAS COOKER is closed and the valve to the SAFE VENTING SYSTEM is opened, allowing biogas to bubble out of the water and exit in the environment safely. The system is designed to prevent air from entering the BIOGAS PLANT.

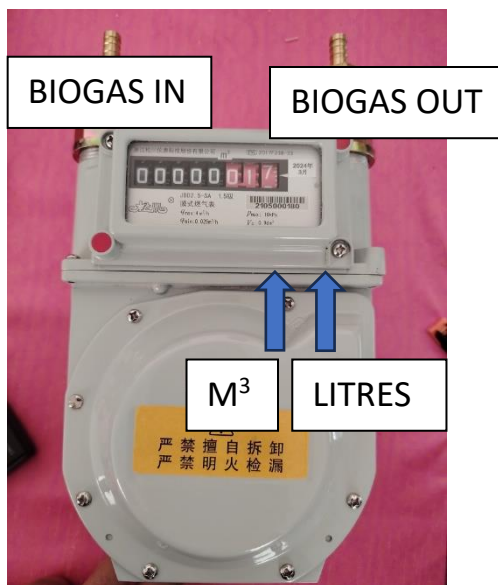
Below we can see these items

BIOGAS EQUIPMENT DESCRIPTION

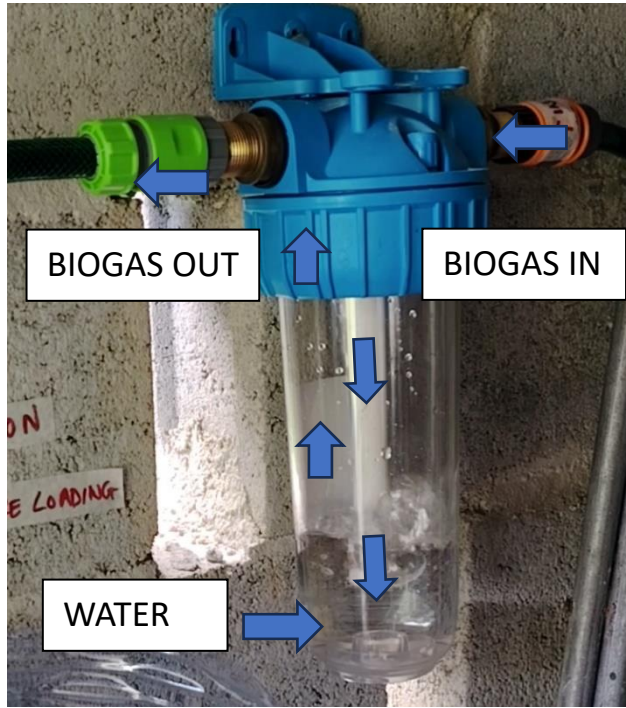


BIOGAS SCRUBBER: The first chamber contains steel wool that reacts with the hydrogen sulfide and remove it from the BIOGAS. The second contain ceramic filter that reacts with other trace gasses and the third chamber contain silica gel that dries the gas. The silica gel will change colour from orange to dark green when hydrated. It can be removed and put in an oven to dry at 105 degrees celcius where it will change back to orange and may be reused.

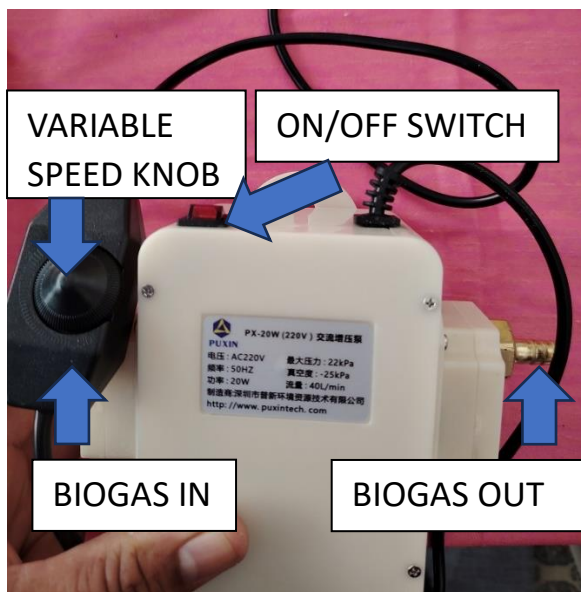
BIOGAS FLOW METER is a device imported from China and passively measures the flow of BIOGAS in the system. The red part measures in litres and the black measures m³.



SAFE VENTING SYSTEM: is a device that contains water. The BIOGAS is passed through water and out the other side. This prevents air from entering the BIOGAS PLANT. The water level must always cover the inlet pipe to allow bubbles to form when the system is operating correctly.



BIOGAS PUMP: The biogas pump is also imported from CHINA and uses 240V AC current to pump biogas. The pump consists of an ON/OFF switch and a variable speed knob to control the pressure of the BIOGAS.



3. Safety Precautions

The AD plant is designed and constructed to be completely sealed from the outside environment. Safety valves are placed within the gas line so that these parts can be closed from the gas supply to facilitate removal and exchange of BIOGAS EQUIPMENT.

If BIOGAS is mixed with air to a certain concentration the mixture can be explosive if ignited and cause serious bodily harm including deaths. The operator of BIOGAS PLANT should follow strict operational guidelines in this manual at all times in order to prevent accidents.

AAI ENTERPRISE PTY LTD, COI and its partners and funders of the TWENEx programme shall not be held liable for accidents caused by operation of the BIOGAS PLANT. Please ensure that safety aspects are respected at all time to prevent such occurrence.

4. Commissioning & Operation

Before starting operation, the following steps must be followed

Step 1: Inspection: The entire BIOGAS PLANT shall be inspected to ensure that all equipment are properly connected and there are no leaks.

Step 2: Filling: The BIODIGESTER must be filled with water completely. Water displaces the air inside the BIODIGESTER and allows a medium for bacteria to grow inside. The BIODIGESTER is full when water start to come out of the DIGESTATE OUTLET. During filling the BIOGAS COLLECTOR may be disconnected to the system so that air from the BIODIGESTER does not accumulate inside.

Step 3: Inoculation: The BIODIGESTER is filled with cow dung or other source of BIOGAS producing bacteria. This step can be done together with the filling (step2). It is recommended that the BIODIGESTER be filled with at least 200 litres of cow dung slurry during this step.

Step 4: Feeding: The BIODIGESTER is given a slurry of vegetable peel not exceeding 10 kg. It is recommended that the vegetable peel be put in a blender with water and shredded to a slurry. This will facilitate loading of the BIODIGESTER and at same time create more surface area which will increase decomposition rate.

Step 5: Air evacuation phase: The BIODIGESTER have a volume of air above the water surface which will need evacuation before allowing sources of ignition. It is recommended that the first batches of biogas received after feeding is evacuated instead of ignited since it will be contaminated with a greater portion of air. This process should take anywhere between 1 to 3 weeks depending on the amount of BIOGAS generated. During this time, there should be no sources of ignition in the vicinity of the BIOGAS PLANT including people smoking etc.

Step 6: Ignition and use: Following air evacuation phase the BIOGAS PLANT is now ready to be used. For this the gas valve to the BIOGAS COOKER is opened and the VENTING SYSTEM valve is closed. The BIOGAS PUMP is switched on and BIOGAS can flow to the COOKER via the BIOGAS SCRUBBER system. The COOKER is ignited until there is burning. This may take a few attempts as the remaining air in the gas line is pushed out by the incoming BIOGAS. As the BIOGAS is being consumed the BIOGAS COLLECTOR will shrink until no more BIOGAS is coming. At this point you can switch off the BIOGAS PUMP. You can only use the BIOGAS when the BIOGAS COLLECTOR contains BIOGAS.

5. Trouble shooting

Issue	Check	Remedy
No biogas is being received	Check for leaks or blockages in the biogas line	Repair all leaks
	Check whether the biogas pump is not defective	Replace biogas pump
	Check whether the biogas collector contain gas. If contain gas then the problem is not with the biodigester	Check for blockages forward of the biodigester. Check that connectors are not blocked (some have non return valves) or valves are closed
	If does not contain gas then the biodigester is not producing gas.	Do not exceed the daily feeding rate (10kg per day). Stop feeding, add some cow dung slurry and wait for gas production.
The biogas is received but is not lighting	Check the stove.	Please use only biogas stove supplied with the plant.
	Check the scrubber. If biogas is too wet it may not light	Replace the silica gel in the scrubbing unit
	The igniter of the cooker	Use a lighter to try lighting the gas in the cooker

6. Biodigester specification

Shape	Cylindrical
Material	Fiberglass
Inlet	4 inch PVC pipe
Outlet	4 inch PVC pipe
Colour	Black
Volume	5 m ³
Dimension (H x L)	1.65m x 4m
Maximum feeding rate (Organic loading rate)	10 kg per day (20 litres including water)
Weight when full	5.6 tons
Maximum gas production	3 m ³ per day
Maximum cooking time	2 hours per day
Hydraulic Retention Time	282 days
Operating temperature	Mesophilic (32 degrees celcius)