Taking Wastewater Treatment to the Next Level: Sludge Wastage Control in Aerobic Granular Sludge

Keywords: aerobic granular sludge, municipal WWT, physical processes, stratification of sludge, settling, upflow, sludge wastage control

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Background

Aerobic granular sludge (AGS) is a relevant technology for wastewater treatment that has been studied over the past 25 years (Morgenroth et al., 1997) and has the potential to overpass conventional activated sludge (de Bruin et al., 2004). Instead of flocs only as in activated sludge, the biomass of AGS consists of a mixture of flocs and granules of different sizes (Figure 1). Advantages of AGS systems over conventional activated sludge systems are 1) the excellent settling properties of the sludge, i.e., no secondary clarifier is needed, 2) different redox zones are present in a granule, i.e., various processes can happen simultaneously and 3) higher biomass concentrations can be achieved, resulting in space and energy savings. In Switzerland, two full-scale AGS systems are under operation: WWTP Kloten Opfikon and WWTP Sarneraatal.

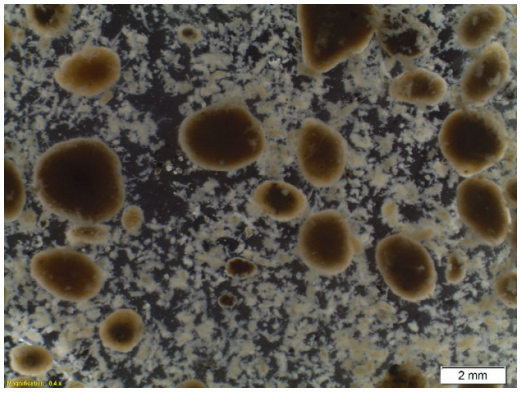

Figure 1: Image of an AGS sample from ARA Kloten Opfikon.

A prerequisite for the use of AGS technology is the formation of granules and their retention in the system. In AGS systems operated as sequencing batch reactors (SBR), a main strategy to enhance granulation is to selectively remove the slow settling biomass (Pronk et al., 2015; van Dijk et al., 2020). However, not only slow settling flocs are removed but also small granules or granule debris that are important for microbial performance. The challenge is therefore to better control what is removed which affects sludge composition, i.e., distribution of flocs and different sized granules, and in turn the microbial performance of the system. Understanding how to control stratification is the next step in our efforts to engineer sludge composition.

In current AGS operation, sludge wastage is either conducted after settling, after settling+feeding or after settling+feeding+recirculation, not knowing however the implications of those strategies on what is wasted. To our knowledge, no wastage strategies have yet been suggested to control sludge composition. We expect the sludge composition to be subject to seasonal variations, underlining the need for a dynamic wastage strategy. **Studying AGS stratification, considering all present sludge compartments, and how it can be controlled will offer a major advance in our knowledge about AGS operation. It will allow us to control the granulation dynamics and thus intervene in the microbial assembly in AGS.**

Objectives of the suggested topic

The main goal of this Master's Thesis is to develop a stratification model and a wastage strategy to control the sludge composition in AGS. The thesis will consist of the following phases:

(A) Short-term stratification experiment
(B) Developing settling model
(C) Simulation of sludge stratification and testing of various wastage strategies aiming for control of sludge composition

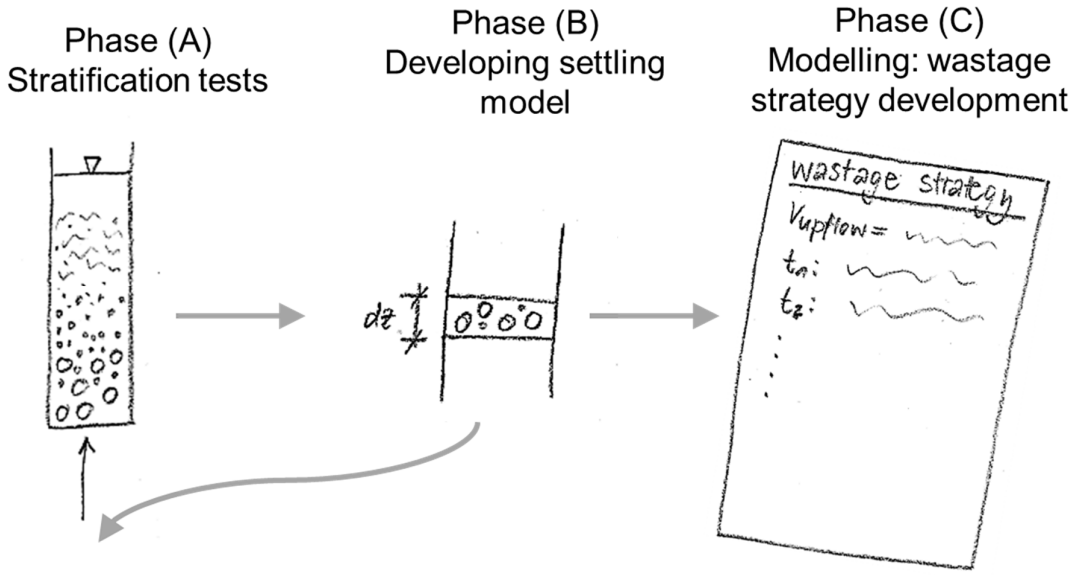

Figure 2: Scheme of working plan for this Master's Thesis.

In a previous Master's Thesis already 3 stratification tests were conducted (A), the results of which can be used for model validation. 1 additional stratification test at WWTP Opfikon is suggested. Furthermore, already a significant part in developing the model was conducted (B): settling parameters were collected, stratification of AGS during settling was implemented and an approach for implementing the upflow was proposed. The next steps will be to verify the upflow approach and implement it in the model, to validate with the stratification tests and to then develop and test wastage strategies (C).

Specific information / Requirements

Knowledge in biological wastewater treatment and interests in 1) advanced technologies for biological wastewater treatment, 2) understanding physical processes and 3) their modelling.
The master thesis will be performed in the Process Engineering department of Eawag in Dübendorf ZH. Office space with computer and access to the existing experimental facility will be provided.

Advisors and Supervisors

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