HIGHER REACTOR TEMPERATURE IN DIGESTERS IS PROFITABLE

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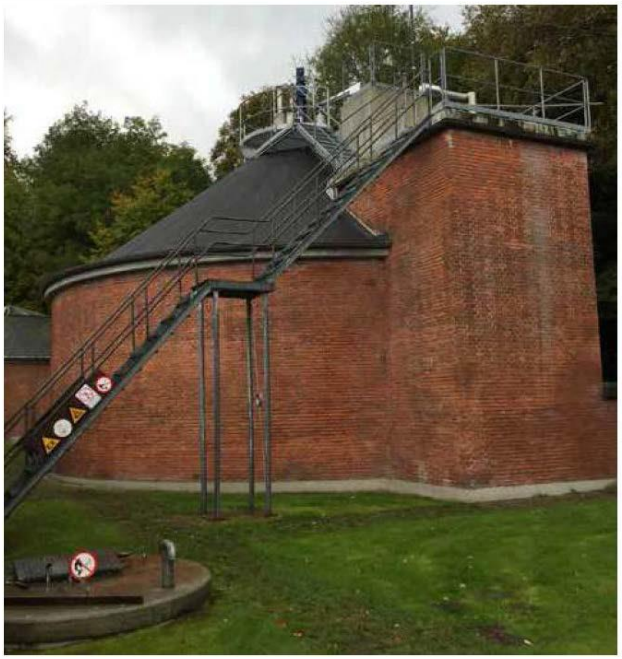

The digester at Sydkystens Renseanlæg in Espergærde.

Efforts to optimise and operate digesters at Danish utilities are increasing. Many utilities have moved away from being energy-consuming/energy-neutral and now want to be energy-producing. This change requires dedicated action regarding the optimisation of biogas production. A system survey will reveal whether the biogas yield can be increased and also clarify whether the existing equipment will be able to handle increased gas production (such as reactor insulation, agitation and heat exchanger capacity).

In 2015-2016, the NomiGas research project studied the effect of minor temperature increases in the mesophilic area for many of the mesophilic sludge-based systems. The residual methane potential was documented at three different temperatures (35, 39 and 42°C) and confirmed that most systems would be able to achieve higher gas yields by increasing the reactor tank temperature from the lower mesophilic area (35°C) to the higher area (39-42°C) (Spildevandsteknisk Tidsskrift 2, 2016. Nielsen et al., 2017). These findings have also been validated in new lab tests with semi-continuous reactors. The findings confirmed that gas production is greater at a higher mesophilic operational level than at temperatures in the lower mesophilic area, and the findings have just been submitted to a scientific journal.

Sydkystens Renseanlæg participated in a system survey and had digestions made of the residual methane potential. Data from the CRS system used to monitor the reactor temperature over the year was compared with data for residual methane potentials. Overall the data documented a potential increased yield of biogas for operation at a higher reactor temperature (42 degrees). The digester was originally operated at a significantly lower temperature than the optimum temperature (between 30-35 °C while the optimum temperature was determined at 42°C). Based on these figures, it was decided to invest in a new heat exchanger in order to be able to increase the reactor temperature from 30-35°C to 42°C. The existing pipe in pipe heat exchanger was replaced by a new heat exchanger capable of heating the digester to a constant temperature of 42°C. The implementation of the heat exchanger also improved the utilisation of the produced residual heat.

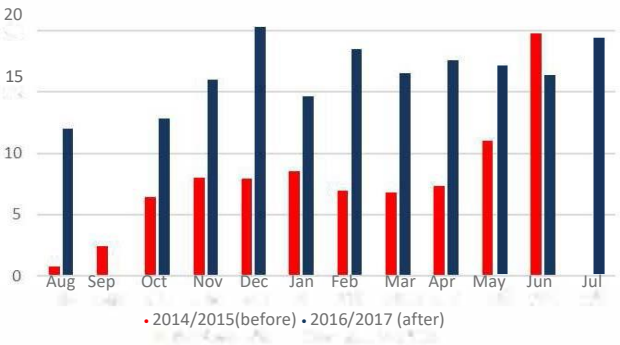

Figure 1. Outline of the biogas yield at Sydkystens Renseanlæg before and after installation of the heat exchanger.

Old heat exchanger.

New heat exchanger

The overall effect of these initiatives has been measured as a difference in the biogas production before and after installation of the new heat exchanger and the change in reactor temperature. As it appears from Figure 1, the yield per m3 sludge doubled from 8 to 16 m3 biogas per m3 sludge. The digester is 990 m3 in total. Overall biogas production was increased by 26% after the change in reactor temperature despite reducing the total sludge quantity by 39% (from 248,362 m3 to 313,849 m3 biogas/year), which gives a payback time for the replacement of a heat exchanger of approx. two years.

Based on the previous data for the residual methane potential, it is estimated that a not insignificant part of the Danish mesophilic digesters could achieve a gain as additional yield by increasing the reactor temperature and maintaining it at a stable level. In many sewage treatment plants, sludge is fed only once a day, which results in a temporary temperature drop in the reactor of up to 2-3 degrees, thus affecting the biogas production. A more even feed, for example 4 times a day, might minimise temperature fluctuations. Moreover, many digesters are operated at a reactor temperature in the lower mesophilic area.

Figure 2. Overview of potential additional methane yield stated as a percentage vs. yield at 36°C. The sludge-based systems examined have been marked with letters (A - M).

As it appears from the graph below stating the additional yield at a reactor temperature of 36°C, the highest biogas yield is often achieved at a temperature in the upper mesophilic area. Consequently, in many cases it will be profitable to increase the reactor temperature for the digesters, which are currently operated in the lower mesophilic area. However, the measurements completed represent snapshot, reflecting the current temperature and performance of the specific reactor contents. Another way of examining the effect of temperature increases will be on a semi-continuous scale with continuous material feed.

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