Biofuels -- The Series

This article is the first installment in an ongoing series that will explore methane, ethanol, biodiesel and waste vegetable oil (WVO). We'll start at the beginning with each one and continue as we build a base of knowledge on the subject. Each article will be accompanied by photos and/or diagrams, so that you'll be able build your system to produce biofuel at your place. We begin the series with methane (CH4). Al Rutan is our Contributing Editor on the subject and is regarded as one of the masters of the craft. There's a short bio of Al elsewhere in this issue. It's good reading so try not to miss it. ldb

Utilizing Natural Design Parameters for Methane Digesters

by Al Rutan

The process of anaerobic fermentation is not "fussy." The reason this can be said is because we know that it occurs in lake bottoms and bogs, swamps and landfills. Obviously, what goes into a landfill is put there without any "rhyme or reason." The biogas formation that results does so from organic material that was simply dumped and then covered with dirt to exclude air.

However, it takes from 50 to 100 years for a landfill to be generating a significant amount of biogas. And this is accomplished without any stirring or heating. But if we want the most biogas possible in the shortest length of time, we need to heed the parameters for the optimum conditions of the process.

We like to think of ourselves as "engineers." This is not the best mindset to have when working with living creatures. Rather, we should better think of ourselves first and foremost as "biologists." An engineer tends to impose on living creatures what he thinks they should have. A biologist is more inclined to be sensitive to what a living organism wants and needs.

Over the last century sewage engineers in many places throughout the world have had time and money at their disposal to study and document anaerobic activity at close range in their labs. We know from this research that optimum warmth is a major factor in rapid gas formation and that gentle mixing also is important. Both these actions mimic what happens in the gut of warm-blooded animals, including ourselves.

Another feature of the process that isn't so readily recognized is the fact that in the gut of an animal the anus is at the end of a long tube. We call it the intestine. While the stomach of an animal is similar to a "pot" the major part of digestion occurs in the intestine and not the stomach. The stomach is a preparation place for what occurs in the gut. So if we adhere to a "natural pattern," the digester is going to be a tube rather than a "bulk container." This makes possible the process of digestion at different points along a route. We are simulating what occurs in a gut.

A gut excludes air, has a gentle, involuntary mixing action we call "peristalsis," and provides constant, even warmth throughout at just the right temperature in a living animal. Given these guidelines, we can look at what a well-designed biogas system should display. We want to accomplish (1) exclusion of air, (2) constant, optimum warmth, and (3) gentle mixing with a minimum of "machinery" and controls.

It is very easy to start designating all kinds of "bells and whistles" to a project. The genius of the best design is to have as little dependence on "machinery" such as pumps and motors with controls as possible. These are the things that shoot up the cost of a system and the bacteria are not impressed..

Monitoring is important. But there are various levels of complexity when it comes to monitoring. We require only the simplest instruments possible. A good design is going to use the natural forces of gravity and and thermosiphon whenever possible to reach the necessary guidelines. This is what we call common sense.

Continued on Next Page

Natural Methane Digester Design . . . cont.

The big challenge for any project is the manner in which warmth is supplied to the digester. Because heat rises the only way to move heat downward if the source of heat is above the digester is with a circulating pump. If this is the case, the circulating pump must run constantly. Any pump running constantly is obviously a huge energy drain.

In the best of all worlds, the design that requires the least expenditure of energy is going to supply warmth to the entire bottom surface of the digester tank. This is done not with pipes or lines of any type but with a "warmth chamber" that covers the entire bottom surface of the digester.

So the heat source, no matter what it is, must be below the bottom surface of the digester, similar to the manner in which the double boiler on a kitchen stove provides even warmth to the unit on top.

For moving warmth around, we need to employ the simple physical action of thermosiphon - the circulation of warmth either in air or liquid by the displacement of what is cooler by what is warmer. Thus warmth can be "moved" if we harness a completely natural process. Again this is really cheap. No pump required.

And for moving the methane gas from one place to another, there is nothing less expensive and more positive in its action than a gasholder that uses the force of gravity to exert pressure on the gas. A flexible fabric can exert pressure, but not evenly between maximum expansion and half-fill. With a flexible fabric for containing gas the pressure is not a constant force. But in a solid vessel with a provision for expansion serving as a gasholder the pressure is constant and consistent because the force of gravity is evenly applied no matter how full or near empty the gasholder is. And again, the force of gravity is really cheap.

If gravity is not employed to move the gas, then a fuel pump must be. This is another piece of equipment that is not necessary in a project of better design.

One last observation about capturing heat from machinery. A common way of picking up heat from a generator is from the exhaust by means of a heat exchanger.

My criticism of this approach is not that it doesn't work but that only a fraction of the heat so generated is "captured." If one puts one's hand on the exhaust pipe after the heat exchanger, the pipe is still exceedingly hot. When heat is being dumped it is not being captured.

The Co-Ray-Vac people have demonstrated with their product (an infra-red heater) that one has not "squeezed" all the heat from an exhaust pipe until one can comfortably lay one's hand on the end of the exhaust pipe. Then we are sure that virtually all the available heat has been transferred to a heat exchanger. Anything short of this means that valuable and expensive heat is being lost to the atmosphere. This is sheer waste and poor design.

What are the best sources of warmth for keeping a digester at optimum warmth? Obviously, one can burn some of the gas produced once the digester is up and running. But this is not the first choice for supplying warmth. Most likely we want all the biogas produced to more directly provide for our needs. Warmth from the sun is the most obvious choice for acquiring digester warmth. And we can think of no better source for harnessing solar warmth than heat tubes. We recommend the equipment available from Back To The Future Solar:

http://www.btfsolar.com

The details for various sized biogas systems can be found on the Methane Gas website:

http://www.methane-gas.com

Click on the tab that says "How To Order" for the specifics found with the Plans for various sized digester systems.

Contact Al Rutan at:

RUTAN RESEARCH
P O Box 50, Liberty Center IA 50145-0050
Phone 612 805 9377
Website: http://www.methane-gas.com

Check out the pictures ofAl and some of the gear described in the article on the next page . . .

Al Rutan with the digester and warmth chamber

Pictured here are views of a methane gas digester system small enough to sit on a sturdy table, yet large enough to produce enough methane gas to fire a Bunsen burner. The reason this digester has been assembled is to visually demonstrate the fact that a digester does not have to be large or expensive in order to be practical.

A digester does not have to be large in order to work well. Gas produced from living creatures occurs in all kinds of situations. All warm blooded animals produce gas in the gut—some more than others. The thing that is essential to understand when harnessing the process for our own energy needs is that both the chemistry and the biology requirements of the organisms that work anaerobically need to be kept in mind. Even a small digester can demonstrate these parameters.

In the picture we see a tank before it is covered with insulation. Beneath the tank is a foil lined enclosure that works as a warmth chamber, providing even warmth for the entire tank.

There is a mixing mechanism in the tank which is turned from time to time by the crank handle at one end of the tank. This mixing mechanism is important. The bacteria that digest the organic material do not have fins as fish do making it possible to swim after food. With bacteria either food must be taken to them or they must be taken to the food. A gentle mixing action supplies this needed motion.

This digester is a displacement flow design. The fill pipe is at one end. The exit pipe is at the other. The organic material that does not become burnable gas leaves the digester via the exit pipe. Gas production is continuous.

Welder Ross Wood holds the mixing mechanism

Ross with the gasholder