Why new anammox plants do not need to be seeded

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INTRODUCTION

Autotrophic anammox bacteria have been described in the scientific literature as “extremely slow growing” in comparison to other types of bacteria used in waste water treatment (WWT), since the first enrichments showed a doubling time of 30 days [12]. The first well-documented start-ups using sequencing batch reactor (SBR) technique, moving bed biofilm reactor (MBBR) or granular process took 6 to 12 months to complete (for example [8]). From this perspective, several studies have focused on discovering useful seeding sources or specific start-up strategies to control the bacteria and shorten the start-up time, and many consultants and contractors have arrived at the misconception that seeding with inoculum is a requirement for successful start-up of all new anammox plants. Consequently, there is a market for exchange of anammox bacteria between contractors and WWT plants based on the perceived advantages in seeding a newly built plant. However, besides costs, availability and dependency, there are further arguments to reject this strategy, especially in relation to biofilm systems (long sludge ages and importance of layer structure) or further applications such as industrial wastewater, e.g. with specific characteristics requiring well-adapted biomass.

The objective of the study is to summarize the common work from the contractor Purac AB and the Institute ISAH at Hannover University regarding one-stage deammonification plants and review the last two decades of literature related to this topic, to make a clear conclusion regarding the necessity of seeding these type of plants.

RESULTS AND DISCUSSION

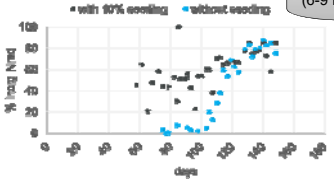
THREE MAIN ARGUMENTS WHY NEW ANAMMOX PLANTS DO NOT NEED TO BE SEEDED:

1. Several full-scale examples from the authors [1,4,8] and colleagues [7,13] provide proof of concept for non-seeded start-ups for reject water in MBBRs

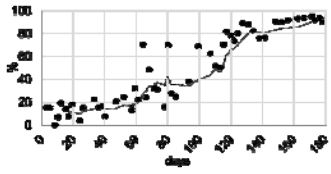
2. Journal papers evaluating anammox doubling time [6,10,12,14] and advances in optimizing start-up conditions [2,11] for anammox bacteria

3. Our recent study [5] has found viable anammox bacteria in both activated sludge and reject water streams, independent of digestion mode or substrate pre-treatment

Examples of carrier material suitable for biofilm growth



Nitrogen reduction over time in two parallel operated laboratory reactors evaluating the necessity of seeding [3].



Nitrogen reduction over time at Bekkelaget reject water treatment during start-up.

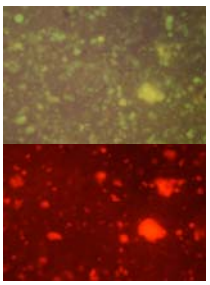


Image of FISH analyses, a useful tool during start-up
a) viable bacteria shine in green
b) anammox bacteria shine in red

CONCLUSIONS

Since the early 2000s Purac and ISAH have tested different start-up strategies; with and without anammox seeding in laboratory, pilot and full-scale. Focusing on the implementation in biofilm systems, we conclude:

- External seeding of biofilm reactors is not essential for reject water treatment, since the anammox bacteria is present in the influent regardless of the type of sludge treatment.
- Start-up times for full-scale projects have decreased since advances in optimized conditions for anammox bacteria and are no longer a limiting factor in a new projects.
- The formatting of system-optimized biofilms is crucial for good and stable process performance and optimal process rates and efficiencies.
- In situ start-up in full-scale applications increases the process operators’ knowledge of the process.

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