Fachhochschule Köln
Cologne University of Applied Sciences

Gummersbach Environmental Computing Center

GECO C

Model-Based Process Optimisation of Agricultural and Industrial Biogas Plants

Introduction

Bioenergy today makes a significant contribution to a reduction in CO_2-emissions and, at the same time, reduces dependency on constantly rising prices for fossil fuels. In 2007, 6% of the energy required in Germany was able to be covered through the use of biomass to produce energy.

Fig.1: Typical Biogas Plant

The development and testing of a process-control system that has the ability to learn in order to optimise the functionality and costs of existing wastewater treatment plants on behalf of small and medium-sized local authorities. The fermentation of biomass in agricultural or industrial biogas plants represents a significant route that is worth exploiting in this connection. Numerous technical developments and increases in efficiency as well as the promotion of renewable forms of energy by the legislature increasingly guarantee the economic operation of a biogas plant. Nevertheless, even charging, stable substrate quality and raw material costs are important parameters for successful operation. In order to keep the energy costs of operating the plant as low as possible and, at the same time, increase the quantity of biogas and improve the quality of the biogas, the Cologne University of Applied Sciences is developing jointly with PlanET Biogastechnik GmbH an intelligent, application-orientated optimisation tool for the everyday management of a plant. Accordingly, operating conditions as well as the most widely varying substrate mixtures can be analysed and optimised.

Project Aims

Testing and installation of suitable process measuring equipment. For the measurement and monitoring of process-relevant parameters that go beyond the standard parameters innovative measuring systems have to be tested and evaluated.
Construction of a simulation model for the simulation and forecasting of the behaviour of the plant on the basis of the measurement data captured for the purpose of optimising the operation of the plant.
Construction of a materials database: Recording of known and unknown substrates, the use of some of which are still in the test phase. These substrates can be read directly into a simulation model.
Optimisation of the biogas process, taking into account the production of methane and the cost of substrates. The testing of different substrate compositions and quantities using the simulation model in order to assess their effects on the biogas process. Optimisation of the substrate feed in order to improve the performance of the plant as well as process stability using innovative optimisation processes.
Use of the simulation model and optimisation processes during practical operation. The simulation model is run in parallel with the plant and supports the operator at all times when it comes to the selection of the best substrate charges using optimisation and forecast calculations.

Wastewater Treatment Plant

Sewerage System

Biogas Plant

Drinking Water

Decentralised Monitoring

PlanET Biogastechnik
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Optimisation and Monitoring of the Biogas Plant Operation

The project partners know from their own investigations that a plant can be considerably improved through the optimisation of the substrate feed and, in so doing, the stability of the process increased at the same time. This stimulates efficiency reserves of the order of 20% which are reflected in a higher biogas yield and lower energy and substrate costs. However, state-of-the-art measuring and control equipment is required.

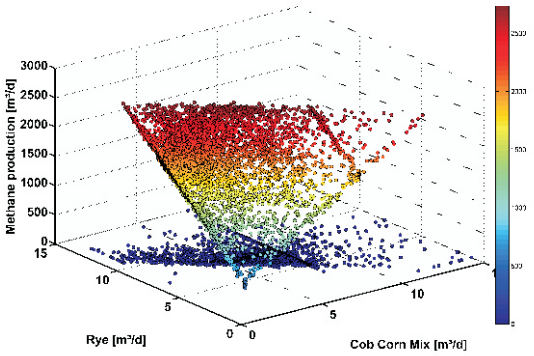

Fig.2: Methane-production for different Substrate combinations

Dry-substance and redox-potential measuring probes are of crucial importance for capturing all of the relevant process parameters. Additional information can be obtained through the use of spectroscopic measurements. Through these the recording of the amount of organic dry-substance and, in addition, the measurement of the concentration of individual organic acids is possible.
For the actual optimisation innovative methods from the field of computational intelligence are used, which model themselves on natural processes for their basic principles. These include, among other things, genetic algorithms which replicate evolutionary processes, and so-called “particle swarm optimisation”, which is modelled on the internal communications behaviour of flocks of birds. Such processes are particularly suited to optimising complex events such as the production of biogas where many parameters have to be taken into account.

GECO▸C - Cologne University of Applied Sciences

With modern equipment, the provision of application-orientated teaching and numerous research and industrial projects, the Gummersbach Environmental Computing Center at the Institute for Automation & Industrial IT, part of the Cologne University of Applied Sciences, offers a comprehensive range of services in the fields of teaching and research.

PlanET Biogastechnik GmbH

PlanET Biogastechnik GmbH is one of the leading builders of biogas plants in Germany and Europe. The portfolio of services offered by the company includes all areas of biogas technology, from the design stage, the construction of the plant up to and including service and biological care provided by an in-house laboratory. Worldwide PlanET Biogastechnik has completed more than 140 biogas power plants of the order of 40 kW of electricity up to 10 MW of electricity. At the same time, every PlanET biogas plant is known for its efficiency, level of innovation and profit-turnover ratio. The intention is for the successful use of PlanET MSR technology to be further developed as part of the MOBIO project.

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