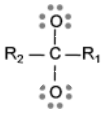
BIOFERM™ ENERGY SYSTEMS

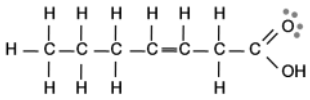
VIESMANN Group

Biogas Technology

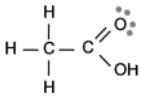
Biogas results from the breakdown of organic material by microorganisms (bacteria and archaea), a process called anaerobic digestion (see chart below). Aerobic organisms, like humans and other mammals, break down carbon substrates using oxygen molecules as electron receptors to derive energy for their bodies to use. Contrastingly, anaerobic organisms do not use oxygen, instead utilizing other molecules found within the organic material as the necessary electron receptors. In the process of extracting energy, the organisms rearrange the molecules of the organic substrates. Primarily, the covalent bonds between carbon atoms of the backbone of complex molecules are broken down to form volatile organic acids (acids that are not stable and will easily transform into another substance). As bonds are broken by consequent reactions, the valence shell (outer ring of electrons) of the carbon atom is left unsatisfied, meaning it is holding too few electrons. New bonds are formed with hydrogen to fill this vacancy. This process facilitates the eventual association between a carbon atom and four hydrogen atoms to form methane. The outcome that humans see is the physical breakdown of organic materials and the resulting production of biogas.



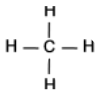
complex molecules
(macro organic materials)



monounsaturated fatty acid



acetic acid
(an organic acid)



methane

Through our highly engineered fermentation system, BIOFerm™ Energy Systems technology enhances anaerobic digestion by providing ideal environmental conditions to efficiently produce top quality biogas from a variety of organic inputs.

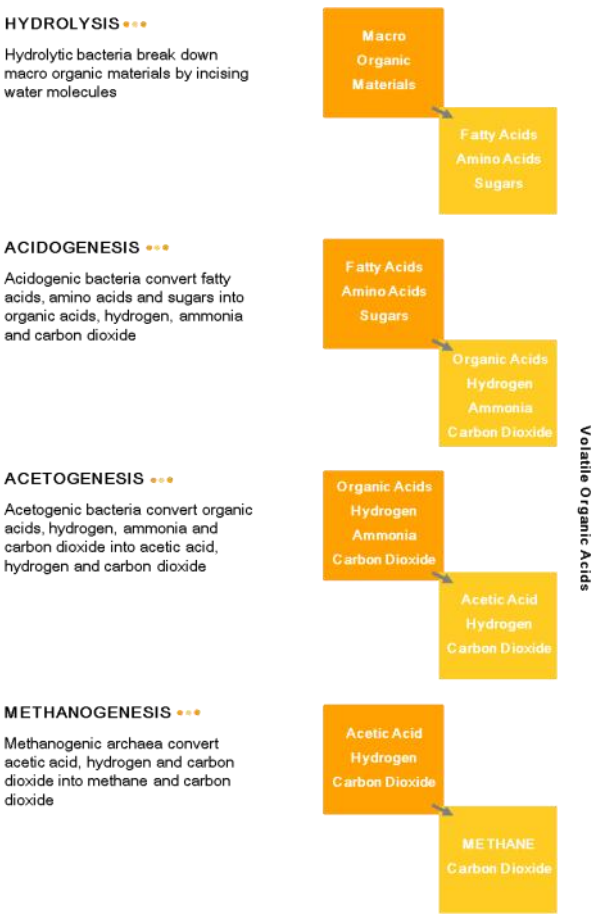
Average Biogas Composition

Methane	45-70 %
Carbon Dioxide	25-55 %
Water Vapor	0-10 %
Nitrate	0.01-5 %
Hydrogen	0-1 %
Hydrogen Sulfide	20-200 ppm
Ammonia	0.01-2.5 mg/m^3

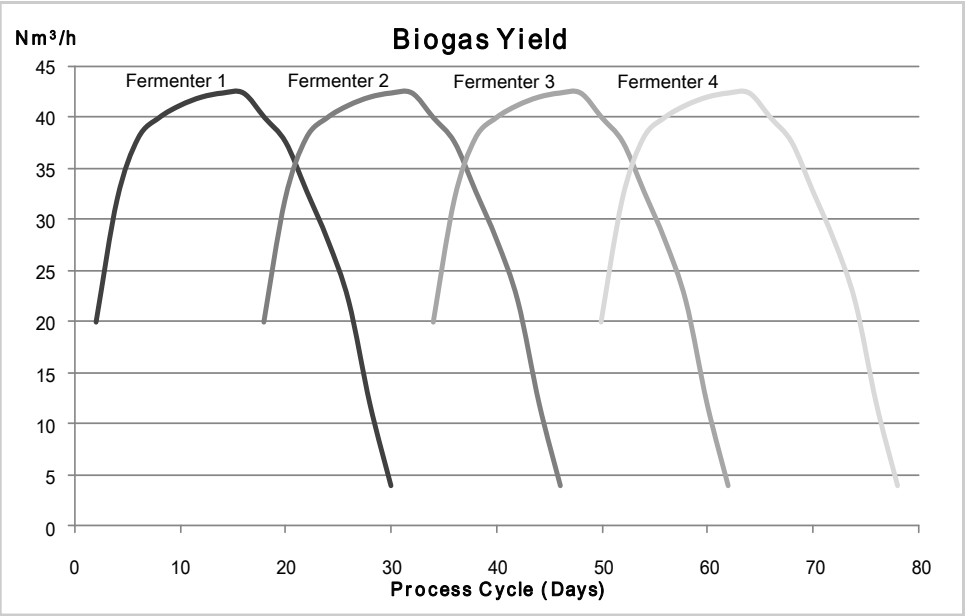
The methane content of biogas is directly linked to its quality; the higher the methane content, the higher burning power the biogas has. BIOFerm™ biogas provides the highest levels of methane possible by optimizing combinations of biomass and organic waste inputs. Active research and development projects continually improve methane yields for all customers.

BIOFerm™ biogas also maintains the lowest possible levels of hydrogen sulfide. Hydrogen sulfide is a toxic and extremely corrosive substance that deteriorates mechanical components of engines and motors, therefore reducing the efficiency of the CHP or boiler. By retaining low minimal hydrogen sulfide levels, BIOFerm™ biogas ensures the highest levels of biogas utilization efficiency as well as safety for the environment.

Anaerobic Digestion

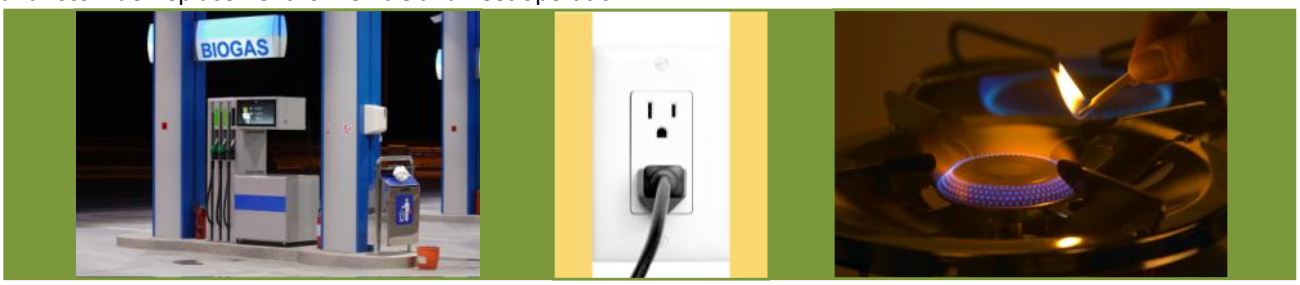


Biogas Production



Peak biogas production occurs between days 7 and 14 of the fermentation cycle. Gas yields from individual chambers are stored and mixed together, increasing consistency in gas content as well as increasing production during organic material exchanges.

BIOFerm™ biogas can be used in many energy generation applications, including: natural gas substitution, electric and thermal power production through a combined heat and power unit (CHP), heat generation through boiler technology and fossil fuel replacement for vehicle and fleet operation.



Energy Generation

Plant Size	Biogas (m^3)	Methane (m^3)	KW_{el} (from CHP)	MMBTU (from Boiler)	Gas Gallon Equivalent[1]
4 Chambers	1,250,947	725,549	341	26,047	210,643
8 Chambers	2,501,894	1,451,098	682	52,810	421,286
16 Chambers	5,003,788	2,902,196	1,364	105,620	842,573
24 Chambers	7,505,682	4,353,294	2,046	158,442	1,263,859

1. Gas Gallon Equivalent represents the amount of gasoline it would take to equal the energy produced by plant. Calculated using heat content values of 124,000 BTU/gallon for gasoline and 36,000 BTU/m^3 for methane (from US Dept. of Energy).

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