ANAEROBIC DIGESTION

Anaerobic digestion is a biological process that produces a gas principally composed of CH_4 and CO_2 otherwise known as biogas. The biogas is produced from the following major organic wastes:

- Solid & liquid animal manure
- Agricultural plant waste
- Slaughterhouse waste
- Food waste and waste from food industry
- Organic components in town waste
- Biodegradable (organic) components of municipal solid waste
- Other green and biodegradable waste
- Waste waters (sewage treatment sludge)

Biogas occurs naturally (uncontrolled digestion), hence its name, amongst others in swamps and lakes when conditions are right. Controlled anaerobic digestion requires an airtight chamber, called a digester. Anaerobic digestion can be used to produce valuable energy from waste streams of natural materials or to lower the pollution potential of a waste stream.

The biogas-production will normally be in the range of 0.15 - 0.60 Nm^3 of biogas per kg of solid substances (0.15-0.60Nm^3/kgVS) for a well functioning process with a typical retention time of 20-30 days.

The combustion of biogas can supply useful energy in the form of steam, hot water or hot air.

Biogas can substitute for natural gas or propane in space heaters, refrigeration equipment, cooking stoves or other equipment. Compressed (liquefied) biogas can be used as an alternative transportation fuel.

After filtering and drying, biogas is suitable as fuel for an internal combustion engine. If for example the biogas is used for power and co-generation, the plant will produce about 30-45% of electric power, 35-50% of exportable process heat and the remaining 20-30% will be used for self-consumption (digester heating, motor drive, etc).

Anaerobic digestion is a complex biochemical reaction carried out in a number of steps by several types of micro-organisms that require little or no oxygen to live. During the process a biogas, principally composed of approximately 65% CH_4 and about 30% CO_2, is produced. The biogas energy content (calorific or heating value) depends on the amount of CH_4.

The calorific (heating) value of typical biogas with 65% CH_4 concentration is about 22 MJ/Nm^3 which is equivalent to 0.55 kg of light diesel oil.

The produced biogas quantity and quality varies with the amount and quality of organic waste fed to the digester. Other major factor is the digester process temperature.

To promote bacterial activity, the digester must maintain a temperature of at least 20°C (ideal 25°C - 35°C). Higher digester temperatures, above 50°C - 65°C, shorten processing time, allowing the digester to handle a larger volume of organic waste.

The process of biological anaerobic digestion which occurs in a sequence of steps is illustrated in the attached picture.

Other very important factors for proper anaerobic digestion process are the residence time and acidity (pH-value).

Residence time has to be well balanced and optimized. The longer a substrate is kept under proper reaction conditions the more complete its degradation will become. But the reaction rate will decrease with increasing residence time.

Longer residence time requires automatically larger reactor for a given amount of substrate to be treated.

Shorter residence leads to a higher production rate per reactor volume unit, but a lower overall degradation.

Comparison of various anaerobic digestion process parameters is shown in the following Table.

DIGESTION PROCESS	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Dry	**Dry solids content of > 25-30%**	**Compact, lower energy input, better biogas quality (<80% CH_4), maintenance friendly**	**Restricted mixing possibilities**
Wet	**Dry solids content of < 15%**	**Better mixing possibilities**	**Higher energy input, lager reactor**
Mesophilic	**Digestion temperature between 25°C and 35°C**	**Longer process time, slower rate**	**Low energy input**
Thermophilic	**Digestion temperature between 50°C and 70°C**	**Shorter process time, higher degradation, faster rate**	**Higher energy input**
Batch	**Substrate in closed reactor during whole degradation period**	**Suitable for small plants with seasonal substrate supply**	**Unstable biogas production**
Continuous	**Reactor is filled continuously with fresh material**	**Constant biomass production through continuous feeding**	

ANAEROBIC DIGESTION PROCESS PARAMETERS

Acidity (pH-value) is other very important factor for bacteria digestion process. It is important to balance the acidity in reactor in such way that the bacteria become most productive.

Unfortunately, for the different groups of bacteria the optimum acidity is not the same.

The complexity of the entire system is increased by the fact that the intermediate products of the digestion have a tendency to lower the acidity, making the later steps in the process more difficult.