REIMLINGEN
BIOGAS UPGRADING

KEY FACTS

Location
Reimlingen
Germany

Application
Community Project
for Biogas

Capacity
1400 Nm^3/h Biogas
700 Nm^3/h Biomethane

Start-Up
2007

COMMUNITY PROJECT REIMLINGEN "AN ABSOLUTELY ATTRACTIVE OPTION"

A community project in Reimlingen created one of the largest biomethane production facilities in Bavaria – Membrane Technology is a convincing upgrading solution.

In the past Bioenergie Reimlingen GmbH & Co.KG produced power and heat. However, as is often the case, there was no optimal use for heat – especially during the summer months. 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 an upgrading output of 700 Nm^3/h providing the energy requirements of approximately 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 recovered 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 biogas fermentation at the site.

"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. Schwaben Netz GmbH has joined 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. A biomethane feed-in station with a compressor unit was built in the immediate vicinity of the membrane upgrading system.

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>
> *Christian Löffler,*
> *Head of Biomethane CHP at Landwärme GmbH*

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PROCESS DESCRIPTION

Requirements: no impurities and methane content of more than 95 percent In Reimlingen a substrate of 50 per-cent maize, 25 percent chopped grain and 25 percent grass and clover is fermented in a so-called dry fermentation system.

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 CO_2. Depending on the fermentation substrate it also contains various amounts of steam as well as sulfur compounds and ammonia. If the impurities and CO_2 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 CO_2 various procedures are available such as: non-pressurized amine washing, pressurized water scrubbing, pressure swing adsorption and membrane separation. "We paid 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 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 system is designed for an hourly capacity of 700 Nm^3 of biomethane. This corresponds to around 1,400 Nm^3/h of biogas in the feed line.

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 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 can damage 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 excess flashover through a filter. The capacity of each filter line is 500 Nm^3/h. They are operated 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 Nm^3/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 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. This is followed by multistage membrane separation into methane and CO_2. 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 feeding quality due to a malfunction or fault, it is returned fully automatically into the biogas storage facility. In practice the biomethane in Reimlingen achieves an average methane content of 97 percent. The CO_2 reaches the catalytic afterburner with around one percent residual methane.

The system could be supplemented with a CO_2 liquefaction unit here. This would mean that any methane slip would pass fully into the natural gas grid. Secondly the liquefied CO_2 could be marketed for applications such as welding gas or for CO_2 fertilization in greenhouses.

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However, unlike in Great Britain or Holland, this CO_2 market does not exist in Bavaria. The investment in CO_2 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. This 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.

"Our production in the future will be heatled. 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 shortterm 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.

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 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 infeed. 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.

In summary 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."

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