Life Cycle of Aerobic Granular Sludge: Microbial Communities & Activities

Keywords: aerobic granular sludge, SBR, microbiology, DNA analysis, activity tests

Proposed: October 2022 Valid until: December 2024

Background

Aerobic granular sludge (AGS) is a technology for wastewater treatment that has been studied over the past 25 years (Morgenroth et al., 1997). 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. In Switzerland, two full-scale AGS systems are under operation: WWTP Kloten Opfikon and WWTP Sarneraatal.

With maturation, granules disintegrate, i.e., 1) granules break apart into smaller pieces, which supposedly serve as seed for new granules, and 2) biomass detaches from the granules' surface. It is unclear to what extent successful granulation results from the densification of flocs and/or from the regrowth on breakage debris, i.e., self-inoculation (Figure 2).

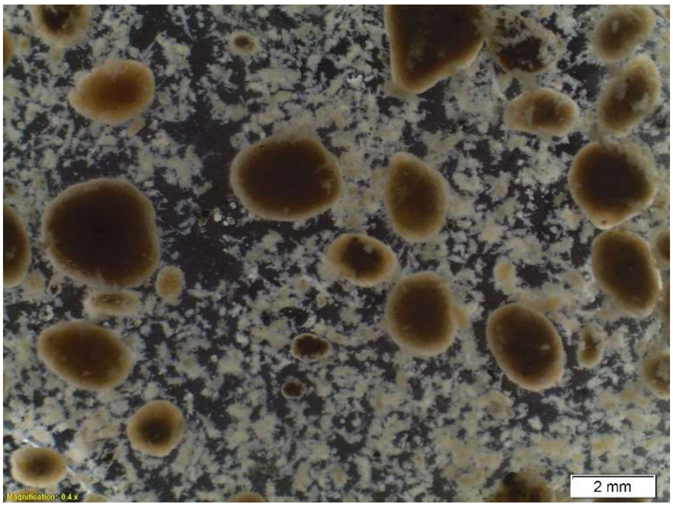

Figure 1: Image of an AGS sample from ARA Kloten Opfikon.

Our overall goal is to better understand the life cycle of AGS. We are currently investigating breakage and detachment to understand the contribution of these two mechanisms to granule disintegration and the kinetics behind it. The next step will be **to investigate the impact of breakage and detachment on the distribution of microbial communities and activities among flocs and different sized granules.**

We hypothesize that microbial communities migrate from larger size classes to a smaller ones via breakage and detachment. Hence, **breakage and detachment supposedly play an important role in the distribution of microbial communities** among the compartments of AGS. Furthermore, we expect the activity of flocs and small granules to be a major contributor to the overall activities, due to their high density and large surface area for mass-transfer.

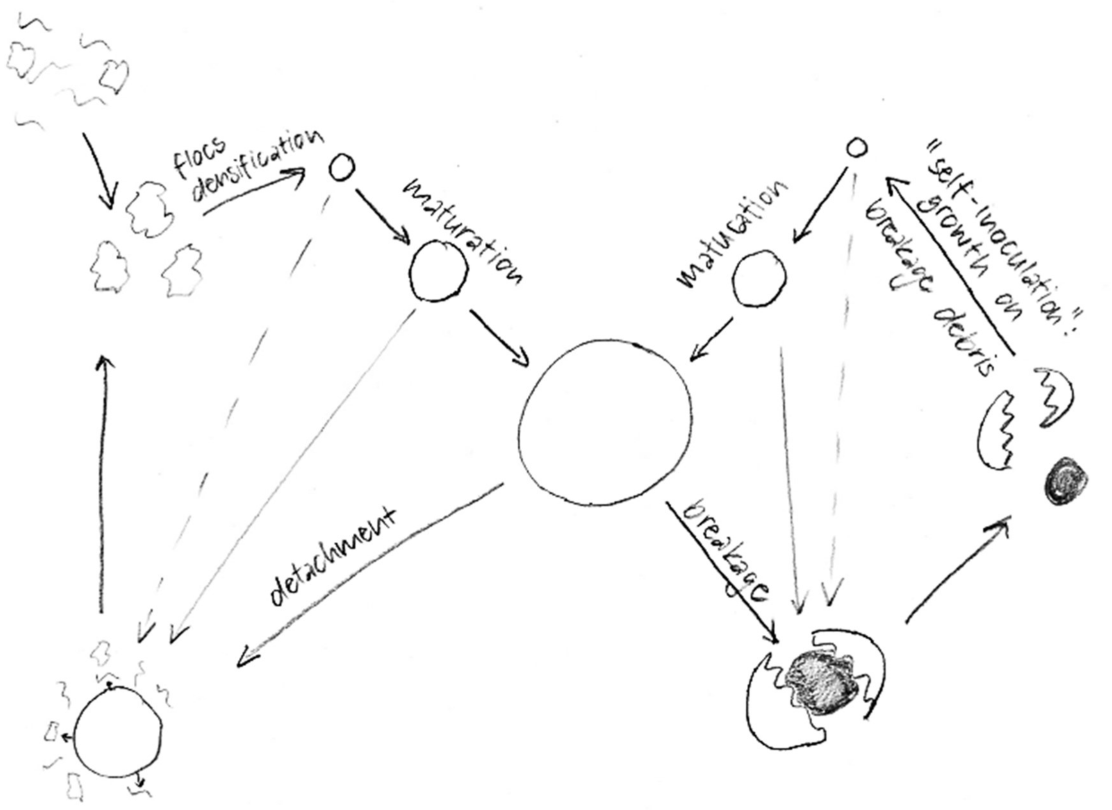

Figure 2: Scheme of the AGS life cycle.

Objectives of the suggested topic

The objective of this MSc thesis is to assess the impact of breakage and detachment on the distribution of microbial communities and activities among flocs and the different sized granules.

The specific research questions are:

- How do breakage and detachment influence the distribution of microbial communities in AGS?
- How are the microbial communities distributed over the granule's radius?
- What is the contribution of each sludge compartment to the overall activities?

To address these research questions sludge samples will be collected from WWTP Kloten Opfikon and WWTP Sarneraatal. The size class distribution of the sludge samples will be characterized, i.e. the fractions of flocs and various sized granules. For each size class, activity tests in terms of nitrogen and phosphorus removal will be conducted at Eawag in lab-scale. The distribution of microbial communities will be analysed for each size class and over a granule's radius.

Specific information / Requirements

Interests in 1) advanced technologies for biological wastewater treatment, 2) microbial processes applied to wastewater treatment and 3) learning new methods such as molecular tools and bio-informatics.

Advisors and Supervisors

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