Monitoring the start-up of a lab-scale SHARON reactor

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INTRODUCTION

CALAGUA research group is studying the pilot plant implementation of the best available techniques to achieve the sustainable performance of a WWTP. Four pilot plants treating urban wastewater are being operated for organic matter prefermentation, biological organic matter and nutrient removal, anaerobic sludge digestion and magnesium-ammonium-phosphate (MAP) crystallization for phosphorus recovery. The next step to achieve the sustainable WWTP is the ammonium removal from the effluent of MAP crystallisation process. This poster presents the preliminary results from the start-up of a SHARON process.

MATERIALS AND METHODS

Pilot plants description

Two 7-litre laboratory scale continuous stirred tank reactors (CSTR) are being operated under aerobic conditions for partial nitritation to achieve a 50:50 mixture ammonium-nitrite. The reactors are being fed with synthetic wastewater which reproduces the crystallizer effluent characteristics. The DO concentrations in the reactors were controlled at 2 mg/l.

Pilot Plant Operation

Reactor 1 has been operated for 7 months with:

- an initial sludge retention time (SRT) of 2.3 days
- influent ammonium concentration was increased step-wise 300-600-1000 mg N/l, resulting in 3.7-1.8-1.1 mol HCO_3^-/mol N
- temperature was progressively increased from 23 to 30ºC

After a complete process failure, the reactor was re-seeded (day 83):

- SRT was changed by modifying the influent flow rate (Figure 1)
- influent ammonium concentration 1000 mg N/l
- reactor temperature 30ºC

After achieving a nitritification degree close to 50 %, **Reactor 2** was seeded with biomass from Reactor 1. Key operational parameters:

- SRT = 4.6 days
- influent ammonium concentration 1000 mg N/l
- reactor temperature 30ºC

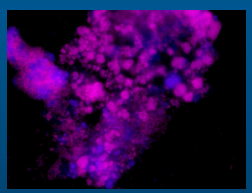
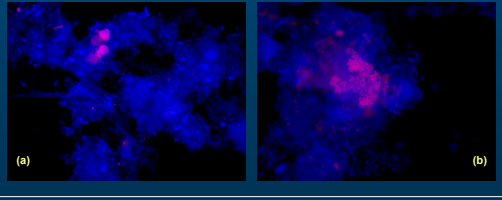


Figure 3. 60x FISH micrograph showing the predominance of ammonia-oxidising β-proteobacteria using NSO190 probe (pink) over total bacteria (using EUB mix probe) at day 59 of the experiment.

Figure 4. 60x FISH micrographs showing the presence of ammonia-oxidising β-proteobacteria using NSO190 probe (pink) and total bacteria (using EUB mix probe) in both inocula: (a) from a biological nutrient removal pilot plant (b) from a full-scale WWTP.



RESULTS AND DISCUSSION

Reactor 1

- After 20 days of operation nitrate concentration was negligible: nitrite-oxidisers were washed-out.
- Ratio ammonium-nitrite 50:50 reached at days 56-60. FISH analysis reveals an abundance of ammonia-oxidising bacteria of 86 % of the total bacteria targeted with EUB-338 mix probes (Figure 3).
- In the second start-up, the system achieved similar performance after 10 days to that obtained after 50 days operation under the first conditions. According to FISH quantification in both start-ups, the inocula contained the same percentage of ammonia-oxidising bacteria (7 %) (Figure 4). Thus, long acclimation periods are unnecessary.
- SRT changes were done to achieve a nitrification degree close to 50% (Figure 1).
- With SRT=4.6 days, significant evaporation was observed (0.5 liters/day). Thus, real SRT was 7 days and measured concentrations were corrected. However, FISH analysis revealed that nitrite oxidizers bacteria (NIT3 probe) represented less than 10 % of the total bacteria. This could be due to temperature, inhibition of nitrous acid, ammonia and/or salinity factors which may play a role in the competition between ammonium and nitrite oxidizers.

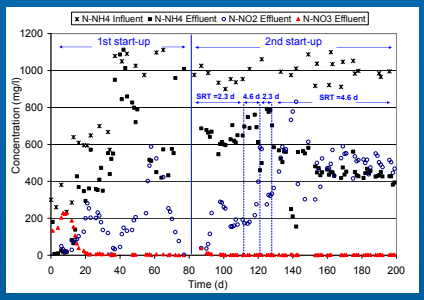


Figure 1. Evolution of influent and effluent ammonium, and effluent nitrite and nitrate concentrations over the experimental period for Reactor 1.

Reactor 2

- This reactor was seeded with enriched ammonia oxidizers bacteria from Reactor 1. Only took one month to reach the steady state. Ammonium and nitrite effluent concentrations were similar to those obtained in Reactor 1.

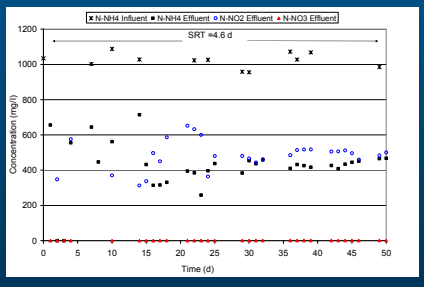


Figure 2. Evolution of influent and effluent ammonium, and effluent nitrite and nitrate concentrations over the experimental period for Reactor 2.

ACKNOWLEDGEMENTS

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