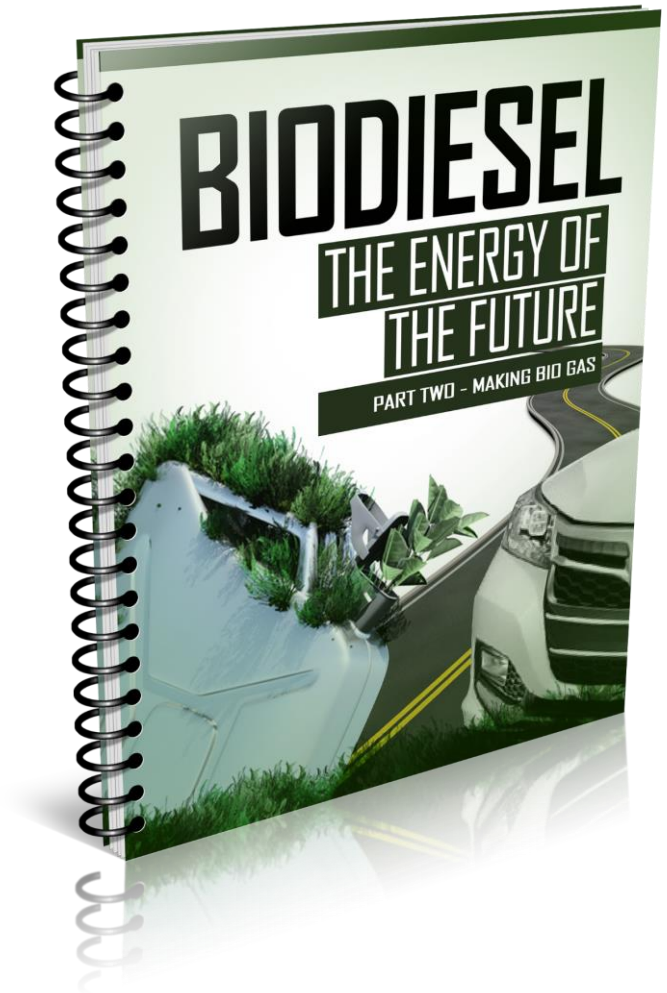
BIODIESEL THE ENERGY OF THE FUTURE – MAKING BIO GAS



Why BIOGAS?

Biogas is a fuel generated from common and renewable biological sources, including from garbage and biological wastes. It is highly advantageous as biogas can power equipment designed to run on non-renewable natural gas.

Why Produce Biogas?

Shifting away from petroleum-based energy sources has one crucial and often overlooked issue: an abrupt shift from petroleum fuels to another medium of propulsion will make every existing power plant, generator, car, truck, ship, and airplane obsolete.

The cost of replacing all of this hardware with models designed to run based on another technology is too great for even the wealthiest nations to bear. Another benefit of exploiting biogas is that it keeps human-produced methane, a far more powerful greenhouse gas than CO2, from entering the atmosphere.

When methane is burned, the emissions are relatively harmless compared to the effects of free-floating methane in the atmosphere. Methane is the primary component of natural gas, which is widely used to heat homes, generate electricity, and even run vehicles.

Biogas is therefore a renewable energy source which can be used by all the technology that currently runs off on non-renewable geological natural gas. Biogas solutions allow common agricultural waste products to be processed into fuel that can run a power plant,

a cooking stove, and even a modified gasoline or diesel engine.

When one considers that some power plants and generators have the potential to be used for over a century, a biogas supply ensures that this equipment will continue to operate even if the original fuels are no longer economically viable.

The Science and Infrastructure Behind it

While biogas emissions are plentiful, harvesting it poses a bit of a challenge. For example, the methane produced by cows could power whole countries, yet it escapes into the atmosphere as there is no viable way to harvest it from cows out in the fields.

Since it isn't possible to take the biogas plant to the cows, we need to take what the cows produce that generates the methane, their dung, to the bio-gas generator. Since the cost of transporting the feedstock over distances can add up, most existing biogas plants are built in remote agricultural areas near large herds of cattle.

This is a good thing so far as it keeps the unavoidable noxious odor of the process away from the population, but it does pose the challenge of getting the biogas to consumers. At the biogas plant, the dung is concentrated, and mixed with water and other materials that decompose in a similar way, creating a slurry. The slurry is then left to ferment in a digestion chamber. The gas can then be easily collected through a pipe at the top of the domed digestion chamber.

Biogas plants require very little energy to produce the unrefined biogas. It is therefore a very cheap fuel to produce. Technology is only part of the equation of getting biogas production up and running; the greatest idea in the world will never get off the ground

without a little seed money. Fortunately for alternative energy producers, many countries have generous subsidies in place for entrepreneurs interested in cashing in on alternative energy.

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What is Bio-gas Generator or Biogas Plant

The bio-gas generator or biogas plant is the small where bio-gas is produced from the biomass waster materials like cow dung. The figure below shows a typical bio-gas generator or biogas plant which uses cow dung for production of biogas. Cow dung is produced in huge quantities especially in the countries that are major producers of milk like India, Australia, US, China and others.

The cow waste which would have created the environmental pollution can be effectively used for producing biogas, which is an excellent sources of renewable energy. This biogas can be used for cooking and heating.

The bio-gas generator or the biogas plant shown in the figure uses process of digestion for production of biogas. Digestion is the biological process that occurs in the absence of oxygen, but in the presence of anaerobic organisms at atmospheric pressure and temperature of about 35-70 degree Celsius. The main part of this biogas plant is the digester where digestion process occurs.

Parts of Bio-gas Generator or Biogas Plant

Let us see the various parts of this biogas plant or bio-gas generator:

1) **Foundation**: The biogas plant shown here has been built within the surface of the earth underground and it is on the foundation that the whole biogas plant is based. The foundation forms the base of the digester where the most important processes of biogas plant occur. The foundation base of the digester is made up of cement concrete and brick ballast.

   The construction should be built in such a manner that it should be able to provide stable foundation for the digester walls and be able to sustain the full load of slurry filled in it. The foundation should be waterproof so that there is no percolation and leakage of water.

2) **Digester**: The digester is the most important part of the cow dung biogas plant where all the important chemical processes or fermentation of cow dung and production of bio-gas takes place. The digester is sometimes also called as fermentation tank. In this cow dung biogas plant digester is built underground over the foundation.

   It forms cylindrical shape made up of bricks, sand and cement. Almost at the middle of the height of digester, two openings are provided on the opposite sides for inflow of fresh cow dung and outflow of used cow dung.

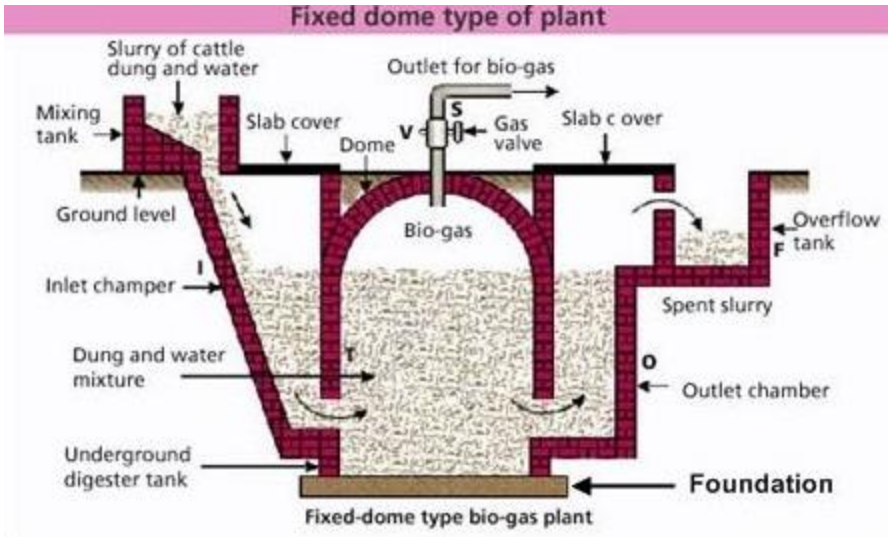
3) **Dome**: The hemispherical top portion of the digester is called as dome. Dome has fixed height, where all the gas generated within the digester is collected. The gas collected in the dome exerts pressure on the slurry in the digester.

4) **Inlet chamber**: The cow dung is supplied to the digester of the biogas plant via inlet chamber, which is made at the ground level so that the cow dung can be poured easily. It has bell mouth sort of shape and is made up of bricks, cement and sand. The outlet wall of the inlet chamber is made inclined so that the cow dung easily flows to the digester.

5) **Outlet Chamber**: Through the outlet chamber the digested slurry from which the biogas has been generated is removed from the biogas plant. A few steps are usually provided in the outlet chamber so that some person can go into the pit and clean it. The opening of the outlet chamber is also at the ground level. The slurry from the outlet chamber flows to the pit made especially for this purpose.

6) **Mixer**: It is the first part of the bio-gas generator, where the water and cow dung are mixed together in the ratio of 1:1 to form the slurry which is fed into the inlet chamber.

7) **Gas outlet pipe and valve**: The gas outlet pipe is located at the top of the dome where the biogas produced in the digester is collected. The flow of the gas through from the dome via gas pipe can be controlled by valve. The gas taken from the pipe can be transferred to the point of use.



Chemical Reactions in Bio-gas Generator

When there is no air is present in the biogas plants, two type of bacteria act on the slurry: acid forming bacteria and gasifying bacteria. Let us see how both these bacteria act:

Chemical Processes in Biogas Plant

In the bio-gas generator cattle dung like cow dung, poultry or piggery dropping, and night soil are used for the generation of the gas. The cattle feed is mixed with water to form the slurry, which is sent to the biogas plant. Here the process of fermentation occurs on the slurry due to which the combustible gas is produced that can be used for various cooking and heating applications.

The byproduct of these chemical reactions is the manure, which is far better in quality compared to the green manure produced from the dung by other processes. Thus the cattle dung used in the bio-gas plants is used completely without leaving any wastes, thus helping in a great way keeping the environment clean. To produce

the biogas on continuous basis the mixture slurry has to be fed continuously.

Chemical Reactions occurring on Slurry in Bio-gas Generator

The slurry is the mixture of the cattle dung and the water, which are mixed in the mixture in the ratio of 1:1. When there is no air is present in the biogas plants, two type of bacteria act on the slurry: acid forming bacteria and gasifying bacteria. Let us see how both these bacteria act:

1) Acid forming bacteria: The acid forming bacteria are formed due to the liquefaction of the cattle feed. When cattle feed is mixed with water, its liquefaction occurs. The acid forming bacteria are a set of saprophytic bacteria that are produced by the process of extracellular bacteria enzyme. These bacteria can exist, develop and multiply in wide range of conditions. The acid forming bacteria convert carbohydrates, proteins, and fats into too the volatile acids and release carbon dioxide.

2) Gasifying bacteria: After the liquefaction process, the next process is that of gasification, which is carried out by the gasifying or methane bacteria. These bacteria act on the acids produced in the previous phase with the help of intracellular bacteria enzyme and convert them into methane and carbon dioxide. This gas can be removed from the dome of the biogas plant and it can be used for various purposes. The flow of the gas can be controlled by the valve.

Factors Affecting the Generation of Gas in Biogas Plant

The amount of the gas and the quality of the biogas produced from the biogas plant depends on a number of factors. These are:

temperature of the substrate, rate of loading of the slurry, concentration of the cattle dung, detention period, pH value of the slurry, nutrients concentration, amount of toxic substance present etc.

The amount of the methane gas produced in the biogas plant depends on the fermentation material used in it. If cattle feed is used in the slurry, the methane gas produced is about 55 to 60% along with 40-45% of carbon dioxide and some quantity of hydrogen sulfide. If night soil is used, the percentage of methane gas can be about 65%.

To understand the working of bio-gas generator or working of biogas plant, please refer the figure below. It shows the biogas plant produced bio-gas using the cow dung and water mixture.

Working of Bio-gas Generator or Biogas Plant

To understand the working of bio-gas generator or biogas plant, please refer the figure above. Here are the various steps of working of bio-gas generator or biogas plant.

1) In the mixing tank the water and cattle dung are mixed together thoroughly in the ratio of 1:1 to form the slurry. This slurry is then transferred to the digester via inlet chamber up to the cylindrical portion level of the digester.

2) The fermentation of slurry starts in the digester and biogas is formed, which is accumulated at the top of the digester in the dome. Since the outlet gas valve is closed, the bio-gas exerts pressure on the slurry which starts moving in the inlet and outlet chamber due

to which the level of slurry drops in digester and increases in the outlet chamber.

3) If the biogas outlet valve is further kept closed, the level of slurry further drops in the digester. Due to gas pressure the slurry reaches to highest possible level in the inlet and outlet chambers.

4) If the gas valve is still kept closed the bio-gas will further get accumulated in the dome and its pressure increases. Eventually, its pressure becomes high enough and it starts escaping through the inlet and outlet chambers to the atmosphere. During its escape the biogas creates bubbles in the slurry in inlet and outlet chambers and there is also formation of froth.

5) The increase in the volume of slurry in the inlet and outlet chambers helps you calculate the amount of biogas generated within the digester.

6) If you want to use the biogas, you can open the valve of the gas pipe and remove it as per the requirement for various applications. When the gas is taken out from the dome, the level of slurry in the digester increases while the level in inlet and outlet valves reduces.

7) When the gas is not being used from the dome of the digester, the levels of slurry in the inlet and outlet chambers will be high and the intake of the fresh slurry in the digester is reduced. When the gas is being taken out from the dome, the slurry from the outlet chamber is removed and equivalent amount of fresh slurry is inducted into the digester to continue the process of fermentation and the formation of the biogas. Thus more is the biogas required more continuous will be the fresh slurry of cow dung and water required.

The size of the digester tank also decides the amount of the gas that can be generated by the biogas plant.

An easier project

If the above project seems too complicated for you, we have a more simple one that you can try using a discarded 18 litre water container as the "digester." A mixture of water and animal manure will generate the methane, which you will collect in a plastic balloon. The 18 litre water container performs the same task as the stomach of a livestock animal by providing the warm, wet conditions favored by the bacteria that make the methane.

What you need

Materials

Used 18L clear plastic water bottle
- Large Mylar helium balloon
- Plastic water bottle cap (with the "no-spill" insert-see photo)
- Copper tubing (40 cm long, 6.5mm (1/4") inside diameter)
- T-connector for plastic tubing (barbed, 6mm or ¼" long)
- 1 cork (tapered, 23mm long)
- Clear vinyl tubing (1.5 m long, 4mm or ¼-inch inside diameter)
- 2 barb fittings (¼" x ¼")
- Ball valve (1/4")
- 6-8L manure pellets (goat, sheep, llama, rabbit, or other ruminant)
- Rubber gloves
- Large plastic funnel (can be made from a 4L plastic milk jug with bottom removed)
- Wooden dowelling or stick (30 to 50 cm long, 2-3 cm thick)

Tools

- Tubing cutter
- Scissors
- Adjustable wrench
- Rubber gloves
- Electric drill with ¼" bit, or cork borer
- Hot glue gun, with glue sticks
- Electrical or duct tape
- Sandpaper (metal file will also work)

The process

Prepare the biogas collection system

1. Cut a 20cm piece of copper tubing. Round off the sharp edges of the freshly cut tubing using sandpaper or a metal file.

2. The Mylar balloon has a sleeve-like valve that prevents helium from escaping once it is filled. This sleeve will help form a leak-proof seal around the rigid tubing. Push the tubing into the neck of the balloon, past the end of the sleeve, leaving about 2cm protruding from the neck of the balloon, as shown below.

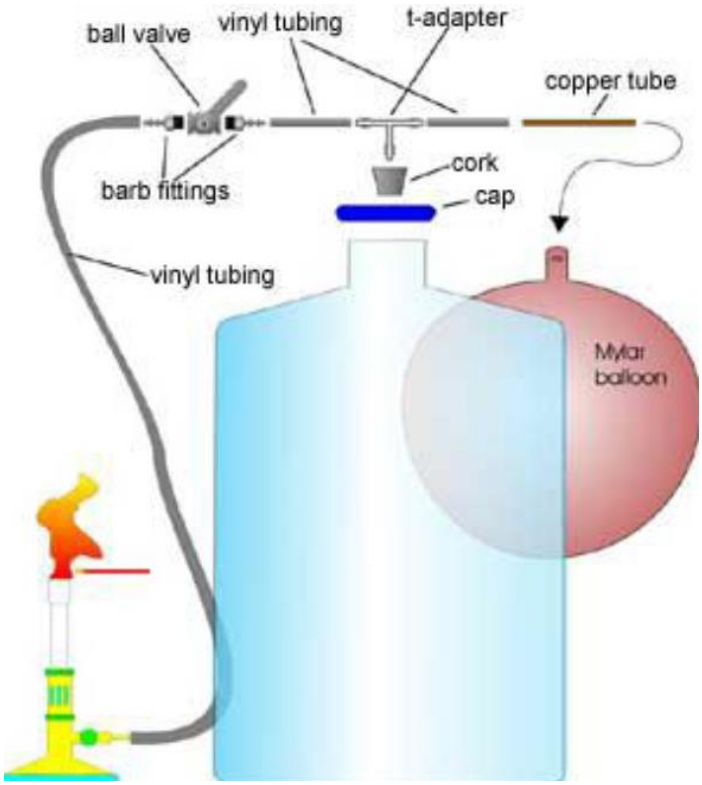
3. Test the tube to be sure air can enter and leave the balloon freely, by blowing a little in through the tube. The balloon should inflate with little or no resistance, and the air should be able to escape easily through the tube.

4. Securely tape the neck of the balloon to the tube as shown in the illustration.

5. Using a drill or cork borer, make a small (4mm) hole in the center of the stopper. Add a few drops of hot glue around and inside the hole and insert the stem of the ¼-inch Tadapter into the cork.

6. Screw the two barb fittings into the body of the ball valve. Tighten with the adjustable wrench.

7. Cut two sections of vinyl tubing, each 25cm long. Use them to connect the balloon to the T adapter, and to connect the ball valve to the Bunsen burner. Assemble the rest of the gas collection system according to the diagram below.



Prepare the manure mixture

This is a job best done outside, with rubber gloves!

1. Cut the bottom off a 4L plastic milk jug to make a wide-mouthed funnel.

2. Place the funnel into the neck of the plastic water bottle and scoop in small amounts of manure.

3. Use a stick or piece of dowelling to push the manure through the neck of the bottle if it gets plugged.

4. Add enough water to bring the level close to the top of the water bottle.

5. Use the stick to stir up the manure and water mixture, releasing any bubbles of air that might be trapped.

6. Clean up carefully. Use soap and wash hands thoroughly.

Final Set-up

1. Snap the cap onto the top of the manure-filled 18 liter water bottle.

2. Be sure the ball valve is closed, but that gas moving from the water bottle can pass freely through the T-adapter to the balloon.

3. Set the biogas generator in a warm location, such as over a heat register or radiator or in a sunlit window. If the biogas generator is placed in a window, be sure to wrap the outside of the container in

black plastic or construction paper, to discourage algae from growing inside the bottle.

For the first few weeks, your biogas generator will produce mainly carbon dioxide. When the aerobic bacteria use up all the oxygen inside the bottle, the anaerobic bacteria, which make methane, can take over. It can take up to a month for the generator to start making biogas with enough methane to be flammable.
When gas begins to accumulate in the balloon, test it by attempting to light the Bunsen burner:

1. First, open the clamp or valve so that biogas can flow back from the balloon to the Bunsen burner.

2. Have a friend squeeze the Mylar balloon gently while you attempt to light the Bunsen burner with a match or spark igniter.

3. If your Bunsen burner ignites, your biogas generator is a success!