

## **T10. Process Analytical Technology — monitoring of biogas processes at meso scale test biogas plants**

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Biogas plants converting animal manure materials and other biomass feedstocks by anaerobic digestion (AD) are among the cheapest and most effective tools for achieving post-Kyoto targets concerning reduction of the emission of greenhouse gases of CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O. Focus in this study is on a mesoscale biogas test plant implementation of Process Analytical Technologies (PAT) to develop chemometric multivariate calibration and prediction models for on-line monitoring and control of the anaerobic digestion process in a re-current loop modus. The larger goal is to prepare for implementation of on-line monitoring and control applications in the biogas and biorefinery sectors, in order to be able to adjust the process according to the demands of the bioenergy supply for producing combined heat and power when needed over the 24 hours or for the biorefinery sector to optimize the product yielding.

Most studies reported in the literature have investigated near infrared spectroscopy (NIR) in laboratory-scale or minor pilot biogas plants; only very few studies exist for on-line process monitoring of full-scale biogas plants of meso-scale biogas plants. It is here necessary to obtain a fairly constant level of VFA concentration which leads to a stable biogas production. VFA concentration levels should not exceed 4–5000mg/l. On-line control and management of VFA concentration levels can speed up or slow down the AD-process.

By comparing pilot plant NIR-spectra to laboratory VFA reference concentrations at the experimental locality Bygholm, it was possible to develop highly satisfactory calibration models by Partial Least Squares (PLS) regression, i.e. acceptable to very good PLS-prediction models for total VFA as well as for all essential individual acids. The average statistics assessing prediction performance, accuracy (slope-value) and precision: correlation ( $r^2$ ), were both 0.92. VFA contents had a significant impact on biogas production. The Bygholm studies took place in a meso-scale 150L bioreactor supplemented with a recurrent loop of the TENIRS modus.