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 “fertigation” [2,4]

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

3. RESULTS

1. Process Performance:

![Figure 1: Reactor performance through 190 days](image)

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Ammonia (mg/L)</th>
<th>Nitrite (mg/L)</th>
<th>Nitrate (mg/L)</th>
<th>Soluble COD (mg/L)</th>
<th>TSS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>50-70</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>70-90</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>90-110</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>110-130</td>
<td>Low</td>
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<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>130-150</td>
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<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>150-170</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>170-190</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

2. Microbial community:

![Figure 2: Order-level taxonomic classification of 16S rRNA amplicons](image)

- Thiotrichales
- Thiothrix
- Chloroflexi
- Bacteroidiales
- Chlamydiae
- Sphingobacteriales
- SRT=3 d
- SRT=5 d

3. Biomechana 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 *Thiobrix* filamentous bacteria
- Sulfate reduction during the anaerobic phase (about 30% of influent sulfate)
- Sulfate reducers outcompeted POA by
  - Competing for influent COD
  - Inhibiting phosphorus release
- 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:

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References: