Biogas plants
Automation, Building, Support
Publisher

GDC - Automation GmbH & Co.KG
Zinnweg 10
D - 33334 Gütersloh

Phone: (+49) (0)5241 / 40 37 - 551
Fax: (+49) (0)5241 / 40 37 - 552

E-mail: info@gdc-automation.eu
Web: www.gdc-automation.eu

Individual to represent: Gunnar Drenkelfort
Tax number: DE249065528

Illustration and Design

Gunnar Drenkelfort

Photo Credits

The rights for all not specially marked images in this brochure are owned by the publisher. All with "source: wikipedia.org" tagged pictures are from the central media archive of the Wikipedia Commons Wikipedia Foundation and have been under the GNU Free Documentation License (FDL) published.

All rights reserved. Any use is subject to the approval of the GDC - Automation GmbH & Co.KG

The contents of this publication was prepared with great care and to our knowledge. The GDC - Automation assumes no responsibility for the timeliness, completeness or quality of information provided. The GDC - Automation is not liable for material or immaterial damages, which directly or indirectly as arise due to the use or disuse or can.
Content

The principle of renewable energy.................................................................04
Closure of the cycle....................................................................................06
Biogas energy - Strong on the rise..............................................................08
Construction of a Biogas plant.................................................................09
Control engineering.................12
The project team........................................................................................21
Completed projects....................................................................................22
The principle of renewable energy

The availability of energy for the supply of a society can be ensured in a considerable amount by natural resources of a modern agriculture.

Biogas plants can produce the high-quality energy source “biogas” by agricultural rest material such as manure from pigs, cattle and poultry. Afterwards, the biogas is transformed to power and heat in specific gas engines. Biogas is won by crops particularly cultivated for this purpose. These crops are called “Renewable Raw Materials”. Maize, grass and grain are very suitable for the biogas production. These crops are easily cultivated and can be stored as silage all-season. Thus, a continuous supply of raw material can be ensured.

BIOGAS PRODUCTION
The technology of the biogas production is known to us for decades and is operated successfully with different organic materials in small and big biogas plants all over the world.

The centre of a biogas plant is the digester in which the methane bacteria use e.g. maize silage as their “food” and then produce biogas. Biogas consists of flammable methane to approx. 50-65 %. The methane within the biogas supplies the necessary y to the gas engine in order to power the generator. The generator produces electrical power which is a well sellable “product”.

As per the German “Renewable Energy Sources Act”, an attractive remuneration is paid for the power produced by renewable raw material. For the biogas plant and consequently for the agricultural company, this remuneration ensures a very good profitability. This Renewable Energy Sources Act also exists in other countries, but with different remuneration rates.
Besides the digester and the Combined Heat and Power unit (CHP), the biogas plant possesses further technical components such as the substratum reception station, pumps, gas treatment units, gas holders and gasholders for the digestate.

DIGESTATE USED FOR FERTILISATION PURPOSES
The digestate plays an important role during the operation of a biogas plant fed with renewable raw material. In the biogas plant only the carbon - transformed into methane and carbon dioxide by the methane bacteria - is extracted from the renewable raw material.
Closure of the cycle

The other nutrients still remain in the digestate; nitrogen e.g. as attractive ammonium. Therefore, the cultivation of renewable raw material can be effected with a low quantity of external fertilisers. The energy comes from the sun!
**THERMAL USE**

Besides the electrical power, heat is produced as well. This heat can be used for the heating of buildings and greenhouses, for the drying of all kinds of goods, for the fish breeding and for many other purposes. In this way the efficiency increases. In Germany, the intelligent use of the heat is rewarded with an additional bonus. In other countries, the bonus can differ.

**TURN-KEY CONSTRUCTION**

The GDC - Automation GmbH + Co.KG, supplier for local and industrial sewage treatment plants, disposes of long-time experiences with biogas. As a general constructor we can cover all project sections with full service: from the planning, the construction and equipment up to the start-up and the commissioning.

We also provide the complete service of the construction of the biogas plant including the approval process and the financing. Furthermore, the continuative support as well as the maintenance on the plant can be offered as an additional service to the customer.

All components are high-quality industry products manufactured for the long-term operation. In this way a failure-free operation can be guaranteed round the clock.

To optimize our support and technology, we work with different supplier for getting the optimal result.
CONSTRUCTION AND PROCESS DESCRIPTION

The biogas process is based on the activity of the so-called methane bacteria. These bacteria “eat” the organic substances existing in manure and other materials. This degradation process consists of several interdigitated stages.

A little portion of “food” is for the growth of the bacteria, but the bigger one is precipitated as gas. The “biogas” mainly consists of combustible methane and non-combustible carbon dioxide. The methane is accumulated in a considerable amount. By means of a gas engine it can be transformed into mechanical, respectively electrical energy.

A biogas plant consists of different components in order to produce biogas from the organic materials:

First of all, the material such as maize silage or manure is conveyed to a reception tank for the intermediate storage. If available, additional fermentable material such as fats can be added there as well. From this tank, the sludge is evenly transported into the digester. The digester is a completely closed-top tank of steel or concrete. The sludge in the digester has a temperature of approx. 35 °C. This high temperature guarantees optimal living conditions for the methane bacteria. An effective gas production can be realised due to these optimal conditions. The digester is equipped with a heat insulation in order to keep the self-energy requirement low. The digester is constructed gas-proof so that the bacteria are strictly insulated from oxygen.

The produced gas is transported from the digester into a pipeline. The condensate and contaminants are separated in a cleaning process. Afterwards, the gas is stored immediately in a gasholder. Then, a CHP transforms it to power and heat. The electrical power can be used for personal purposes or can be fed into the local power grid. The latter is effected with remuneration as per the German Renewable Energy Sources Act (EEG). The remuneration rates in other countries can differ compared to the German remuneration system.

The heat is partly used for the heating of the digester. The excess heat quantity caused during the power production in the CHP can be used e.g. in the sow breeding, in greenhouses, in drying processes etc.

The biogas process runs continuously, i.e. sludge is daily pumped into a gasholder and a corresponding quantity is taken away again. The digested sludge is stored in a gasholder until it is spread on the field. The reception tank and the digestate tank are built next to the digester. The pumps, the gas treatment unit as well as the CHP are installed in factory-made, pre-assembled containers installed on strip foundations.
Construction of a Biogas plant

CONSTRUCTION OF A BIOGAS PLANT
A biogas plant is a small factory possessing different devices, tanks and machines such as pumps and engines, in order to produce biogas and to transform it into power. The components must be coordinated expediently in order to achieve an effective and failure-free operation. The essential components for the biogas plant are described on the following pages in order to get an overview of the construction.

DIGESTER
The digester, or fermenter, is the most important component of a biogas plant. In the digester the renewable raw material is transformed to biogas. Therefore, the digester is a big gas-proof tank of reinforced concrete or steel. The GDC - Automation can provide both digester systems (see below) according to the requested and the necessary requirements. The reinforced concrete digesters are manufactured by our company.

DIGESTER CONSTRUCTION
The digester is a vertically standing cylinder with a diameter to height ratio of 1:1 and is equipped with a special casing. The slim digester of reinforced concrete has a construction height between 8 to 20 m. The roof of the digester is of reinforced concrete and is gas-proof. The roof is accessible, so that all important safety-related and technical devices can be reached in case of maintenance and repair works.
The safety-related and technical equipment of the digester is mainly installed in the gas dome fixed in the roof construction. Via this gas dome the extraction of biogas out of the digester is effected as well. A powerful vertical mixer is installed via the gas dome in order to reach a sufficient circulation and agitation of the fermenting content. The material used for our reinforced concrete digesters is high-quality concrete resistant against attacks of numerous aggressive media. The head space is additionally equipped with a PE-HD-coating in order to protect the concrete efficiently against sulphur corrosion.

The external wall of the digester is heat-insulated and is furthermore equipped with trapezoidal panels. The working platform and the ladder are included in delivery. Furthermore, the connections for the feeding and extraction of sludge and gas are included. The heating of the sludge is effected by a double pipe heat exchanger fixed outside.

**SLIM CONSTRUCTION**

In comparison to flat digesters, slim digesters have the following advantages:

* **Roof construction**

  Stable roofs can be manufactured very easily due to the relatively small diameter of the digester. Efficiently working agitators can be fixed as well. Losses of heat can be minimised due to a good heat insulation installed in the roof. Thanks to a good insulation the requirement of specific heat can be minimised, so that the produced heat can be used economically. Thus, the yield of the biogas plant is increased. In comparison to thin membrane roofs, the losses of heat are to 75% lower.

  The thin construction is a prerequisite for an optimal homogenisation of the fermenting content. The ratio Height : Diameter = 1 : 1 is advantageous for an efficient mixing of the content. Sediments and swimming layers can be combated due to the small surface. Therefore, a good distribution of heat and fresh fermenting material can be achieved with a low energy input. This procedure is an essential prerequisite for the optimal biogas production. This is achieved more easily and reliably with a slim construction. In case of a malfunction the agitator can be demounted without emptying the digester.

* **FEEDING DEVICE FOR SUBSTRATUM**

  The substrata producing biogas are very manifold. A biogas plant can be operated with liquid substrata such as manure or with solid material as e.g. maize silage or grain. An adapted feeding device is an indispensable necessity for a failure-free operation. In the feeding and preparation device the substratum is liquefied and transported into the digester. Thus an effected operation is achieved.
DIGESTATE
The sludge leaving the digester is still a useful material. The renewable raw material has only been extracted from the carbon. Nitrogen, phosphor and other plant nutrients still remain in the material and can be used for the agricultural fertilisation. Thus, the digestate is intermediately stored in a gasholder keeping the material for 180 days. Especially the nitrogen – in the form of the soil-compatible ammonium – can be used very efficiently in the vegetation period.

GAS TREATMENT
The biogas leaving the digester must be prepared before it is used in the generator in order to achieve a long durability of the engine. Basically the condensate (water) must be extracted from the gas. Furthermore, the hydrogen sulphide must be extracted as it appears in different concentrations. Hydrogen sulphide is toxic and very corrosive. The GDC - Automation disposes of comprehensive experiences and techniques concerning the effective extraction of contaminants out of the gas. A pressureless gas holder ensures a constant supply to the CHP. An emergency flare completes the gas treatment and ensures an environment-friendly and save disposal of the gas.

COMBINED HEAT AND POWER UNIT
The Combined Heat and Power unit (CHP) transforms biogas into electrical power and heat. Both forms of energy are valuable secondary energies generating high revenues and making the biogas plant cost-efficient. CHP’s can be delivered in all expedient sizes. The CHP can be delivered pre-assembled in a container for a quick installation. Another possibility is to install it in buildings. The power from the CHP is fed via a transformer – which is subject to the conditions of the German Renewable Energy Sources Act - into the local power.
CONTROL ENGINEERING

Basically, a biogas plant is technologically simple. But a certain complexity of measurement and control technology must be installed in order to realise an optimal biogas production.

A biogas plant contains the following measurement devices:

1. a weighing equipment for solid substrata
2. a flow rate device for liquid substrata
3. a gas quantity measurement
4. a gas pressure measurement
5. a gas temperature measurement
6. a gas quality measurement (methane – carbon dioxide)

By measuring the produced gas quality the operator can find out, if the theoretically producible gas quantity has actually been reached. The recording of data concerning the pressure and temperature is very important for the translation to standard cubic metres, so that the values are comparable. The gas quality indicates a qualitative as well as a quantitative information about the operational reliability of the biogas plant.

The balancing between the added quantity of substratum and the obtained quantity of biogas enables the easiest control concerning the operational reliability and efficiency of the biogas plant.

7. Gas quality - hydrogen sulphide

The content of hydrogen sulphide within the biogas must be reduced in order to avoid a damage of the gas engines and a pollution of the environment; generally a direct influence on the process stability may not be expected.

8. Temperature of the digested sludge
9. pH-value of the digested sludge
10. Redox-potential of the digested sludge

The temperature measurement – preferably effected in different heights within the digester – indicates the constancy of temperature and the mixing quality.

The pH-value itself is only a limited significance. In the normal span (pH 7,0 – 7,5) the usual buffer capacity hides possible malfunctions. Consequently, an error may be indicated too late in the pH-measurement. In combination with the measurement of the CO2– content, a calculative connection to the NH4– content in the digested sludge can be easily set. Thus, an information is provided concerning the buffer capacity, the process stability and the development of deleterious NH3.

The Redox potential of the digested sludge provides effective indications concerning the process stability, as a low Redox potential forwards the process of the methane development.
The measurement of the

11. Hydrogen content within the biogas

provides an indication concerning the stability of acidification, described as the pre-stage of the development of methane. In case of a too high acidification – which is not balanced with the methane development – hydrogen can not be used for the reduction of CO2 and therefore escapes as gas. Thus, an early signal is available in case of malfunctions.

Degradation pathways with time axis
Our thrust has always been a pioneering spirit. Once again we approach this industry with "unconventional" ideas capable to become an innovation reality. Our concepts and unusual planning projects share in common our serious commitment.