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IfU
Institut für Umweltingenieurwissenschaften
Institute of Environmental Engineering
Chairs of Urban Water Management

Master's Thesis 2023:

Possible Topics in Urban Water Management

Modelling of Aerobic Granular Sludge systems: toward the development of a good modelling practice (GMP) unified protocol

Background

Aerobic granular sludge (AGS) systems represent a relevant alternative to conventional activated sludge systems. Around 80 wastewater treatment plants based on aerobic granular sludge (AGS) and operated as sequencing batch reactors (SBR) are operational or under construction worldwide. However, their design and operation of AGS-SBR is mostly empirical. Empirical design criteria are site/situation specific, while the results of dynamic models, when properly used, can be relied upon for generalizable accuracy (Rittmann et al., 2018). Models can for example be used by engineers for the planning, design, optimisation, and evaluation of existing or new wastewater treatment plants (WWTP). But while the number of AGS systems implemented at full scale is growing rapidly, practicing engineers are still in need of a more appropriate AGS model. Eawag recently developed a complete and powerful AGS model (Derlon et al., 2022). But while this model integrates all the processes relevant to AGS systems (plug-flow feeding, selective sludge removal, SBR operation), it has not yet been calibrated and confronted with datasets from full-scale installations.

Objectives

The main objective of the proposed master thesis is to **(1) critically evaluate the Eawag AGS model by confronting it to datasets from full-scale AGS installations and (2) to develop a good modelling practice (GMP) unified protocol specific of AGS system.** The specific research questions and tasks are:

- To define what dataset is required for the calibration of AGS models (e.g., sludge bed stratification, sludge composition, effluent quality).
- To contribute to the collection of such dataset by conducting measurement campaigns.
- To adapt the AGS model to the design/operation of Sarneraatal WWTP (e.g., implementation of an ammonia controller to control the SBR cycle).
- To calibrate the current Eawag AGS model using these datasets.
- To aggregate the knowledge gain from this calibration effort into a GMP unified protocol.

Approach

The Eawag AGS model implemented in Sumo® software will be used in this master thesis (free access and more information can be found here: https://www.eawag.ch/en/department/eng/projects/abwasser/ags-aerobic-

granular-slugde-model/). This model includes a reactor model, a *1-D biofilm model* and a *biokinetic model* (Sumo1). The *reactor model* consists of an available assembly of 4 completely stirred tank reactors (CSTRs) organised in series, so that plug-flow conditions are mimicked during feeding at the reactor bottom. Datasets from a full-scale AGS plant will be monitored at Alpnach-Sarneraatal WWTP, in collaboration with Wabag.

Requirements

Interests in (1) advanced technologies for biological wastewater treatment, (2) modelling of biological wastewater treatment plants.

Advisors

Main supervisor: Nicolas Derlon (Eawag)
Advisors (ETHZ responsible professor): Prof. Morgenroth (ETHZ)
Project partner: Wabag, WWTP of Sarneraatal, WWTP of Opfikon

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References

Derlon, N., M. Garcia Villodres, R. Kovács, A. Brison, M. Layer, I. Takács and E. Morgenroth (2022). Modelling of aerobic granular sludge reactors: the importance of hydrodynamic regimes, selective sludge removal and gradients. Water Science and Technology. 86(3): 410-431.

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