# Methane Digester

**Introduction**

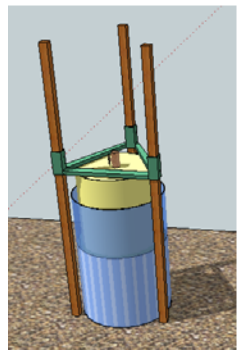
Methane production is used worldwide to create a burnable fuel in communities where animal waste and vegetation is widely available. At D Acres we are constantly striving to become self-sufficient by using all resources produced by the land and its inhabitants.

Methane digestion is a form of anaerobic digestion, which means bacteria breaks down organic materials in an oxygen-absent environment. Through multiple processes methane and carbon dioxide are produced. In the initial phases of designing a small-scale methane production system experimenting will be required to figure out an appropriate digester setup.

Below is our first prototype for a methane digester. Although in theory it seems it would fulfill the requirements to produce methane, it was unable to produce efficiently due to slurry binding, low pressure, and temperature of the slurry.

**Design**

The first design uses two barrels—a 30-gallon and a 55-gallon. The barrels are high-density polyethylene (HDPE). This a non-corrosive material that is not susceptible to the acids produced in the methane formation process unlike steel drums, which rust and degrade.



**3D sketch**

The original 3D rendering was completed in Google SketchUp, a free download available online. See end of document for detailed image.

**Exit valve**

The top of the 30 and 55-gallon barrel is removed. Some barrels have a fixed lid and will require cutting to remove. A power drill is used to make a hole for the gas valve installed in the top of the 30-gallon barrel. A female adapter is used on the inside of the 30 gallon barrel to fix the male adapter into place followed by an elbow pipe, PVC ball valve, and a barbed fitting. Polyethylene piping is used as the gas line. The material is very low cost and is commonly used for irrigation. Silicone is used to seal any leaks.

The total cost of the system is priced at $246 if everything is bought new. The majority of the cost is for the HDPE barrels. The current unit was built with supplies found onsite leaving D Acres with no supply cost. Install time is approximately 4 hours. This includes gathering manure for the slurry—a mixture of manure, grass, and water stirred in the 55-gallon barrel. Three parts water to one part pig manure are used in the images shown. These ratios were recommended by the sources cited at the end of the document.

**Slurry**

The 30-gallon barrel is placed in the slurry and as much air is removed from inside the barrel as possible. Three posts act as a track for the 30-gallon barrel to follow as gas is produced and prevent tipping. Rocks are also placed on top of the 30-gallon barrel to keep the system pressurized and balanced.

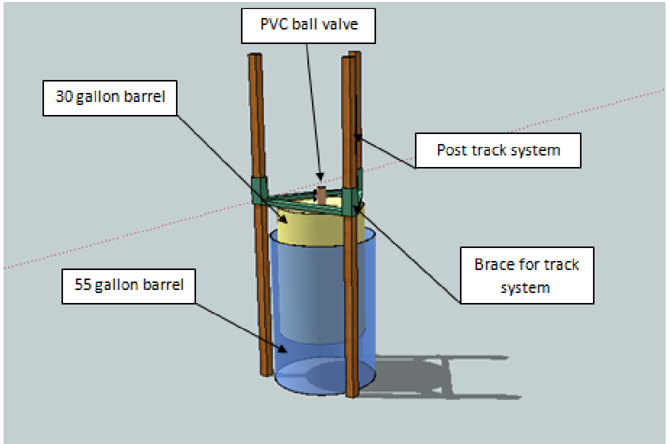
**Digester**

The slurry performs best at a temperature of 85°F to 95°F. Due to seasonal changes in New Hampshire the digester is painted black and compost is piled underneath and around it to increase the internal temperature. The temperature is the most challenging factor for producing methane. With cold nights and rainy days the slurry has difficulty remaining at high enough temperatures to have substantial production.

**Note**
After two weeks gas production should be noticeable. Do not attempt to ignite the first batch of gas because it will be mixed with oxygen from the initial set-up and will be highly explosive. Release this first batch through the gas valve.

**Application**
The unit will be used for demonstration purposes and will be fed through the stove shown in the image to the right. Each batch of slurry should reach peak production after eight weeks and will need to be replaced after twelve weeks.

**Stove**




**Design analysis and conclusion**
After two months the digester has not yet been successful in lighting. Errors include the slurry binding, low pressure, and temperature of the slurry. At the beginning of the design it was not expected that the manure would rebind after it had been turned into slurry. The manure turned into a single mass that floated to the surface of the water. The manure enclosed the bottom of the 30-gallon barrel and pushed it upwards giving the appearance that it had been filled with gas. It is uncertain how much gas was present. When the air was released from the 30-gallon barrel

through a Bunsen burner it had no reaction with fire. It is presumed that if the slurry could have been regularly mixed the methane production would have been much more successful.

A high pressure could not be obtained due to the seal of the outlet pipe being compromised when too much weight was placed on top of the 30-gallon barrel [to pressurize the system]. Without high pressure the original stove could not be used and a Bunsen burner was substituted. The original stove worked if a propane tank was used, but no airflow was present when the digester was engaged. The Bunsen burner had airflow, but the gas would not light. This could be due to a lack of concentration of methane.

The methane digester had originally been set up at the end of August. A very limited time was available to experiment with the process before the temperatures dropped too low. Keeping a constant 95°F can be difficult, even with a large pile of compost surrounding the digester. Now that winter is beginning to set in, the nights reach freezing temperatures and cool the system below productive levels. During the day it is mostly cloudy with temperatures around 40°F. Any more attempts will have to be done in spring.

**Alternative Design**

To account for the slurry separating into its two parts, water and manure, a 4:1 ratio of water to manure will have to be used. If the digester is in batches it will be very difficult to mix the slurry after the system has been closed.

To create a higher pressure system the digester will need to have a closed lid. The danger of this is that if the pressure builds up too much the gas will find the weakest point of the barrel and escape through that. That means a leak would occur near the outlet pipe or the lid would be blown off. To create a pressure release, a flexible pipe could be attached to a hole in the top of the barrel with a weight on it to keep it closed. Whenever the pressure becomes greater than the weight, it will “burp” and release a small amount of gas through the pipe.

Because the new system would be closed it could be entirely buried in compost, with only the outlet and release pipe visible. In the warmer months this would be enough to keep the system at an operating temperature of 85°F or greater.

**Materials Needed**

An HDPE container would still be most desirable due to its noncorrosive traits. A removable lid will be necessary. This type of container will cost at least $100 plus shipping and is referred to as a 55-gallon open head plastic drum. For the two shutoff valves located at the barrel and at the burner, a PVC ball valve will be appropriate with polyethylene piping. Demonstration purposes and the small-scale production system will only require a Bunsen burner for lighting the methane gas.

*For more information on anaerobic digestion and methane digesters visit any of the following links:*

http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/FRG/Recycle/biodig/manual.htm

http://www.appropedia.org/Home_biogas_system

http://www.small-farm-permaculture-and-sustainable-living.com/methane_generator.html http://en.wikipedia.org/wiki/Anaerobic_digestion