POWERSTEP

YOUR FLUSH, OUR ENERGY

Don't under estimate the power of wastewater!

Case Study BIOFOS Avedøre – from biogas to a more usable form of energy

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INTRODUCTION

Innovative concepts of advanced wastewater treatment plants (WWTPs) have already been proposed in order to maximize the energy recovery from wastewater while minimizing the energy demand for its treatment , thus changing the perception of wastewater from waste to resource. The combination of technologies proposed in EC funded project POWERSTEP will lead to design of energy-positive WWTP. One innovative way to achieve this goal is biogas valorization and especially the power-to-gas concept. Combining power-to-gas facilities within WWTPs has been proposed relatively recently and generally with the advent of biological methanation technologies. Combining power-to-gas within a WWTP is particularly interesting because the by-products heat and oxygen can be recycled on-site and because WWTPs are usually situated close to demand centers, allowing the gas to be injected into a low-pressure distribution. At the WWTP Avedøre, POWERSTEP focusses on the integration of biomethanation testing the "power-to-gas" concept by operating the world-largest plant.

OBJECTIVE

By 2020, 80% of Denmark's energy supply will come from green sources (i.e. wind, biomass). Unlike these fluctuating sources of energy, Avedøre provides a smart-grid solution.
In a short-time, it converts electrical energy to chemical energy by converting the biogas CO2 component into biomethane. The biomethane is injected into the Danish National Gas Grid, where it is stored until needed.
Biological methanation reactors can use raw biogas as a source of CO2, which increases the methane production of existing biogas plants.
Electrochaea built a 1 MW biological methanation plant at the Avedøre Municipal WWTP that upgrades biogas to biomethane. It combines CO2 from current raw biogas production, a unique biocatalyst, and hydrogen produced with excess solar and wind power.

PILOT PLANT CONFIGURATION

The demonstration site is located at the Avedøre Municipal WWTP. The plant has a 1 MW electrical input and consists of an alkaline electrolysis and an biological methanation stage. Fig. 1 shows the biomethanation reactor. CO_2 for biogas-upgrading coming from the biogas gained as output for the digesters. The methane is finally injected into a 4-bar distribution grid and the heat is used in buildings

Fig. 1: *Biomethanation reactor using CO_2 produced in the digesters to perform biogas-upgrading for gas grid injection*

PROCESS; EXPERIMENTAL RESULTS

Two basic chemical reactions are required to produce CH_4. The gaseous energy substrate H_2 is produced by electrolysis (Eq. 1). H_2 together with CO_2 (e.g. from biogas or other industrial waste streams) is then converted into CH_4 (Eq. 2). This methanogenesis is mediated by the biocatalyst employing a unique set of enzymes.

1. Electrolysis: $4\ H_2O \rightarrow 4\ H_2 + 2\ O_2 + Heat$
2. Methanation: $CO_2 + 4\ H_2 \rightarrow CH_4 + 2\ H_2O + Heat$

The process is under operation since April 2016 Fig. 2 shows a very high H_2 conversion rate up to 98%. Electrochaea`s biocatalyst as a robust microorganism produces in the next step efficiently methane by converting the gained H_2 in a stable and continuous manner.

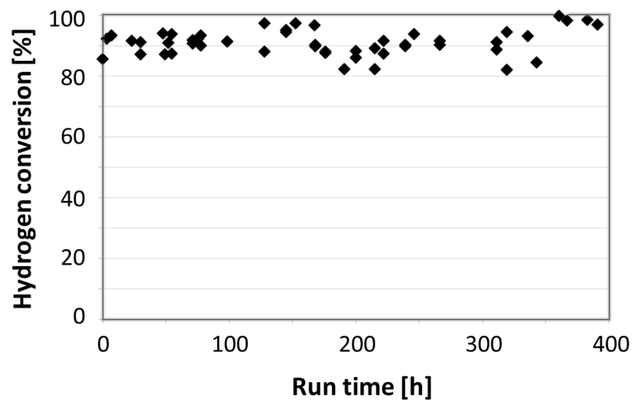

Fig. 2: *Hydrogen conversion performance by the methanation*

SYSTEM INTEGRATION

Fig. 3 shows that the methanation reactor is an important module and can be fully integrated into the process scheme of a WWTP to become energy-positive.

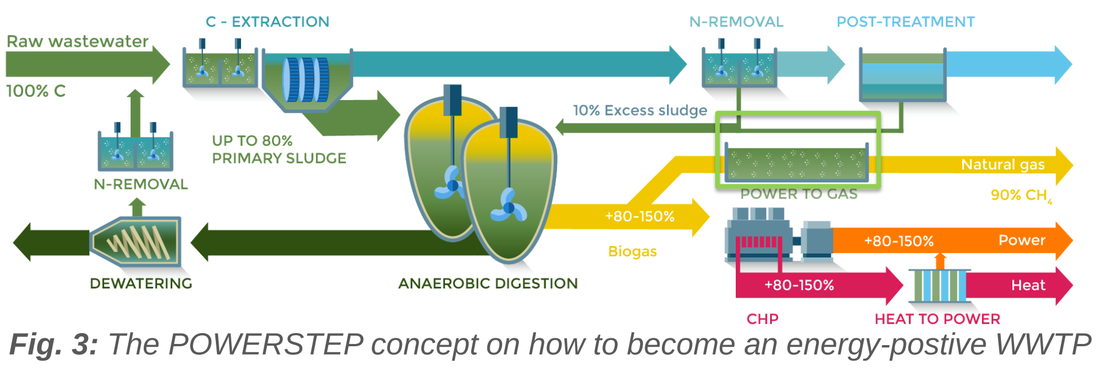

Fig. 3: *The POWERSTEP concept on how to become an energy-postive WWTP including „POWER-To-GAS" as an important module*

PROJECT PARTNERS

Electrochaea BIOFOS NEAS ENERGY

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