Sustainable Technologies

Biomass Conversion

From Manure to Methane: How a Digester Works

Presented by

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at

solfest

FROM BIOMASS TO BIOGAS TO ENERGY

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Methane Digester BENEFITS

1. Energy Production
2. Odor Reduction
3. Greenhouse Gas Reduction
4. Sterile effluent
5. Liquefied nutrients
6. Compost sale
7. Profit center

Methane Digestion Process

Anaerobic digestion process is the decomposition of organic matter in the absence of oxygen. The byproducts of this decomposition are biogas, which is about 60% methane and 40% CO_2, and effluent, which consists of undigestable matter that makes good fertilizer.

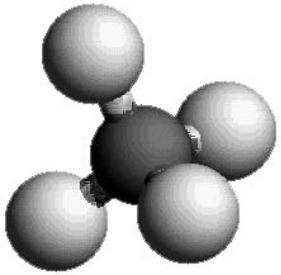
The anaerobic digestion process is divided into 3 separate steps, each of which is performed by a different group of microorganisms:

1-**Hydrolysis**: Breaking down of complex organic molecules
2-**Volatile acid formation/Acidogenesis**: The conversion of the organic molecules into acetic acid, CO_2, and hydrogen
3-**Methane formation**: The conversion of organic acids to methane and CO_2.

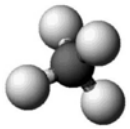
Conditions Necessary for Digestion:

- A creamy slurry
  - No oxygen in the sealed digester
    - Ph of 7.5 to 8
      - Temperature of 95°F

Optimal Conditions for Digestion



CH_4



Temperature

Pretreating at 100° F (optimal mesophilic conditions) yields about 4 times more CH_4 and methane digestion at 130° F (optimal thermophilic conditions) results in a 25% reduction in turnover time.

Water Quality

Low SO_4 content in water. Water high in SO_4 causes H_2S formation during fermentation, requiring more scrubbing.

Feedstock

More lipid/protein in feedstock produce more CH_4.

Atmosphere

A ratio of 4:1 H_2 to CO_2 maximizes CH_4 output. 2 psi pressure drives digested effluent removal, favors methanobacteria growth, and helps condensation of H_2O out of biogas when cooling is applied.

Slurry Composition

A 30:1 carbon to nitrogen (C/N) ratio is optimal for producing new cells and methane. Different kinds of manure or green waste can be added to “fine tune” the slurry composition for maximum efficiency.

Types of Digesters

Batch Digesters

After feedstock manure is added, the tank is sealed and the manure gets digested until no more biogas can be effectively extracted. Then, the manure, gas, and byproducts are evacuated and new feedstock is added in for the process to begin again.

Continuous Feed

Feedstock manure is constantly or regularly added to the digester and byproducts are constantly removed. Thus, they are advantageous because they produce gas in a steady, predictable flow. These are usually multi-stage digesters, since the physical separation of the digestion processes naturally facilitates continuous feed.

Plug and Flow

The manure being added is used to push out the effluent through displacement. This is different than other continuous feed digesters, which use mechanical systems to pump out effluent.

Batch vs. Continuous

Batch Digester

Pros

- Simple & cheap to construct

Cons

- Punctuated supply of gas
- Odors released during emptying cycles

Continuous Digester

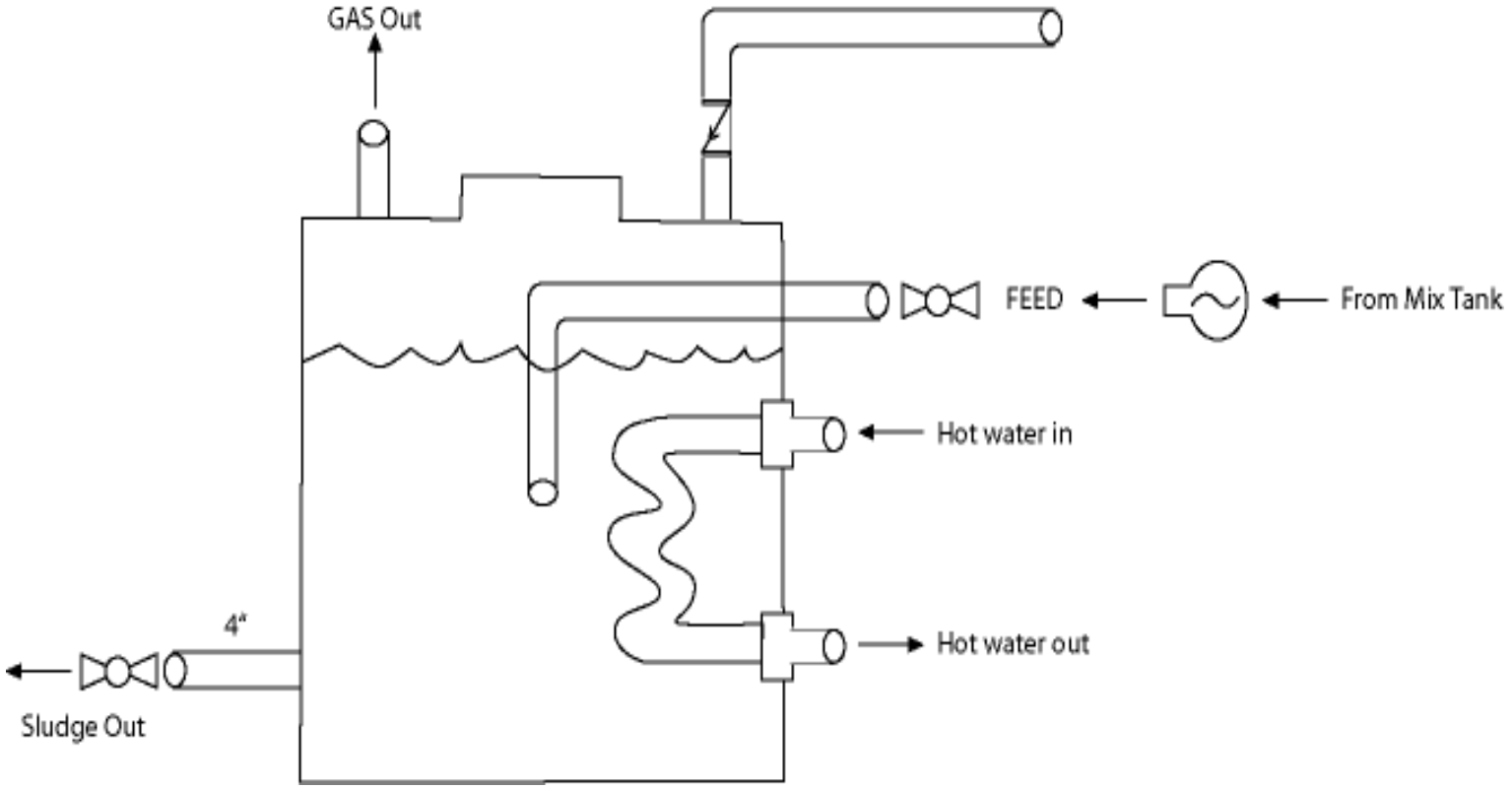
Pros

- Steady supply of gas
- Less odors
- Higher throughput/lower retention time
- Higher efficiency (from process optimization)

Cons

- Higher initial cost and complexity of construction
- Higher maintenance costs

Digester Construction



Types of Digestion Tanks

Covered Lagoon
The lagoon serves as a holding pond for waste. Usually, animal wastes are washed into here by flushing pens with water. Sometimes, fibrous solid wastes are removed to prevent a buildup of solids. A floating, impermeable cover traps the biogas for later use.

Concrete Tanks
Ideal for very large scale, underground or partially buried units.

Polyethylene Tanks
Light, durable, and resistant to corrosion. Allows for very cheap and reliable smaller systems. Can be easily transported.

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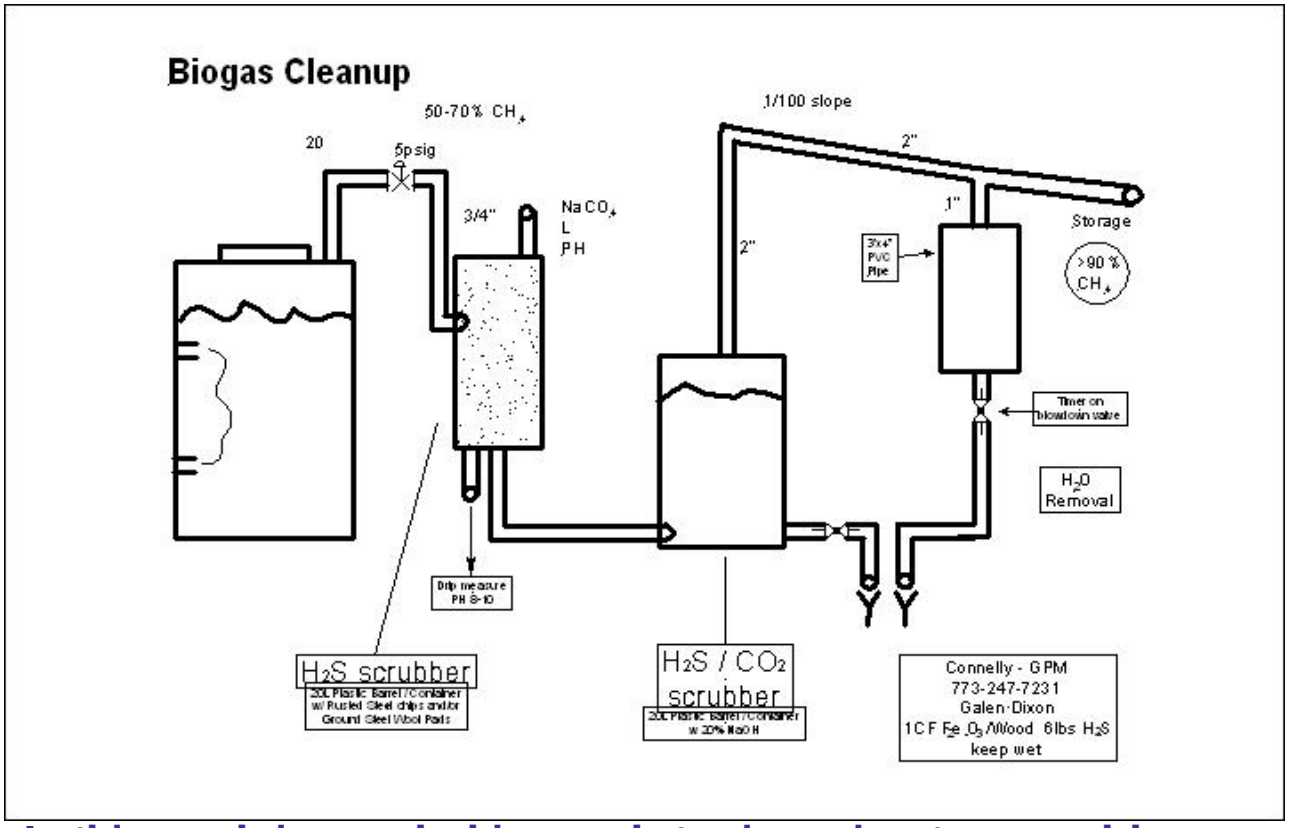
Biomass Conversion

Biogas is about 60% methane, the rest is mostly CO_2, and H_2S. To get pure methane, the biogas needs to be filtered.



In this model, wood chips and steel wool act as scrubbers.

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Fin

Gracias por la atencion - Thanks for your attention

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