photo: torben skøtt/biopress

Biogas experiments on a large scale

– Research Centre Foulum inaugurates the largest test plant in the world

A new test plant within Research Centre Foulum is expected to make it easier for researchers to optimise gas outputs of livestock manure and energy crops, amongst others. Currently, we are only utilising around half of the gas potential contained in biomasses, which means that there are great perspectives for improvement of new and existing biogas plants.

By Torben Skøtt

On Tuesday October 30th 2007, the World's largest biogas test plant was inaugurated at Research Centre Foulum, now part of the Faculty of Agricultural Science at the University of Aarhus. The inauguration saw a lot of positive feedback about the plant, but also a certain level of frustration with the fact that it has taken almost ten years to finish the project.

– We want the new biogas plant to contribute to the process of placing Denmark at the global forefront within the field of utilising energy and nutrients from livestock manure and other types of biomasses, the Minister of Food, Agriculture and Fisheries Eva Kjer Hansen expressed through a press statement that was released at the time of the inauguration. The minister did not take part in the event at the research centre because she had chosen to dedicate her time to the election campaign going on at the time. Bent Hansen, chairman of the region of Mid-Jutland, and Martin Merrild, who is the mayor of Struer and has a number of positions of trust within the agricultural industry, did participate in the event. They opened the gas tap together, marking the inauguration of the plant worth DKK 25 million.

photo: torben skøtt/biopress

Together, Bent Hansen (left) and Martin Merrild opened the gas tap, marking the plant inauguration.

Two plants

In fact, Foulum features two, not just one plant: a test plant and a production plant. The latter will be handling around 29,000 tonnes of manure and around 2,000 tonnes of biomasses stemming from stables and fields belonging to Research Centre Foulum. This will generate around 850,000 cubic metres of methane gas, which will be converted into heating and electricity within the local CHP plant.

The test plant itself contains four reactors with appurtenant precontainers, as well as the dosing system for feed-in of solid products such as forage remains, floor bedding, energy crops etc. This makes the plant one of the most advanced and flexible test plants in the world.

– We expect the various technological measurements, which will be tested within the new plant, to make biogas plants of the future more effective and stable in operational terms, and to obtain a larger total environmental win than what has been generated so far in the first plants, said Gunnar Hald Mikkelsen, operations manager at the new plant.

Apart from carrying out research with a view to optimise processes within the biogas reactors themselves, it will also be possible to carry out experiments on various types of biomasses. By being located within Research Centre Foulum, an extensive base of raw materials from the centre's production livestock, including dairy cattle, pigs, poultry and minks, will be readily available for utilisation within the plant. Furthermore, the centre is able to supply energy crops, straw and other types of biomasses.

There is still plenty of work to do before the entire biogas potential can be fully exploited. In existing plants, the conversion of organic material from livestock manure and straw, as an example, is only 50-60% of what is actually possible in theoretical terms.

Many ideas have been drawn up on how to improve biogas production methods, but very often, scientific proof and practical method tests are lacking. One of the tasks of the new plant is to deal with this shortcoming. The plant, financed by the Ministry of Food, Agriculture and Fisheries, will provide researchers, students and biogas producers alike with completely new possibilities of developing technologies on a large scale.

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Managing director at Xergi, Frank Rosager (at the rostrum) passes on the "starter switch" to Martin Merrild and Bent Hansen (left).

The company Xergi is one of the producers, who is definitely going to use the new plant. Xergi has been in charge of delivering the plant, and they have placed their development department at the Centre for Bioenergy and Environmental Technology Invention, one of Research Centre Foulum's neighbours. ■

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higher when adding fresh manure than when adding degasified biomasses. It definitely seems that the most efficient and safest method of ammonium inhibition is a combined addition of manure and degasified biomasses.

The worst thing to do is to continue adding the daily amount of manure, or to dilute the biomass using water. Adding water leads to a faster process re-establishment than if nothing had been done, however, this strategy leads to a relatively low gas production level. The reactor, which saw no intervention efforts at all, also saw the most significant acid level increase, indicating that the process in this particular reactor was influenced more than in any other one.

LCFA inhibition

Biogas process inhibition by means of adding LCFA showed more or less the same results as the ammonium inhibition experiments (see figure 2). When the biomasses were diluted with degasified biomasses and manure respectively, the biogas production was re-established within 3-4 days. When adding water, it took 5-6 days, and when not intervening at all, the biogas production was re-established after 10 days.

This line of experiments also tested the extent to which an addition of rotten fibres and bentonit would influence the process. Whereas the fibres worked fast (6 days), bentonit worked a little slower (8 days). Nevertheless, the latter was more effective than when just adding the daily amount of manure. Cutting off manure supplies altogether lead to a very inefficient re-establishment process that lasted 42 days.

Once the process had been re-established in all reactors, the experiments were repeated (not shown). When replacing half of the biomasses with fresh manure or degasified biomasses, the response time was the same as in the initial experiments, but when simply adding the daily amount of manure, the process happened a little bit faster (9 days). This shows that the process is capable of adjusting to a higher LCFA concentration level. Adding fibres made the process work a little bit slower than in the initial experiment (8 days), but adding bentonit (18 days) and water (21 days) made the process work markedly slower this time around.

Conclusion

The experiments led to the overall conclusion that following a process interruption caused by ammonium or fat, it is important to dilute the biomasses as this leads to a reduced concentration of inhibiting materials. However, dilution is not the only important factor; adding a substrate in the form of fresh or degasified biomasses is also needed in order to obtain a satisfactory re-establishment of the process.

As the process inhibitions might vary from one interruption to the next, it is difficult to pinpoint the best strategy. The results might serve as a source of inspiration and reference when a plant manager wants to select a strategy for dealing with an imbalanced process. Before selecting a particular strategy, conditions such as temperature levels, organic load, waste composition and the reason for the imbalance must also be taken into consideration.

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1. See also the article "Optimisation of the biogas process" in Bioenergy Research no. 13-2006, pages 1 - 4. ■