A new operational approach for secondary settling tanks to improve nitrogen removal in water resource recovery facilities

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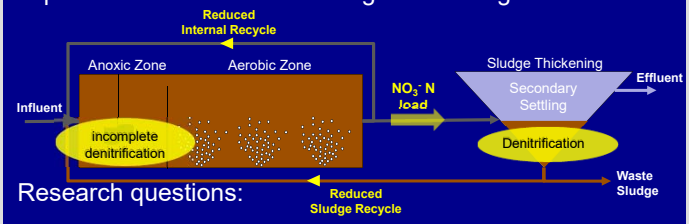
Introduction

Reactive secondary settling tanks (SST) can be used to improve denitrification in existing N-removing WRRFs.



Research questions:

1. Characterize SST denitrification kinetics and efficiency
2. Optimize and control operational conditions in SST
3. Characterize settling and thickening behavior of sludge

Potential Advantages

- **Improved** overall **N-removal** efficiency & effluent quality
- Reducing internal sludge recycle & **energy gain**
- **Additional capacity** for denitrification without new design & construction

Potential Disadvantages

- N_2-bubble induced **sludge rising** (Figure 1)
- Operational **control**

Figure 1. Sludge rising problem on SSTs

Experimental Work: different operational scenarios

To better understand reactive settling process kinetics and denitrification performance 5 operational scenarios were tested by creating different sludge blanket heights (SBH) and sludge activity levels :

Scenario 1 – Standard operational conditions
Low SBH in the SST

→ **Scenario 2 – Reduced sludge recycle**
Increased SBH in the SST

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Scenario 3 – Addition of external carbon

← **Scenario 4 – No internal sludge recycle**
High NO_3 Loading

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Scenario 5 – Addition of external carbon
At high NO_3 loading

→ **Scenario 6 – Reference Scenario**
Standard operational conditions

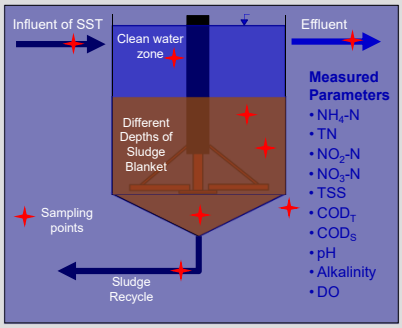


Figure 2. Sampling points & measured parameters

Figure 3. Sensor & laboratory analysis

Results

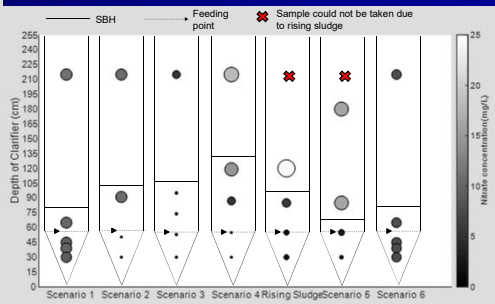


Figure 4. NO_3-N profile of SST

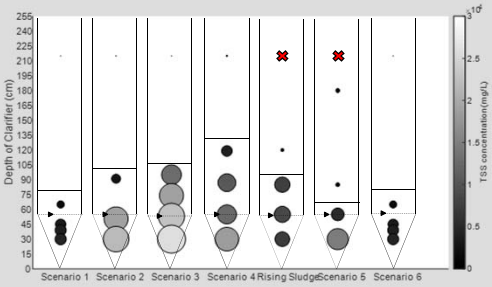


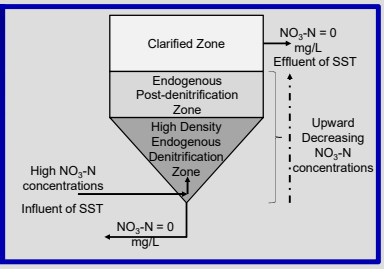
Figure 5. TSS profile of SST

- No SST denitrification under reference conditions
- Consistent 90-95% nitrate removal at reduced sludge recycle rates
- **Sludge thickening** is crucial for SST denitrification performance
- Rising sludge observed at high nitrate loads

- Significant potential for denitrification in the SST but optimum operational conditions & NO_3 loads need to be determined.

Conclusions

Denitrification efficiency is linked to increased HRT in the thickened sludge blanket. A potential new operational approach would be feeding the influent to the bottom of the tank.



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