The FBI Hydrolysis Technologies

The Fermentation Process

Anaerobic digestion is a 4-stages biological and chemical process. Many microorganisms are involved, including acetic acid-forming bacteria (acetogens) and methane-forming archaea (methanogens). These organisms convert the biomass into biogas. Most biogas plants still have one or several digesters where all the different bacteria have to live together (1-stage fermentation). But the different bacteria prefer a different environment (pH-value, temperature, organic acid concentration, etc) where they can work in a most efficient way.

Therefore, FBI has developed the partial-aerobic hydrolysis technology. This means that the first stage of the digestion process, the hydrolysis process, is now a separate process in an extra tank. In that tank, air is injected because only aerobic bacteria can produce the enzyme cellulase. Cellulase can open cellulose and hemi-cellulose from fibrous materials (like grass, straw, green waste, etc.) and turn them into sugar (that is later turned into biogas). Thus, more kind of biomass can be digested.

Advantages of the FBI partial-aerobic hydrolysis techology

Higher biogas yields

Fibrous organic material with high cellulose and hemi-cellulose contents are digested and turned into sugar and thus more biogas can be produced. Plant cell walls are made of layered mashes of microfibrils. These microfibrils consist of cellulose, hemicellulose and lignin. The more fibrous a plant is or the elder it gets the higher the portion of the macrofibrils of the total plant becomes. Cellulase could be added daily to the fermentation process to increase the gas yield but this is too expensive. The FBI partial-aerobic hydrolysis allows cellulase forming bacteria (strictly aerobic) to reproduce themselves and thus to produce continuously cellulase, almost for free. So, for fibrous plants (grass, reed, etc.) and dry fibrous biomass (straw, manure with straw, bagasse, etc.) much more biogas can be produced by the digestion of cellulose and hemicellulose.

Higher methane concentration

In the hydrolysis unit most biological processes for the formation of CO_2 take place. The CO_2 leaves the unit with the exhaust air. Thus, the biogas has a 3-5% higher methane concentration than with a 1-stage fermentation process. This lets CHPs run smoother and helps saving cost on biomethane upgrading plants.

Stable fermentation process

With the separation of the sensitive methane forming process from the acidification process the whole fermentation process runs much more stable. The methane bacteria just get mostly acetic acid to digest and not an ever changing mixture of volatile fatty acids (VFA) with high concentration of the unwanted propionic and butyric acids. In the hydrolysis unit itself bacteria get more energy by the input of some air. Thus, VFA are suppressed and propionic acid particularly is faster turned into acetic acid. Air in general suppresses butyric acid formation.

Less digester volume

Due to the much better environment conditions for the methane bacteria less hydraulic retention time (HRT) is necessary. With the FBI partial-aerobic hydrolysis process an HRT of 20 to 25 days is enough. Thus, digester volumes can be reduced or more biogas can be produced with the same volume. For a typical biogas plant running with grass or corn silage and a HRT of 70 days only half of digester volume is necessary (higher TS-content in 1-stage process digester than in a digester after

hydrolysis treatment). The HRT of the partial-aerobic hydrolysis process goes from just 1 day to 1.5 days, depending on the feedstock.

Trouble-free hydraulic processes

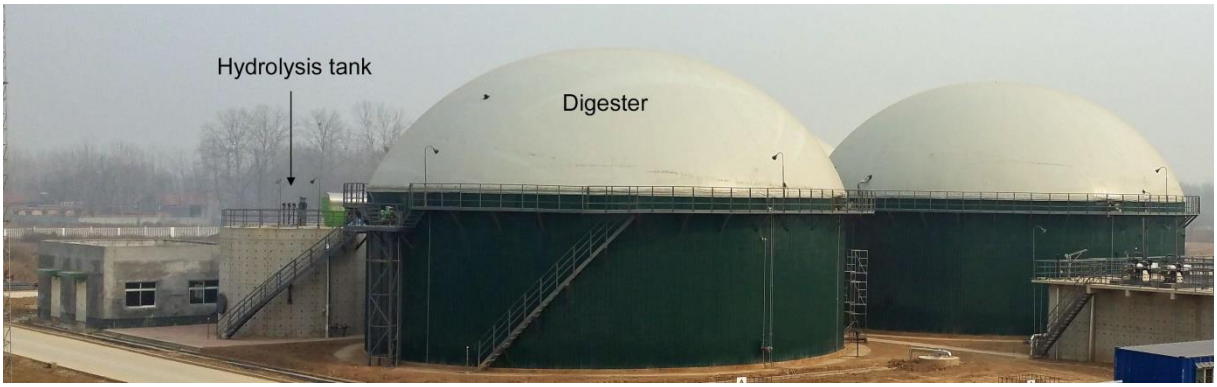
With the FBI partial-aerobic hydrolysis most of fibrous materials are being liquified and thus pumping and agitating are easier and there are no more floating layers in the digesters. The picture below show the treatment of straw in the hydrolysis after 24 hours treatment. It can clearly be observed that the crude structure of the straw has disappeared showing that in just a short time bacteria can open up the fibers and make them available for the fermentation process.

R&D

FBI runs three laboratories in Germany, Switzerland and China. Each facility is specializing in a local topic. In China, for instance, the focus of research lies on bagasse, rice straw, rice husks and cotton seed hulls; typical Asian biomass that is avalable in abundance there. The partial-aerobic hydrolysis technology has a huge impact in these countries to help them to find new and economically interesting ways to treat their waste biomass and produce renewable energy.

References

FBI designed and erected more than 200 biogas plants worldwide, whereof there are more than 25 plants using the partial-aerobic hydrolysis technology.



Typical FBI Chinese biogas plant running with pure corn and wheat straw. The Chinese plants have 1 to 6 hydrolysis tanks (350 m^3 each) and up to 8 digesters (up to 8'700 m^3 each).