POWERSTEP

YOUR FLUSH, OUR ENERGY

Don't under estimate the power of wastewater!

CASE STUDY 2 – SJÖLUNDA WWTP

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CHALLENGE

POWERSTEP is a project that demonstrates the required treatment schemes for energy-positive wastewater treatment.

In Europe, the municipal wastewater sector consumes the annual power generation of two large power plants. Concurrently, organic matter contained in municipal wastewater accounts for 12 times as much chemical energy potential. In conventional wastewater treatment, the majority of this organic matter, or carbon source, is generally being oxidized in aerated biological treatment and/or used for nitrogen removal through denitrification. To achieve energy-positive wastewater treatment plants (WWTPs), however, this carbon source should instead be utilized as biogas.

An increased carbon extraction for biogas production typically challenges nitrogen removal in conventional wastewater treatment plants, given the dependence of denitrifying bacteria on an easily accessible source of carbon. Achieving net energy production in WWTPs hence requires an integrated combination of technologies, including 1) carbon extraction for biogas recovery, 2) nitrogen removal with minimal carbon utilization and 3) biogas valorisation and efficient energy management.

At Sjölunda WWTP, enhanced carbon extraction is of high interest both to increase the biogas production and to reduce the energy required to aerate the high rate activated sludge (HRAS) reactors, where organic matter is currently being oxidized. Simultaneously, there is a need to remove nitrogen from the wastewater without utilizing the valuable carbon. This need could be met using a biofilm process for partial nitritation and anammox.

COMPACT CARBON EXTRACTION

Microscreen filtration is a compact solution for enhanced carbon extraction.

The Hydrotech microscreen technology (drum- or discfilter) employs woven cloth filter elements installed on the periphery of a drum or disc, and utilizes an inside-out flow pattern. The filter is robustly designed with few moving parts to ensure long-life and low maintenance costs.

Veolia Water Technologies have installed more than 9000 Hydrotech microscreens worldwide, making the Hydrotech microscreen technology a proven solution for wastewater and process water filtration. However, the use of microscreens as primary treatment for enhanced carbon extraction is yet an innovative use of the technology.

Sjölunda is a suitable treatment plant for the demonstration of enhanced carbon extraction with microfiltration: since nitrogen removal through pre-denitrification is performed to a very limited degree, the higher the carbon extraction, the better for the overall energy savings.

Coagulants and flocculants can be added upstream the filter unit in order to improve the filterability of the particles, and hence the optimal carbon extraction at Sjölunda will rely on the balance between costs for additional polymer/coagulants versus more biogas obtained due to increased extraction yield.

NITROGEN REMOVAL WITHOUT CARBON

Nitritation-anammox is a promising option for carbon-free, mainstream nitrogen removal.

At Sjölunda WWTP, nitrogen removal is primarily done with post-denitrification using methanol as an external carbon source. As part of POWERSTEP, this case study will demonstrate a possible replacement of the current process by using anaerobic ammonium oxidation (anammox).

For anammox, ammonium and nitrite are biologically converted directly into nitrogen gas without any further requirement for carbon sources. Nitrite used by the anammox bacteria is produced by the oxidation of ammonium by ammonium oxidizing bacteria, resulting in large savings on aeration compared to complete nitrification traditionally used in nitrogen removal.

The nitritation-anammox process is today well established in the treatment of reject water from sludge-dewatering. However, the process remains challenged in mainstream treatment due to cold and diluted water, which requires new concepts and solutions to maintain stable operation.

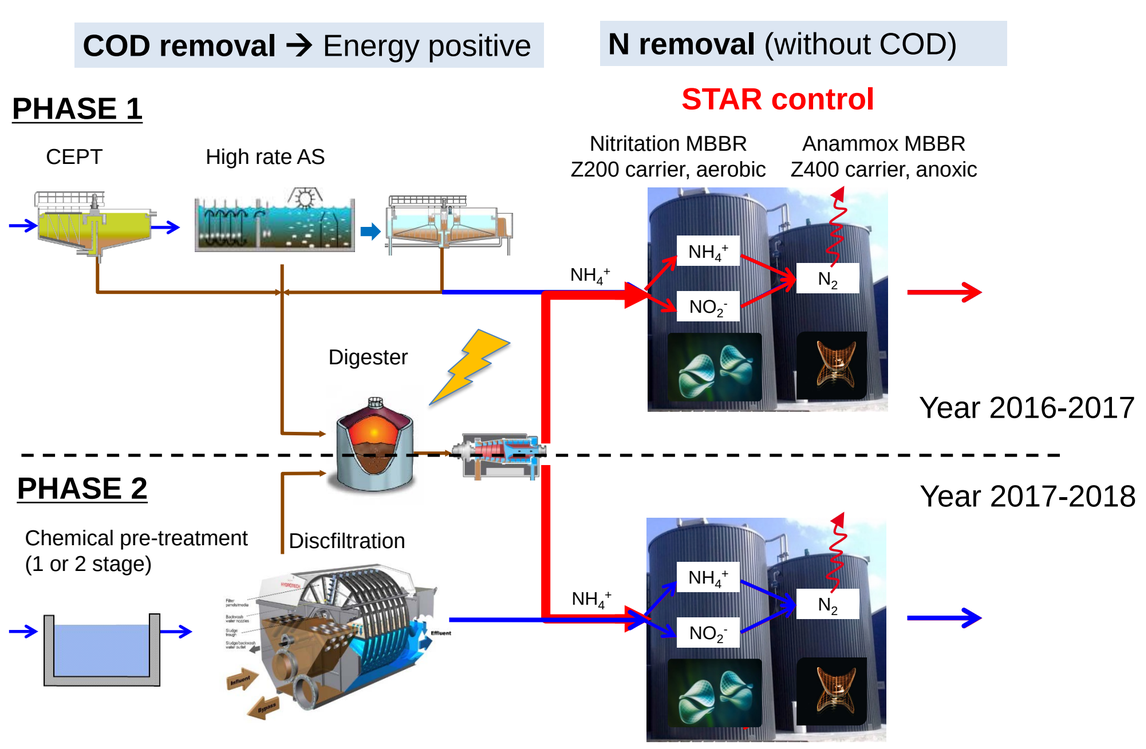
At Sjölunda WWTP the concept of mainstream nitritation-anammox will be demonstrated in two Moving Bed Biofilm Reactors (MBBRs). A new suspended biofilm carrier which can control the biofilm thickness, the Z-carrier, will be used to provide a selective biomass in the biofilm [1]. In the nitritation stage, a thinner biofilm thickness (200 µm) is chosen in order to promote AOB before the nitrite oxidizing bacteria (NOB), while the slow-growing anammox bacteria will be safely secured in 400 µm thick biofilms in the consecutive anammox stage.

In addition to controlled biofilm thickness, a new concept for operation, including temporarily exposure to sidestream wastewater, will further suppress NOB activity in favour of AOB and anammox [2]. An on-line control system for mainstream nitritation-anammox (STAR Utility Solutions™) will secure stable operation and high efficiency at lowest possible energy requirement.

GOALS AND OUTCOMES

Expected deliverables from the case study are:

- *Large-scale prototype demonstration based on a 3-stage concept, with two different pre-treatment processes for COD removal (below), followed by nitritation- anammox for mainstream nitrogen removal*
  - *Phase 1: primary clarifier and high-load AS*
  - *Phase 2: discfilter*
- *Demonstration of a stable and safe remote control scheme with online monitoring*
- *High carbon extraction capacity through pre-filtration with discfilter*
  - *using a minimum of chemicals*
  - *producing an effluent with lowest possible remaining COD*
- *Optimized nitrogen removal capacity in the nitritation-anammox process*
- *Characterization of nitritation and anammox biofilms, defining:*
  - *Maximum activity (batch trials)*
  - *Microbial composition (sequencing)*
  - *Characterization of biofilm structure (3D imaging)*
- *Estimated energy balance for the new concept, measured by energy consumption and compared to the current treatment at Sjölunda WWTP*
- *Estimated cost savings for the new concept (such as reduced operation costs by savings in aeration and carbon source)*



[1] Piculell M, Welander P, Jönsson K, Welander T. Evaluating the Effect of Biofilm Thickness on Nitrification in Moving Bed Biofilm Reactors. Environ Technol 2016;37:732–43.

[2] Piculell M, Christensson M, Jönsson K, Welander T. Partial nitrification in MBBRs for mainstream deammonification with thin biofilms and alternating feed supply. Water Sci Technol 2016;73:1253–60.

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