

HAFFMANS BIOGAS UPGRADING - STANDARD SYSTEM

COMMUNITY PROJECT REIMLINGEN, GERMANY

CASE STUDY

“AN ABSOLUTELY ATTRACTIVE OPTION”

A COMMUNITY PROJECT IN REIMLINGEN IS CREATING ONE OF THE BIGGEST BIOMETHANE PRODUCTION FACILITIES IN BAVARIA – MEMBRANE TECHNOLOGY IS A CONVINCING UPGRADING OPTION



Pentair Haffmans Biogas Upgrading System

CLIENT

Community project for Bioenergie Reimlingen GmbH & Co.KG
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In the past Bioenergie Reimlingen GmbH & Co.KG produced power and heat. However, as is often the case, there was no optimum use for heat – especially in summer. This is why the majority of the biogas is now being upgraded with a retrofit membrane system and fed into the natural gas grid.

The biomethane system is operated by Landwärme GmbH from Munich. It has a capacity of 700 Nm³/h and so covers the energy requirement of around 4,000 single-family dwellings.

The biogas system was built in 2006 by farmers in the municipality of Reimlingen, located in the Bavarian rural district of Donau-Ries. The plan was to convert the biogas obtained into power with two 1 MW biogas engines and feed it into the grid of EnBW. The waste heat produced was going to heat the Foundation Hospital in Nördlingen and temper biogas fermentation.

“Unlike heat and power, gas can be stored very effectively.” That’s the theory: because over the years it was shown that much more heat is produced than is removed. This applied particularly in the summer months. At this time of year the excess heat could be used to dry firewood, but that was not really satisfactory, as Karl-Heinz Geiß, Partner of Bioenergie Reimlingen, explains: “If we do not have optimum heat utilization for half the year, this makes little ecological sense in the long term. We were therefore looking for an alternative and found gas upgrading. Unlike heat and power, gas can be stored very effectively and so really can be used in an appropriate way.”

This brings everything back to Munich-based Landwärme GmbH and Christian Löffler: “If some of the heat cannot be used because there are no consumers, biogas upgrading becomes the considerably better economic and ecological choice. This initial situation applied exactly to Reimlingen. We therefore decided to invest in a suitable upgrading system here. “Landwärme was set up 2007 and today operates as a project developer, biomethane provider and service provider throughout Europe. As a link between the biogas producer and biomethane customer, Landwärme at present operates three upgrading systems including Reimlingen. Two others are at present under construction.

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Schwaben Netz GmbH has been gained as a third partner. Finally the biomethane must be transported to the end consumer. For this Schwaben Netz laid a 20 kilometer long gas pipeline to connect the biogas system. In addition a biomethane feed-in station with a compressor unit was built in the immediate vicinity of the membrane upgrading system.



Feed-in station

Condition: no impurities and methane content of more than 95 percent

In Reimlingen a substrate of 50 percent maize, 25 percent chopped grain and 25 percent grass and clover is fermented in a so-called dry fermentation system.



Substrate

Around 85 percent of the biogas is produced in this ten-day stage. 14 percent is then obtained in the post-fermenters and 1 percent in the fermentation residue storage. This biogas consists of roughly around 50 to 60 percent methane and 40 to 50 percent CO₂. Depending on the fermentation substrate it also contains various amounts of steam as well as sulfur compounds and ammonia. If the impurities and CO₂ are separated from the biogas, it is graded as natural gas and can be fed into the grid. For this a methane content greater than 95 percent is required.

For the separation of CO₂ various procedures are available such as: non-pressurized amine washing, pressurized water scrubbing, pressure swing adsorption as well as membrane separation. "We gave close attention to the technology beforehand. We went to trade fairs and inspected many systems. Of all the processes that we saw, membrane separation was the simplest as regards control, operation and maintenance. What we are essentially discussing here is only the compressor," explained Mr Geiß.

"In Landwärme projects we work exclusively with membrane separation." For Mr Löffler, too, who handled the investment in Reimlingen, the membrane process is the method of choice: "With the systems operated by Landwärme we work exclusively with membrane separation. No chemicals are used here as in amine washing and the gas pressure is within the range of the connection

values demanded. On the other hand, in the non-pressurized processes the compressor capacity must usually be increased."

Landwärme finally decided in favor of Pentair Haffmans membrane upgrading. Mr Löffler recalls: "Among other things we looked closely at their waste processing in Augsburg. It was really impressive." The upgrading in Reimlingen is designed as a container solution. The main process steps gas scrubbing and dehumidification, activated carbon filtration as well as membrane separation are in this case each combined in a function container. The membrane upgrading is designed for an hourly capacity of 700 Nm³ of biomethane. This corresponds to around 1,400 Nm³/h of biogas in the feed line.



Activated carbon filtration

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Membrane separation

Purification with a counter-current scrubber and activated carbon filtration

The first process step is the cleaning of the incoming raw gas. Here all the water soluble components such as the unwanted ammonia are separated in a counter-current scrubber. In addition the gas in the container is cooled and so removed.

This is followed by activated carbon filtration that removes all hydrogen sulfides. This is an extremely important process step, because acids are produced from these sulfur compounds during later combustion and attack the engines or other components. In total three double filters are connected in parallel in the filtration container. A continuous check for hydrogen sulfide is carried out in the relevant filter line between the two filter containers. This is a reliable way of excluding unnoticed flashover through a filter. The capacity of each filter line is 500 Nm³/h. They are charged in parallel depending on the quantity of raw gas. The activated carbon filtration thus has a total capacity of 500, 1,000 or 1,500 Nm³/h.

A compressor unit is installed after the filters that sets the necessary membrane pressure, as well as a safety stage with oil separator. This very complex purification of the biogas is used by Pentair Haffmans in all its systems, to ensure the maximum possible service life of the membranes.

Average methane content of 97 percent in practice

Before the actual membrane separation the biogas is cooled again and so dehumidified as far as possible. This is followed by multi-stage membrane separation into methane and CO₂. The methane permeate is purified as far as the required feed-in unit of greater than 95 percent. The operating pressure of the membranes may be up to around 10 bar, which makes optimum adjustment to the pre-determined feed-in pressure of the relevant natural gas grid possible. Should the biomethane not meet the required feed-in quality due to a malfunction or fault, it is returned fully automatically into the biogas storage facility. In practice the biomethane in Reimlingen does however achieve an average methane content of 97 percent.

The CO₂ reaches the catalytic afterburner with around one percent residual methane. The system could be supplemented with a CO₂ liquefaction unit here. This would mean firstly that any methane slip would pass fully into the natural gas grid. Secondly the liquefied CO₂ could be marketed for example as welding gas or for CO₂ fertilization in greenhouses. However, unlike in Great Britain or Holland, this market does not exist in Bavaria. The investment in CO₂ liquefaction is therefore not economically attractive for Reimlingen at present.

"We produce power, heat or biomethane exactly in accordance with the demand."
The membrane system is supervised and controlled by the staff of Bioenergie Reimlingen. Its control is incorporated in the central control room of the biogas system for this purpose. At night or on bank holidays the staff can also dial in over the Internet. In addition a 24/7 teleservice contract was signed with Pentair Haffmans.

"Our production in the future will be heat-led. This means: if heat energy is removed, then either one or both engines will operate. If it is not, we will supply the excess biogas to Landwärme for natural gas production. Furthermore we can still offer positive and negative balancing energy", was how Mr Geiß explained the new strategy at Bioenergie Reimlingen. This balancing energy is necessary to buffer any short-term surpluses or shortages in the power grid. If for example heat is produced for the hospital with one engine during the winter, this can be turned off very quickly at any time. At this time Reimlingen is feeding one MW less power into the grid. This so-called negative balancing energy balances out short term power spikes in the grid. If on the other hand there is not enough power in the grid, Reimlingen can immediately feed in up to 2 MW positive balancing energy with its two engines.

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An important factor for taking over this buffer function is the flexibility of membrane separation. If positive balancing energy is required, the gas upgrading system reduces its capacity fully automatically by up to 75 percent. And should maximum balancing energy be required for a lengthy period, the membrane system can be turned off at the press of a button. At the same time Bioenergie Reimlingen can now

access identical production capacities for both power and natural gas feed-in. This means the greatest possible flexibility, as Geiß stresses: "We produce power, heat or biomethane exactly in accordance with the demand." Last but not least according to Geiß this approach offers the highest level of security against flare gas losses: "It is simply unrealistic for the engines and gas upgrading to be down at the same time for so long that the biogas has to be flared off. We are therefore also in an excellent position as regards our overall efficiency.

To sum up biomethane is an absolutely attractive option for any biogas producer, who can supply around 700 Nm³ raw gas per hour and has a connection facility to the natural gas grid."

ABOUT PENTAIR HAFFMANS

Pentair Haffmans develops and produces metering equipment for quality control, microfilters and CO₂ systems for the brewing, soft drinks, wine, bioethanol and biogas industry.

Pentair Haffmans is a multinational company with a strong focus on innovation and customer satisfaction and a worldwide presence in over 150 countries. All our technologies follow the same overriding principle: to protect the environment and at the same time reduce operating costs.

Since 2011 Haffmans has been part of the Pentair Group, a globally operating industrial enterprise with a broad base, with headquarters in Minneapolis, USA, and over 30,000 employees worldwide.



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