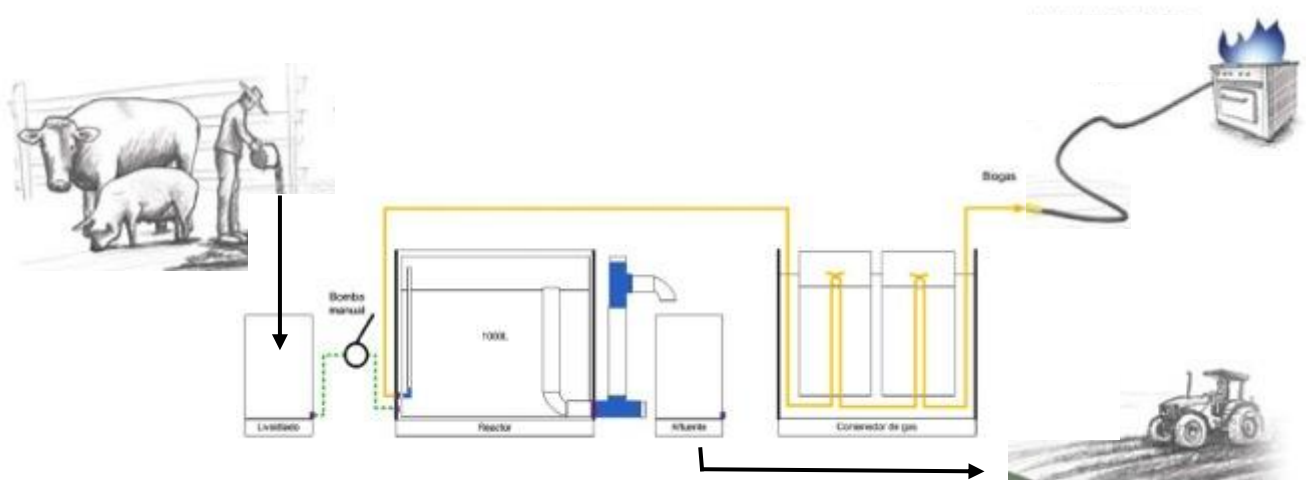


The Srenak Biogas Manual

How to construct a household biodigester



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1. Introduction: Project Biogas-Para-Todos (Biogas-For-All)

1.a. About this project

This project called Biogas-Para-Todos (Biogas-For-All) was brought about through the collaboration between the two Dutch foundations “Imagine” and “Katalysator”, the Colombian organisation “Transitional Minds” and the community “Anthakarana” situated in the region of Quindío, Colombia. The objectives of this project were to:

- 1) Teach residents of rural areas in Colombia, through a practical course, how to build a biodigester so as to produce their own cooking gas from renewable resources;
- 2) Produce an instructional manual (which you are reading now) with which other interested parties can make their own household biodigester;
- 3) Create an instructional video visually showing the basic steps of building a biodigester.

To achieve these objectives, a three-day course was held in the community of Anthakarana, situated in Quindío, Colombia, in which peasants from different parts of Colombia, as well as teachers and individuals from sustainable communities were taught the theory of how a biodigester works, as well as a hands-on course in constructing a biodigester. By replicating this biodigester in their own communities, participants have the potential to save money, help the environment, and contribute to energy independence. Through a naming contest held with participants, this biodigester has been named the *Srenak* biodigester, which means “an alternative means of making fire” in the indigenous language of one of the participants from the Misak indigenous people.

From this course, an instructional video has been made, visually showing the basic steps of building a biodigester with footage from the course. This can be viewed at the webpages of Katalysator and Transitional Minds (refer to the ‘contacts page’ at the end of this document). This manual is the other product which provides a more in depth look into the theory and practice of how to build the *Srenak Biodigester*.

We hope you find this information useful and inspiring. If you have any comments or want further information, please contact us through the list of contacts at the end of this document or go to www.stichtingkatalysator.nl/biogas-colombia-uk.



1.b. Partners involved

The Dutch foundation “Imagine” is participating in this project by providing financial support. The foundation has the objective of working to support biotechnology projects in developing countries.

The Dutch foundation “Katalysator” aims to help local companies working for sustainability in developing countries. From this foundation, three representatives travelled to Colombia to provide biodigester course, and have contributed to this manual. They are as follows:

Jelmer Tamis is the expert on the theory of how a biodigester functions. Jelmer has a Master degree in Life Science and Technology.

Coen van Gennep, with a Masters in Environmental Science, is the expert in the technical construction of the biodigester.

Alain Simons is the chairman of the foundation. Alain is a Human Kinetics Technologist and is in charge of the organisation of the project and acquiring funding.

The organisation Transitional Minds (Mentes en Transición) is the local partner in Colombia and is dedicated to managing and supporting projects that promote transitions toward a more socially and environmentally responsible society. The representatives of this organisation are:

Thomas Macintyre, with a Norwegian nationality, has a Masters in International Development Studies and has worked with several sustainable initiatives in Colombia and South America.

Martha Chaves is a Colombian biologist with a Masters in Forest and Nature Conservation, and is currently pursuing a doctorate in Sociology of Rural Development and Change at Wageningen University, the Netherlands.

The Ecovillage Anthakarana is dedicated to bridging the gap between ancient knowledge, art and new technologies for the development of human processes friendlier to the environment. The representative of this ecovillage is *Osiris Alvarez*. Osiris is an expert in sustainability in practice, having been a resident for more than 4 years in the ecovillage. Osiris is also in charge of maintaining the pilot biodigester constructed during the 3-day course in Anthakarana.

1.c. Objectives of this Manual:

This manual has three objectives:

- 1) The first objective is to provide a summary of the general theory of how biodigesters work, as well as the specificities of the *Srenak Biodigester*.
- 2) The second objective is to provide practical information as to the materials and tools needed in the design, and a step-by-step guide demonstrating how to construct the Srenak Biodigester.
- 3) The third objective is to provide a case study of the biodigester built in Anthakarana during the three-day-course, with which to show the real life challenges encountered during its operation and maintenance.

2. What is a biodigester and how does it work?

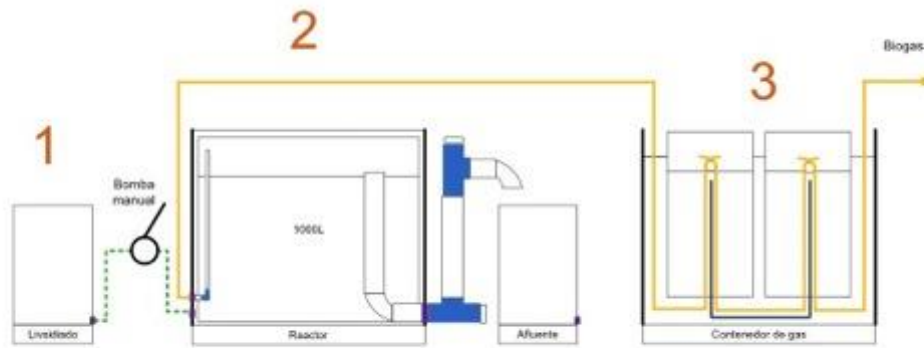
A biodigester is a system which converts organic waste into combustible gas. It is usually made up of a vessel, or vessels, in which organic materials ferment in the presence of microorganisms to produce gas. This gas can be collected and used to cook food on a primus, as is the purpose of this workshop, or modified to generate electricity or heat water. The left over material, known as the effluent, can then be diluted and used as a natural fertilizer in the garden.

A biodigester works through the production of biogas which is a natural process, much like the human body's production of gas. Carbohydrates, proteins and fats are digested in the biodigester and produce gas. This gas can be connected to a stove, like the normal tanks of propane, and used to cook with. The protagonists of this process are microorganisms. Like the yeast which ferments beer, and the *Lactobacillus* which creates yogurt, microorganisms found in animal manure and organic waste convert organic material into methane, CO₂ and other compounds. This process only happens anaerobically, i.e. without oxygen.

3. How does the *Srenak* Biodigester work?

There are many forms of biodigesters, from expensive large-scale systems based on large quantities of animal manure, to cheaper smaller scale systems which come as simple as a single barrel operation. These are all based on the principles above of micronutrient fermentation, but the different designs are differentiated by size, complexity and cost.

The *Srenak Biodigester* is designed to produce gas at the household level and is made of three components (see diagram below):



1. The containers in which the organic materials are mixed with water and where the acidogenic fermentation occurs, producing a liquid with concentrations of organic acids. This liquid is called the *leachate*. This process is similar to putting a tea bag in a cup of water: the organic materials are diluted in water and begin to ferment.
2. The second step is pumping the leachate into a second anaerobic vessel (i.e. where there is no oxygen) called the *reactor*, in which the methanogenic reaction will take place. This process produces a biogas which contains methane (the burnable gas) which is then collected in a third component.
3. This is the gas container in which the gas is stored and ready for use.

Special features of the *Srenak* Biodigester are as follows:

1. Works with organic residues from the kitchen, not only manure as in most other systems.
2. It is movable and can be made in modules, increasing gas capacity.
3. Most connections are below the water-line which means there are fewer possibilities for leaks. Should there be a leak, it is more easily identified. This is important because

fewer leaks reduces maintenance as well as the leakage of methane into the atmosphere which is damaging.

4. It is designed to decrease the likelihood of gas pipe blockages and holds more biomass in the reactor leading to greater gas production.

5. Its simple design also means that the biodigester can be used by anybody who wants to produce biogas and has access to animal manure and household organic residuals such as vegetable and fruit scraps.

6. By separating the leaching step and the methanogen step in two different containers, no solid particles will enter the methanogen reactor, eliminating the chance of blockage of the pipes.

4. Where can a biodigester work?

In principle, this biodigester can work anywhere as long as it has a steady supply of organic material, micro-bacteria and temperatures above 5 degrees Celsius. However, there are some considerations to take into account.

1. Distance of biodigester from the kitchen: The closer the hose which connects the biodigester is to the cooking stove, the greater the gas pressure at the stove. However, the organic material added to the biodigester, and the effluent which leaves, produces a smell, not always pleasant, so it should be far enough away from the kitchen so as not to be an inconvenience. The fermentation of residues also needs clean water.

2. Temperature: The bacteria work faster, and hence produces more gas, when the reactor material is warmer. For this reason it is advisable to place the biodigester in a warm place, for example, where the sun can heat it during the day.

This model can theoretically produce an estimated 2-3 hours of cooking gas per day, though in practice this depends on many factors which will be discussed later on.

5. Preconstruction requirements and considerations

5.a. Materials

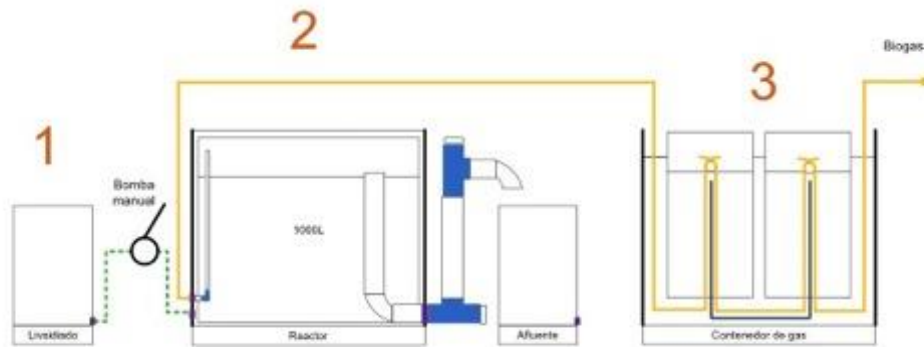
The Srenak biodigester model involves simple materials and tools which can be found at the local hardware store. Furthermore, the design is flexible enough to allow for “artisanal” modifications, using other second-hand parts which may be cheaper and easier to find. (See annex 1. For the list of materials).

5.b. Tools

General tools needed are a hammer, saw, drill, screwdriver, as well as nails, screws etc for the building of the reactor, as well as spades for preparing the site. In addition, it is useful to have a “hole saw kit” (Juego de Sierras copa) to make the holes in the containers.



6. How to construct a Srenak biodigester



All screwing connections use silicon tap, and smooth connections are sanded and pvc glue is used.



6.a. Construction of the leachate container

This model uses three leachate containers, though the number depends on the amount of leachate you decide to pump into the reactor. The leachate containers are created by first drilling a hole at the bottom of a 140 liter container (Materials needed: 140 liter container, drill, hole saw kit size 1")



The next step is constructing a hose connection. (Materials needed: PVC Tank connector 1", Tap PVC 1", Adapter pipe to hose 1")



A false bottom is then constructed and placed at the bottom of the container so only the liquid, and not the organic material, enters through the tube and into the reactor. As only liquid, and not solid mass, is entering the reactor, the reactor does not need to be emptied regularly of organic materials. (Materials needed: pieces of wood, plastic netting, saw, screws, screwdriver, 1" hose 5 meter)



6.b. Construction of the Reactor

The reactor is made up of three parts: The first part is where the leachate enters the reactor (1); the second part is where the gas produced in the reactor can leave for the gas holder (2); the third part is where the leftover leachate (known as the effluent) can leave the reactor (3).

(1) The first part is the where the leachate enters the reactor. Before drilling any holes its very important to turn the whole container 90 degrees so that the lid of the container is on the side and not on the top. Also make sure the original tap of the container is at the bottom. This avoids gas leakage at a later stage. The first hole involves drilling a 1" hole in the 1000 liter container. This is located near the bottom-right of the tank. (Materials needed: 1000L Container, PVC Tank connector 1" , Tap PVC 1", Adapter pipe to hose 1", hole saw size 1")



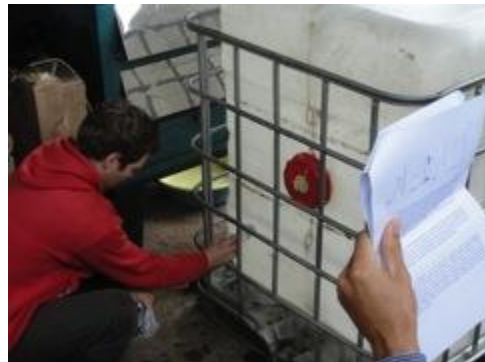
A tube connection is then made which fits to the tube leading to the leachate tanks. (bottom left of the picture on the right). A hand pump is then mounted on the reactor (middle of picture). When the taps are all open, the leachate from the containers can then be pumped (from above to below) into the reactor. If the leachate container is located sufficiently above the biogas reactor, the leachate can enter the reactor through gravity, so the pump can be bypassed. For this an extra T connection can be installed. (Materials needed: Handpump with 1" connectors, 1" hose 5 meter).

(2) The second part of the reactor is where the gas produced in the reactor can leave for the gasholder. First a hole is drilled (materials needed: hole saw $\frac{1}{2}$ ")



Then a tube connection is made on the outside. (Materials needed: Connector $\frac{1}{2}$ ", Male gas adapter $\frac{1}{2}$ ")

Because the gas produced will be in the top 25% of the reactor, it is necessary to connect a straight tube on the inside of the reactor that connects the connection below the water-line, and goes up to one of the top corners of the reactor where there is no slurry.



The opposite picture below shows the measurement of the length of pipe that will connect on the inside of the tank. (Materials needed: PVC Elbow 1", Adapter 1"to $\frac{1}{2}$ ", PVC Pipe 1")



Making the connections on the inside of the reactor was accomplished using the access from the red lid seen on the picture above right, and a piece of bamboo extended through the hole for the leachate on the other side of the tank.



(3) The third part of the reactor is where the leftover leachate (known as the effluent) can leave the reactor.

This involves drilling a 4" hole at the bottom of the reactor and placing a tank connector. It is important to use silicon to insure the connection does not leak as well as screws. Note that the piece you see in the picture below has a connecting piece on the inside. (Materials needed: Tank connector 4", Silicon kit, bolts+nuts)



4" tubes and elbow joints are then connected as shown in the picture below. At the top and bottom of this connection you will have removable lids. The bottom lid can be removed if there is a need to empty the reactor, while the top lid prevents rain and other materials from entering the reactor. The protruding tube which dips down is the overflow tube. This is placed at $\frac{3}{4}$ of the reactor height, meaning that at this point, any liquid pumped into the reactor will result in the same amount of liquid leaving through this overflow pipe. This prevents the reactor from filling up as the space above is needed for the gas. (materials needed (all PVC): 2x T piece 4", 1x elbow 4", 1m pipe 4", 2x endpiece with screw 4")

6.c. Construction of the Gas-holders

To create the gas-holder, the top of a 1000 liter container is cut off. (Materials needed: 1000L container)



Holes are then made in the 240 liter containers, which, when they are inverted, will allow them to be submerged in the water. (Materials needed: 2x 240L drums)

These containers are then fastened to the lid of the 1000Liter container, with the open ends of the container facing the lid. (Materials needed: cut off top of 1000L container, 240L drums, bolt and nuts)



The next step is connecting the gas tube leaving the reactor (yellow tube in picture)...

...and the tube which connects the gas holder to the stove...

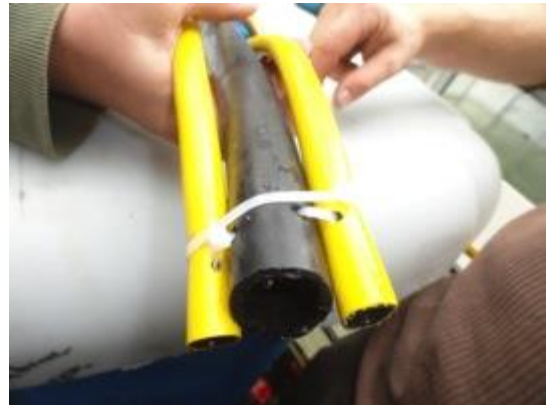


Together in the gas holders.

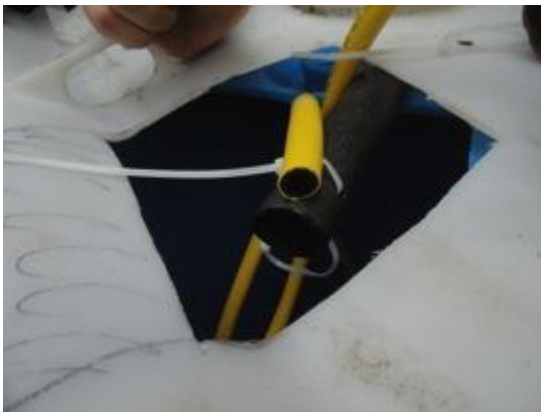
The yellow gas tube carrying the gas from the reactor is then connected to a semi-flexible black tube which goes inside the first gasholder (inverted 240 Liter container). This black tube, in the shape of the letter “U” joins the first container with the second container (refer to the schematic diagram on page 10). It has the double function of allowing the gas from the first container to enter the second container



(thus doubling the gas volume), and because of its stiff nature prevents the flexible gas hose from falling into the water as the gasholders move up and down depending on gas production and consumption.



(Materials needed: 3m polyethylene tube 1", 20 meters of gas hose ½")



The lid with the two containers attached and the connected hoses are then placed into the open 1000 liter container, with the lid facing downwards.



The 1000 liter container is then filled with water, and chlorine added to prevent mosquitos. Rocks are placed on the lid of the gasholder, weighing it down, creating more gas pressure. This can be seen in the opposite picture, between the two blue containers. The number of rocks and thus the weight depends on the type of stove used, the length and diameter of the gas tube and other factors. The optimal weight is best calculated through trial and error.



6.d. Connections to cooking stove

The most practical solution for biogas is to have a double connection for the stove. One connection is kept for normal gas from a canister, while the other is for the biogas. This means it is easy to switch between the two depending on the production of biogas. In the picture below, the yellow hose is the biogas, while the orange tube is for propane from a canister. The top connection goes to the stove. Depending on which switch is turned, biogas or propane will feed the stove. (Materials needed: Metal T piece $\frac{1}{2}$ ", Male gas adapter $\frac{1}{2}$ ", Tap metal $\frac{1}{2}$ ")



7. Operation

1) *Start up:* To activate the reaction in the reactor, a starting material is needed. This starting material, called an *inoculum*, should be rich in micro-organisms that perform anaerobic fermentation. A typical inoculum has a volume of between 10% and 50% of the volume of the reactor (the higher the percentage the faster the biodigester will start working). The best inoculum source is the sludge from other biodigesters. If this is not available, then second best is manure from mammals. This step only needs to be done once. This can be fed into the reactor through the red lid as shown in the picture below.



2) *Leaching:* Organic waste should be collected in containers and fresh/rain water should be added until it covers the material. Then it should be left to ferment for between 5 to 10 days. Almost any organic materials can be used, but certain compounds have an inhibitive effect on the methane formation, such as coffee and bird droppings (like chicken manure) and should be limited or avoided.



3) *Feeding the reactor:* Only the liquid part of the leachate is pumped into the reactor. This prevents the biodigester from filling up with fibrous materials that may cause blocking of tubes. The maximum amount of liquid to be pumped in everyday is estimated at 200 liters for this model, or 25% of the holding capacity of the reactor. The left over solid material can be composted.

4) *Effluent handling:* When the biodigester reaches its maximum volume, then every liter pumped in will result in one liter flowing out through the overflow/effluent tube. This liquid is rich in nutrients such as nitrogen and phosphate after the methanogenic reaction. It can be used again to leach the next batch of organic material, or to fertilize the garden. Note: re-using the



water to leach the materials will gradually result in a build up of salts and other inhibitory compounds in the liquid which will eventually kill the bacteria needed for the reaction. We therefore advise that at least every 5th time you remove the effluent from the reactor, you remove it from the system (use this water for fertilizer!) and fill the new leaching container with fresh water.

5) Flushing the system with gas

The last step which is very important is flushing the system with gas from a canister. This removes the oxygen in the system (at a certain ratio of oxygen and gas the mixture becomes explosive) and means that any gas produced should be of a height enough quality to burn. Flushing the system is accomplished through inserting the canister gas tube through the effluent tube of the reactor and pumping in gas. This is a good way to see if the system is working as the gasholder containers should rise as the gas is pumped in if the exit gas hose is closed. There should also be no leaks in the system. Fill the gas-holder with gas, open the exit gas hose and let all the gas out. Repeat this three times to insure all oxygen has been removed from the system. It is important to note that it can take up to 4 weeks for sufficient gas to be produced which will allow for cooking.



8. Troubleshooting

The following are reasons why the biodigester is not producing burnable gas:

A technical reason could be that the gas tubes are blocked, or there is a gas leak in the tubes and connections. Although this is minimised in the design, there is always a danger. To solve this problem, first visually check if there is a problem with the tubes, for example, a bent tube. If this is not the case, to find leaks in the pipes and connections make a mixture of soap and water and spray it on the system pipes and connections. If there is a leak with sufficient pressure then bubbles will be formed where the gas is leaking. Replace the part, or patch it if this is not possible. Given the case that there is not enough gas pressure to produce bubbles then it may be necessary to pump gas (not oxygen) into the gas container so as to generate the pressure needed to observe bubbles resulting from the leak. If this still does not solve the problem then it may be necessary to disconnect the tubes and pump water through them to clear any potential

blockages. In this case it is important to afterwards pump gas through the tubes to remove all the water.

On the other hand, there is the possibility that the digester does not work for *biological reasons*. If you do not start with an organic starting material (inoculum), or the inoculum does not have a high enough concentration of microbacteria, then the digester will take much longer to start producing gas. Be patient, the biodigester will eventually start producing gas. The optimum pH for the material of the reactor is between 7 to 8. If the material in the reactor has a pH of less than 6, then it is too acidic and will not produce gas. One solution to this is to add an alkaline substance such as lime (agricultural and construction) until the pH reaches the optimal range. Do this slowly as it is easy to add too much. The pH can be checked using pH measuring tape sold in stores that sell chemical products.



Another reason for the malfunction of the digester can be an overload of leachate being added to the reactor will may cause the sediment at the bottom of the reactor to be expelled, thus removing the bacteria needed for the reaction. To solve this add more starting material and add less leachate. Reversely, it may happen that after a long period of operation the system has accumulated too much sediment. This can easily be solved by removing excess sediment through the same access where the leachate is added.

9. Advantages and considerations of this biodigester

Economic advantages: Apart from material and maintenance costs, there are no costs involved in producing the gas. If you can produce enough gas for your household needs, then you do not need to buy or transport gas from the city or town.

Ecological benefits: This system produces gas from renewable materials such as cow manure and kitchen residuals whose by-products can be used as fertilizer, giving energy

to plants, whose fruit and vegetable residues can then be used again for the biodigester. This creates a closed loop where nothing is wasted. Purchased gas, on the other hand, is not a closed circuit as is extracted from non-renewable sources. In other words, it is not being replaced and it will one day run out. Furthermore, its extraction involves a lot of damage to the environment. By generating and using biogas we also avoid chopping down rainforests for firewood, whose burning also impairs our respiratory health. Finally, the Srenak biodigester model is not dug into the ground so it does not affect the watertable.

The good life (El buen vivir): If you are interested in renewable energy and sustainable living then it is rewarding to take responsibility for your own waste and create your own energy from the resources around you. It is a creative and responsible everyday activity, giving you more independence to your way of life. Remember that the money you are not spending on gas can be used to improve your quality of life and that of your family.

Responsibility: Despite all the advantages of a biodigester, it is important to remember that its construction involves initial costs, patience and responsibility in its maintenance. One first has to acquire the materials for a biodigester, build it, be diligent in feeding it organic materials, and still it will take around 4 weeks before it will start producing gas. Like us humans, the biodigester is a living system which will work differently depending on the number and type of microorganisms in the system, the type and frequency of the organic material being fed. Some experimentation will be needed to fully optimise the system. The following section will outline the experiences of Anthakarana with their Biodigester.

10. Case study: The Srenak biodigester in Anthakarana

This case study discusses the challenges faced during the operation of the biodigester, as well as means to optimise gas production and burning. It is told by Osiris who is charge of the Srenak Biodigester constructed in Anthakarana.

The idea of generating cooking gas from leftover organic waste from our food is definitely something appealing, yet the process of adapting theory to practice needs careful consideration and creativity.

The following are variables we have had to consider in the management of the bio-digester model we have in the ecovillage: temperature; quality of organic waste; frequency of feeding the bio-digester; taking care not to enter stages of low productivity; mosquitoes; taking advantage of leftover effluent; the model of stove and burners for optimum use of gas in the kitchen; and relative time of combustion compared to gas generating capacity.

Temperature: A warm environment is conducive to the reproduction and life of the bacteria in the reactor. Thus, if the bio-digester is exposed to sun most of the day, the bacteria are more active and more gas is produced. Reversely, if you are going through periods of cold, or have the reactor in an area that receives many hours of shade during the day, then less gas is produced.

Quality of organic waste: The best organic material to produce the "tea" that will feed our reactor needs to have a high content of material to decompose, i.e. more food for our bacteria, which leads to more gas, so it is of vital importance not offer ingredients that are too dry, or perhaps pre-digested by other bacteria. This ensures optimum production of gas by the reactor.

Periodically 'feeding' the bio-digester: Like our body, the system needs regular and high-quality food to maintain a good population of bacteria inside the reactor. If the system does not receive this, there may be a disequilibrium in the proportion of gas and carbon dioxide, i.e. there will not be a good quality gas to burn on the stove in the kitchen. Always remember, if you do not feed the bacteria, they will simply die and the entire system will have to be reactivated.

Avoiding periods of low productivity: It is important to take into consideration the quality of the organic waste being fed into the system, as well as how regularly it is fed so as to regulate the relationship between what we can produce in gas per day and the consumption we use. If we consume too much gas then the gas level can be too low, risking the entry of water into the gas hoses. This would then require flushing the

system to remove the water, resulting in a loss of accumulated gas, and the need to wait until the system begins producing gas again.

Mosquitos: The water that is around the gasholders is stationary, so mosquitoes, animals or bugs can use it to lay their eggs. We must be careful to regulate the pH of the water so as to avoid creating a breeding ground for mosquitoes. I recommend the use of lime and/or hypochlorite to avoid these problems. It is important to note that lime results in sedimentation, so there will eventually be some maintenance.

Harnessing the effluent: Our star by-product, the effluent can and should be used to fertilize the plants in our garden. It is an excellent fertilizer and does not harm the plants as it comes in concentrations low enough not to burn or over-nourish our crops. The main recommendation is, for health reasons, not to apply on the edible leaves of plants, because the remaining bacterias from the process in the reactor can remain on the plants for indeterminate periods of time and is not recommended to ingest these in any way. My recommendation is to maximize the use of this fertilizer, applying it directly and abundantly on the earth for the recovery of the dynamic layer of nutrients and micro-organisms in the soil.

The models of the stove and burners: The gas mixture and pressure of the system is different to that found in normal pipes and gas cylinders, so an industrial stove may not serve this system, and minor modifications may be needed for traditional burner stoves i.e. you may have to use a little ingenuity and creativity according to the needs and possibilities of each type of stove.

Finally, I would like to add that having a bio-digester is like having a new toy, in which manuals provide an overview of the operation, but each operator must be aware of the different provisions and possibilities according to the environment and use of each system. In this way you can optimize the system exponentially, and likewise, our quality of life as we generate independence in fuel consumption for cooking, and use the by-products natural fertilizer for our crops and plants. These are extra benefits for the farmer.

Good luck!
Osiris

Contact Information

For general, technical enquiries and questions about courses outside of Colombia please write to:

Foundation Katalysator
www.stichtingkatalysator.nl
info@stichtingkatalysator.nl



For enquiries into the construction of biodigesters in Colombia and upcoming courses please write to:

Mentes en transición
(Transitional Minds)
www.transitionalminds.org



For specific enquiries into the biodigester in Anthakarana and questions about materials please write to:

Ecovillage Anthakarana
ecoaldeaanthakarana.blogspot.com/

Material Costs: Annex 1

	COMPONENTE (ES)	COMPONENT (IN)	CANTIDAD	PRECIO/UNIDAD	PRECIO	SUBTOTAL
LIVSIDIADO/ AFFLUENTE	caneca 140l	drum 140 liter	4	35000	140000	
	malla zaranda	netting big	2	12500	25000	
	Incertos PVC 1"	Adapter pipe to hose 1"	4	2000	8000	
	Flanche pvc 1"	Tank connector 1"	4	5000	20000	
	Adaptadores Machos 1"	Male adapters 1"	4	1000	4000	
	Llave pvc 1"	Tap pvc 1"	4	7000	28000	225000
REACTOR	tanque 1000l	container 1000l	1	200000	200000	
	flanche de brida 4"	Tank connector 4"	2	20000	20000	
	Tee 4"sanitario	T piece 4"	2	18500	37000	
	Codo 4"pvc	PVC elbow 4"	2	5500	11000	
	Tubo 4"pvc	PVC pipe 4"	4	17500	70000	
	adaptor 4 limpie	Endpiece with screw 4"	2	11900	23800	
	Llave pvc 1"	Tap pvc 1"	1	7000	7000	
	Flanche pvc 1"	Tank connector 1"	1	5000	5000	
	Adaptadores Machos 1"	Male adapters 1"	1	1000	1000	
	Incertos PVC 1"	Adaptor pipe to hose 1"	1	2000	2000	
	Incertos PVC 1"	Adaptor pipe to hose 1"	7	2000	14000	
	Adaptadores Machos 1"	Male adapters 1"	2	1000	2000	
	bomba succion manu	Handpump	1	33900	33900	
	manguera cristal 1"	Tranparrant hose 1"	10	4500	45000	
	manguera cristal 1 1/2"	Tranparrant hose 1 1/2"	3,5	4850	16975	
	Tee 1"	T piece 1"	1	12000	12000	
	Flanche 1/2"	Connector 1/2"	1	4000	4000	
	Codo pvc 1"	PVC Elbow 1"	1	1500	1500	
	Buje de 1"a 1/2"	Adapter 1"to 1/2"	1	1500	1500	
	Adaptador macho 1/2"	Male gas adapter 1/2"	1	4500	4500	
	Tubo 1"pvc	PVC Pipe 1"	2	1500	3000	515175
CONTENEDOR DE GAS	caneca 220l	drum 220 liter	3	50000	150000	
	tanque 1000l	container 1000l	1	200000	200000	
	manguera gas 1/2"	Gas hose 1/2"	20	2000	40000	
	Tee 1/2"metalica	Metal T piece 1/2"	1	5000	5000	
	Adaptador macho 1/2"	Male gas adapter 1/2"	3	4500	13500	
	Llave metalica 1/2"	Tap metal 1/2"	2	10000	20000	428500
MISC	Teflon industrial	Gas tape	1	5000	5000	
	candellas	bolts+nuts			21823	
	Silicona	Silicon kit	1	14000	14000	
	Pistola silicona	Silicon pistol	1	8000	8000	
	Abrazadera 32mm	clamp 32mm	20	1500	30000	
	Pegante pvc 240 cm3	PVC Glue 240cm3	2	20000	40000	
	Abrazaderas 1/2"	Clamp 1/2"	10	700	7000	125823
TOTAL					In COP	1294498
					In Euro	470