Sewage Sludge and Co-Substrates as Flexible Energy Sources

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Introduction
At municipal wastewater treatment plants (wwtp) energy demand and generation are separately optimized processes that are separated spatially and temporally from each other. Correlating to operating conditions at a wwtp, the energy consumption shows daily, weekly and annual variations (cf. Fig. 1). Though, today's energetic optimization is typically based on average values, impacts of daily variations cannot be considered. Furthermore, digesters are operated in a continuous manner with a steady gas production. Sewage sludge and co-substrates contain chemically bound energy resp. are energy storages, which offers the theoretical possibility to cover proportionally occurring peak loads by target-oriented feeding the digester.

As shown in Figure 1, the energy demand varies over the day. Figure 2 shows the annual load duration curve of electricity purchase of a wwtp. The impact of co-digestion on gas production shows high potential for the future of energy efficient wastewater treatment plants. The impact of co-digestion on gas production takes place at a wwtp in Germany with a size of 32,500 PE (population equivalent), operating two digesters in parallel. Raw sewage sludge is charged continuously into both digesters, whereby co-substrate (food waste) is charged discontinuously into digester 1. Based on the large scale examinations, laboratory-scale digestion tests (15 L reactor, hydraulic retention time: 20 d) are conducted under mesophilic conditions. Hereby, several substrate ratios (raw sludge/food waste) are used to identify specific conversion rates after charging.

Results and Conclusions
Directly after charging co-substrate the gas production in digester 1 increases immediately; after 5 h the gas production of both digesters is almost equal again (cf. Fig. 3).

The conversion rate curves can be described as logarithmical function starting with a high conversion rate within the first hour decreasing rapidly afterwards (cf. Fig. 4). As expected the conversion rate of the test series charging 20% co-substrate shows the highest values. The dosage as well as the conversion rate of co-substrates can be an important component of a smart control system.

Perspective
The potential of wwtp as flexible energy sources and storage might be one of the key aspects for the future of energy efficient wastewater treatment plants. The implementation of a load management. This and other new processes such as e.g. thermal pressure hydrolysis process are research objects of the joint research project ESiT – “Wastewater treatment plant of the future: Energy storage in interaction with technical infrastructure between the poles of energy generation and consumption”. The conventional digestion and high-load digestion are conducted in semi-technical scale under mesophilic conditions to examine the flexibility of the digestion.

Nowadays wwtps are considered as energy consumers, in future wwtps might be considered as possible energy supplier and storage. Therefore the flexibility of a wwtp referring to energy generation will increase and further potential for efficient use of energy could be developed through the interaction with technical infrastructure such as power companies. Further information can be found on:

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