BASIC KNOWLEDGE

BIOGAS PLANT

Rising energy requirements and the limited availability of fossil energy sources make new energy supply concepts necessary. Energy production from biomass plays an important role in future energy concepts besides solar and wind energy.

In a biogas plant, microorganisms biologically degrade the organic starting substances (substrate) under exclusion of light and oxygen. The product of this anaerobic degradation is a gas mixture which primarily consists of methane. This gas mixture is called biogas.

The complex processes of anaerobic degradation can be simplified as four consecutive phases.

Phase 1: Hydrolysis

The substrate used in biogas plants is available as undissolved, high-molecular compounds such as proteins, fats and carbohydrates. Therefore these compounds first have to be broken down into their individual components. Hydrolysis products are amino acids, sugars and fatty acids.

Phase 2: Acidification

The hydrolysis products are then biochemically decomposed further, primarily into propionic acid, butyric acid, acetic acid, alcohols, hydrogen and carbon dioxide.

Phase 3: Formation of acetic acid

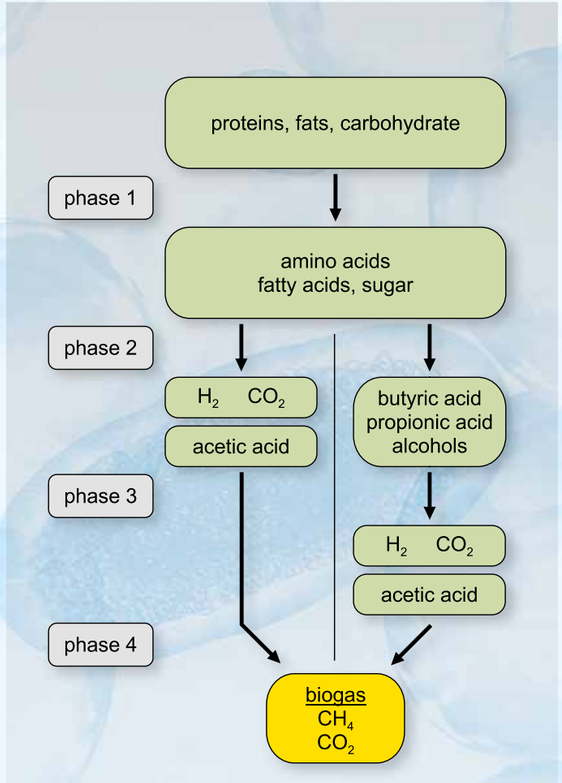
The products of the previous phase are now converted into acetic acid, hydrogen and carbon dioxide.

Phase 4: Formation of methane

Methanogens can use either acetic acid (CH_3COOH) or carbon dioxide and hydrogen for their metabolism. So methane (CH_4) can be produced in the following two reactions:

$$CH_3COOH \longrightarrow CH_4 + CO_2$$

$$4H_2 + CO_2 \longrightarrow CH_4 + 2H_2O$$



Fundamental principle of anaerobic degradation

Use of biogas

The biogas produced can now be combusted in a combined heat and power plant. This converts the energy stored in the biogas to rotational energy. A connected generator then converts this rotational energy into electric power. In addition to electrical energy, a combined heat and power plant also produces heat which can, for example, be used to heat the reactor or buildings.

How a biogas plant works:

1 *slurry from from livestock husbandry*
2 *renewable raw materials (e.g. maize)*
3 *storage for shredded raw materials*
4 *storage for feeding the bioreactor*
5 *bioreactor (fermenter)*
6 *storage for digestate*
7 *biogas treatment*
8 *combined heat and power plant*
9 *water circuit to heat the bioreactor*
10 *feed of the current into the public power grid*
11 *digestate (use as fertilizer)*

Ambient conditions

The microorganisms involved in the anaerobic degradation have different requirements regarding the ambient conditions. This applies primarily to the pH value and the temperature. Especially methanogens are very sensitive to deviations of these two process variables from their respective optimal value.

If all 4 phases of the degradation take place in one reactor, a compromise regarding the pH value and temperature needs to be found. This results in a lower biogas yield. From a process engineering point of view, a two-stage process in two separate reactors is more practical as this enables the ambient conditions to be adjusted more specifically to the respective bacteria.

Parameter	Phases 1+2	Phases 3+4
pH-value	5,2…6,3	6,7…7,5
Temperature	25..35°C	35…60°C

Optimal ambient conditions for anaerobic degradation