Low-sludge age EBPR process for resource recovery – microbial and biochemical process characterization

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1. INTRODUCTION

Current research promotes resource recovery using different strategies:

• Energy recovery using A-stage systems [1]
• Phosphorus recovery using low-SRT EBPR systems [2,3]
• To minimize nitrification, thus producing ammonium rich medium for phototrophic organisms [2]
• Water reuse for “fertilization” [2,4]

Common element: short-SRT EBPR systems

2. OBJECTIVES

• To start-up a short-SRT EBPR system and describe process performance
• To define the microbial community, affecting the performance of the short-SRT EBPR system
• To quantify energy recovery

System: sequencing batch reactor fed with municipal wastewater

3. RESULTS

1. Process Performance:

- Ammonia, nitrite and nitrate at the end of the aerobic phase and ammonia in the influent; b) phosphate at the end of the aerobic and anaerobic phases and influent; c) soluble COD at the end of the anaerobic and aerobic phases and total COD in the influent; d) phosphate removal; e) sludge volumetric index; f) total suspended solids. Phase A: from day 50 to day 78

2. Microbial community:

- Order-level taxonomic classification of 16S rRNA amplicons at selected days of the reactor operation. Taxa abundance is expressed in percentage (left axis). Alpha-diversity at the order level measured as Shannon index (white dots, right axis).

3. Biomethane potential:

- EBPR effectively removed phosphorus at SRT=3 d and *Accumulibacter phosphatis* was the main PAO (based on qFISH)
- Bulking correlates with poor phosphate removal (highlighted in red, in Fig. 1)
- High abundance of *Thiothrix* filamentous bacteria
- Sulfate reduction during the anaerobic phase (about 30% of influent sulfate)
- Sulfate reducers outcompeted PAO by
  1. Competing for influent COD
  2. Inhibiting phosphorus release
  3. Phosphate removal restored by reducing the anaerobic phase length (highlighted in green in Fig. 1)
- Up to 40% of influent carbon is recovered as methane at SRT=3 d

4. Highlights:

- EBPR effectively removed phosphorus at SRT=3 d and *Accumulibacter phosphatis* was the main PAO (based on qFISH)
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Figure 1: Reactor performance through 190 days

- Ammonia, nitrite and nitrate at the end of the aerobic phase and ammonia in the influent; b) phosphate at the end of the aerobic and anaerobic phases and influent; c) soluble COD at the end of the anaerobic and aerobic phases and total COD in the influent; d) phosphate removal; e) sludge volumetric index; f) total suspended solids. Phase A: from day 50 to day 78 – anaerobic SRT=1.2 d and aerobic SRT=1.75 d; phase B: from day 78 to 83 – anaerobic SRT=1.2 d and aerobic SRT=1.25 d; phase C: from day 83 to 109 – anaerobic SRT=1.2 d and aerobic SRT=1.75 d; phase D: from day 109 to day 132 – anaerobic SRT=0.88 d and aerobic SRT=1.75 d; phase E: from day 132 to day 156 – anaerobic SRT=0.68 d and aerobic SRT=1.75 d.

Figure 2: Order-level taxonomic classification of 16S rRNA amplicons at selected days of the reactor operation. Taxa abundance is expressed in percentage (left axis). Alpha-diversity at the order level measured as Shannon index (white dots, right axis).

References: