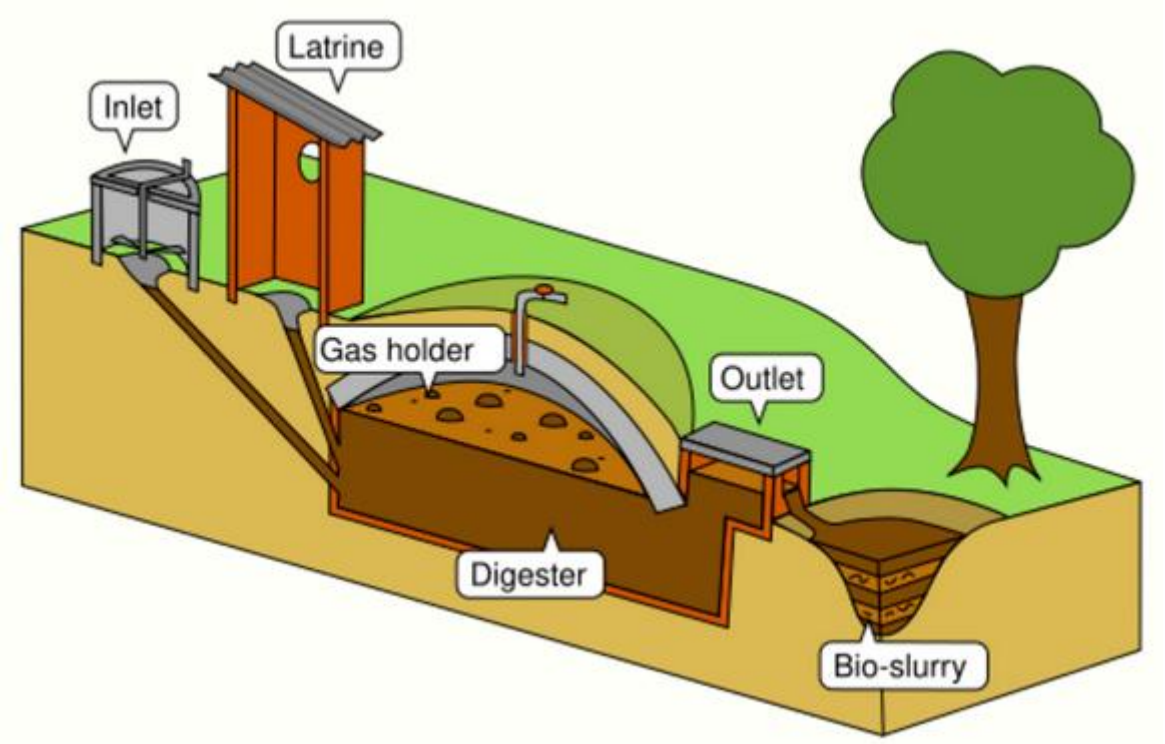
Manual for a Tropical Biodigester



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In this manual you can read how to operate a small scale digester in tropical area's.

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Here's some interesting links :

https://www.youtube.com/watch?v=1OkUqO86TaM

https://www.youtube.com/shorts/Kbk_axlq5vc

https://www.youtube.com/shorts/B46Kyh8nwQE

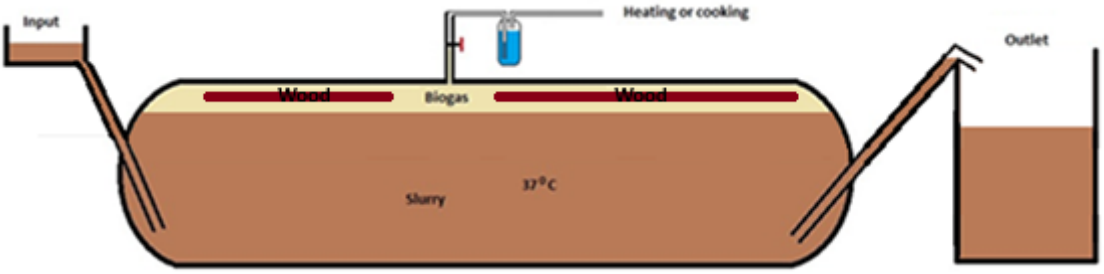
https://www.youtube.com/watch?v=x9_PjK6Z9eo

https://www.youtube.com/shorts/VxkmYFOgolY

https://www.youtube.com/watch?v=but5ntRMQQc

1. Design

The design of the digester is based on the picture below:



- The digester is made of a tank, or container that has the gasstorage within.
- Input and outputpipes are positioned as far as possible from eachother.
- The hightdifference between the slurry in the container, and the in and outputpipes is determined by the pressure of the Biogas.
- In and outlet may not be tightly closed.
- The container has to be gas and liquid tight
- The optimum temperature for operating this digester is 37^0 C.
- In tropical area's it won't be necessary to ad heat to the system or prewarm the inputmaterial.
- In the chapter Gasstorage, you will find the necessary safetymeasures.

2. Starting up

Starting up a digester is best done by filling it with output material of another digester, or fresh cowmanure. Not totally filling the tank might cause a dangerous situation because of the air in the not filled up space. Air contains oxygen, wich makes the gas produced combined with that air to an explosive gas. If the biogas is produced in an airfree space of the tank, it can only burn when combined with air or oxygen. (coming out)

3. Input

The inputmaterial for a digester, has to contain organic matter. It is the organic matter that under the right temperature and the presence of the right bacteria wil be transformed into biogas. All types of manure (also human) can be used. Better not use manure with a lot of straw in it. The straw is not easily digested bij the bacteria. To much Urine will because of the high nitrogencontent have a inhibitory effect on the gasproduction. Urine also contains no organic matter, so is best kept out of the digester.

Soap and other cleaning or desinfectant or detergent products must absolutely be kept out of the digester. They will kill the necessary bacterialife, and stop the digester with producing biogas.

The total content of the digester has to be fluid, so if the dry-matter input is high, some water can be added. The average drymatterpercentage of the input should be between 10 and 20 %.

Vegetable-rests and plant material (without sand) are very suitable for digesting. To make the material fit for the fastest possible digesting, it should be chopped (mashed) into as small as possible pieces. The bacteria must be able to digest (eat) the material. Large chunks take a lot of time to digest, and will reduce the gasproductioncapacity of the digester. Plantmateriaal (like Vegetable-rests) have a drymatterpercentage below 20%.

4. Biogas

Biogas is a mixture of gases. About 60 % is methane, wich is also the biggest part of natural gas. About 35 % of biogas is carbondioxide (CO_2). The rest is hydrogen sulfide (H_2S) and some other gases. About hydrogen sulfide you will read more in the chapter Gasstorage. The Methane is the gas that burns.

5. Exploiting

a. Daily input

Keeping the digester running (producing) means feeding it regularly. The bacteria in the digester like to have a regularly menu. Changing the menu will take the bacteria a while to adapt to the change. Depending on the type of input, it will take the bacteria about 30 day's to produce optimally. So on average you must daily add 1/30 part of the digestercontent. For example, if you have a 50 m^3 tank as a digester, that for 20 % will be used as gasstorage, you must daily add

80 % x 50 m^3 : 30 days = 1.333 liters (1,33 ton) of material

b. Daily output

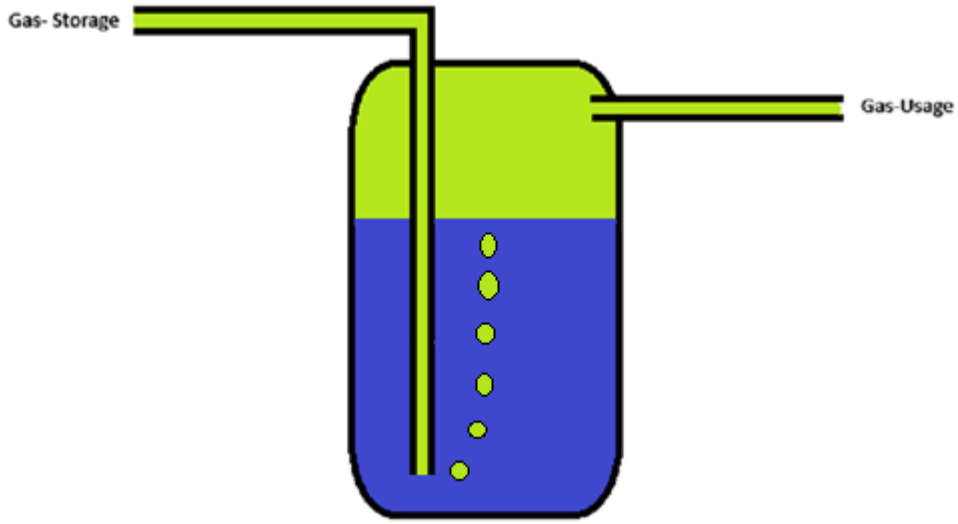
The daily output of a digester is only about 2 % less than the daily input. In the design as drawn in chapter 1, the output will automatically flow out, and is best kept in a storage for further use as fertilizer, for wich it is very suitable. This storage me be an open system.

6. Gasstorage

The quantity of biogas that is produced per ton of inputmaterial depends fully on the type and quality of that material. Cow-manure can produce 20 to 30 m^3 biogas per ton material, high quality plantbased restmaterial can produce up to 200 m^3 of biogas per ton input.

a. Safety

Between the biogascontainer (in the digester) and the end-use system (cooking stove) of the biogas there has to be a safetysystem. It is the easiest way to make that safetysystem of a water filled jerrycan, like in this drawing:



The safest way is to make two of these systems. One close to the digester, and one close to the end-usage. (cookingstove)

b. Desulfurization

Like written in the chapter Biogas, a part of the produced gas is Hydrogen Sulfide. This is a stinky, mildly toxic gas. To prevent or control this gas in usage, some rough beams of wood should be fixed in the gasstoragepart of the digestercontainer. Doing so and regularly bringing in a little bit of air in de gasstorage, a specific type of bacteria will grow on the wood, and take out the sulfur in the biogas.

c. Production

With as an example, a digester of 50 m^3 wich is for 20 % of its capacity is used for gasstorage, the effective digestercontent is 40 m^3 (tons). With an production of 25 m3 biogas per ton input and a residence time of 30 days, the daily production of Biogas will be: 33 m^3 per day. That is the equivalent of about 20 m^3 of natural gas, or 55 kg Propane.

7. Output

a. Storage

The (slurry) output, besides the biogas, out of a digester, is called digestate. Digestate has a slightly lower organic matter content than the input but with a higher availability of mineral content. The difference is transformed into biogas. Digestate is a high quality fertilizer. It should be used for arable farming. The urine, of wich in the chapter Input is written that it is best to keep out of the input, can directly be added to the digestate.

b. Usage

Cookingstove

Biogas can be used for cooking with a stove like this..

Storagebag

For transportation to use at home, a lightweight stroragebag of 500 liters can be used.

8. Longterm maintenance

It is hard to keep the input completely clean. Over time a settling layer of sand will form on the bottom of the digester. It won't harm the proces, but does harm the capacity. Gasproduction will descend because the effective content gets smaller. If that happens, the digester must be totally emptied and cleaned. After cleaning the proces has to start up again as if it is a new system. However, keep a serious quantity of the old content (free from sand) available to make an effective restart. During that maintenance, don't forget to place new fresh logs for desulfurization.

Be aware that no person can go in to the tank for cleaning, because there is no oxygen in the tank. Going in will have a person faint within seconds. Many accidents have happened with that. People can only go in with special (compressed air) equipment, or heavily ventilated.

Good Luck with your Digester!!!