A Low Capital Approach for Performing Separate Centrate Deammonification

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26th Ward WWTP

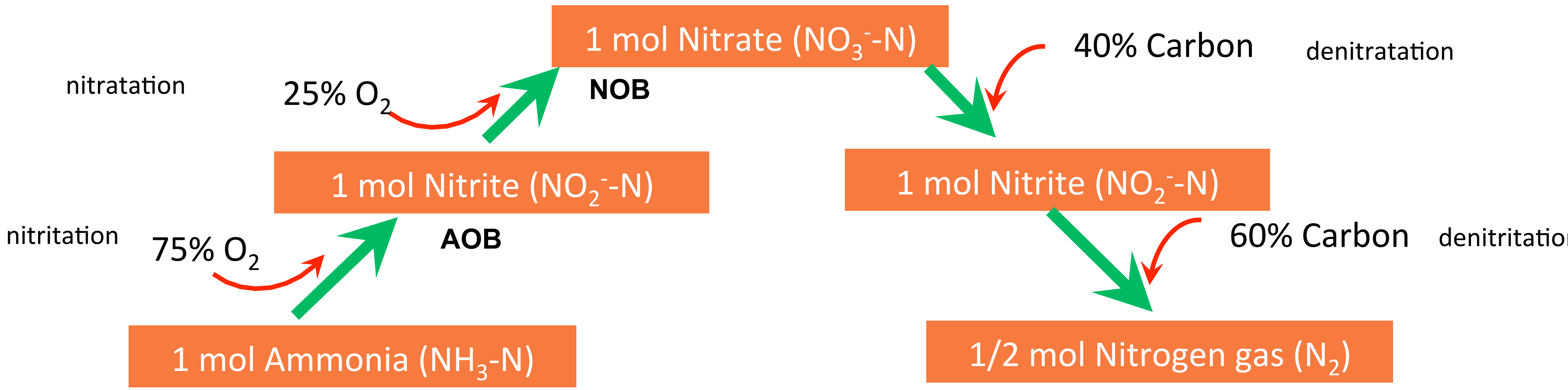
85 mgd

3 Aeration Tanks,

1 Aeration Tank dedicated to Separate Centrate Treatment (SCT)

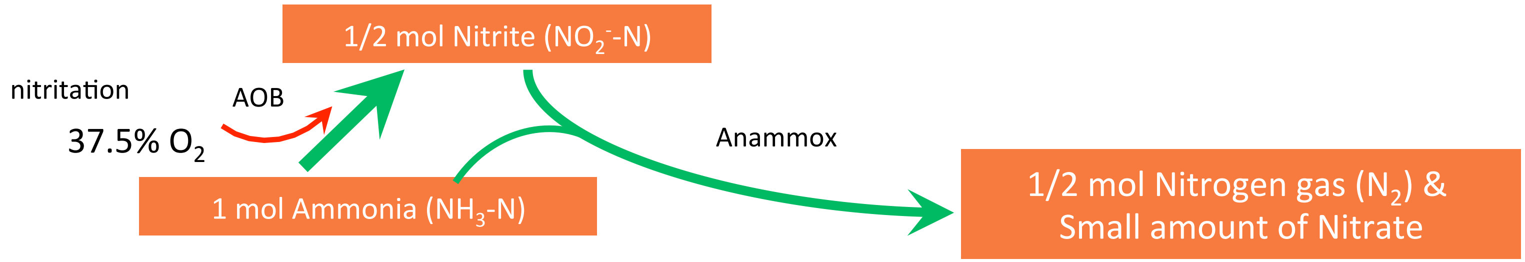
- Receives digested sludge from other WWTPs
- ~33% of influent load to secondary treatment is from centrate

26th Ward utilizes nitrification and denitrification for centrate treatment



- Current approach for SCT uses nitrification and dentrification
  - 4.57 g O_2/g NH4-N
  - 6 g glycerin as COD/g N

Implementing deammonification would reduce operating costs



Key requirements for commercial deammonification

- Anoxic conditions
- Simultaneous presence of ammonia and nitrite
  - NOB suppression
- Long SRT
  - Selective retention of anammox

	ANAMMOX	ANITAMOX	DEMON	CLEARGREEN
Proprietary retention strategy	Tilted plate settler	Plastic carrier and screen	hydrocyclone	SBR Control

Implications for 26th Ward and other SCT facilities

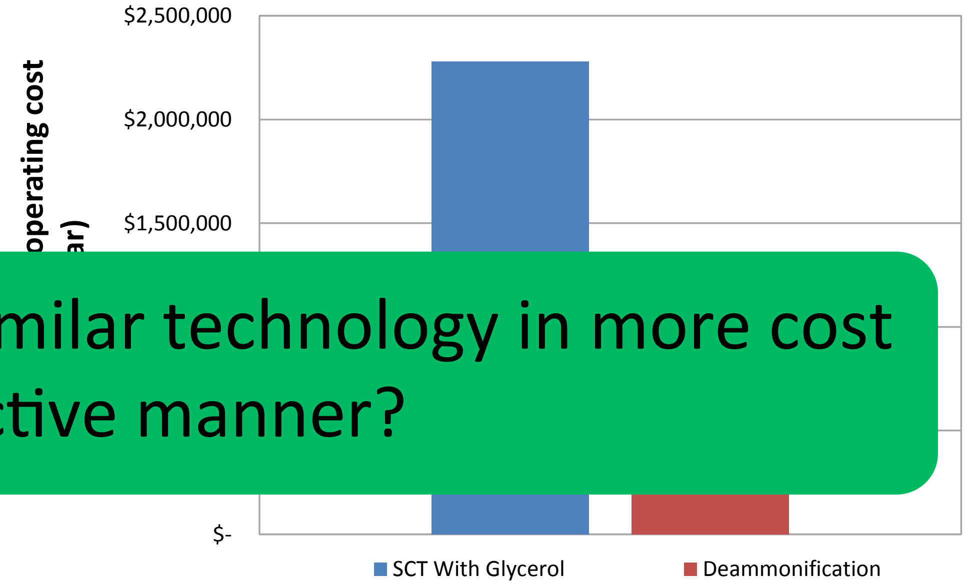
Significant retrofit of tanks and equipment

Acquisition of proprietary devices/ controls

Need reacto

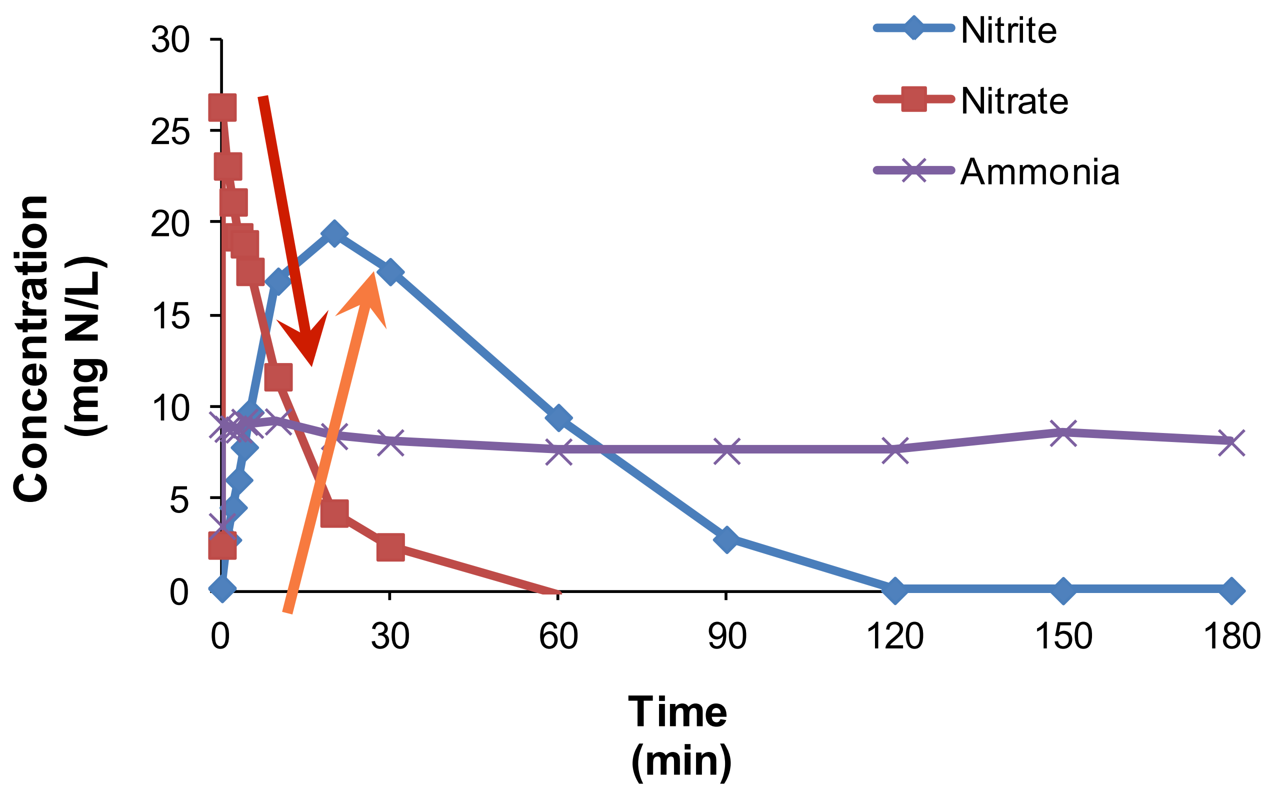
BUT

Significant upside in terms of operating energy and costs using anammox based technology



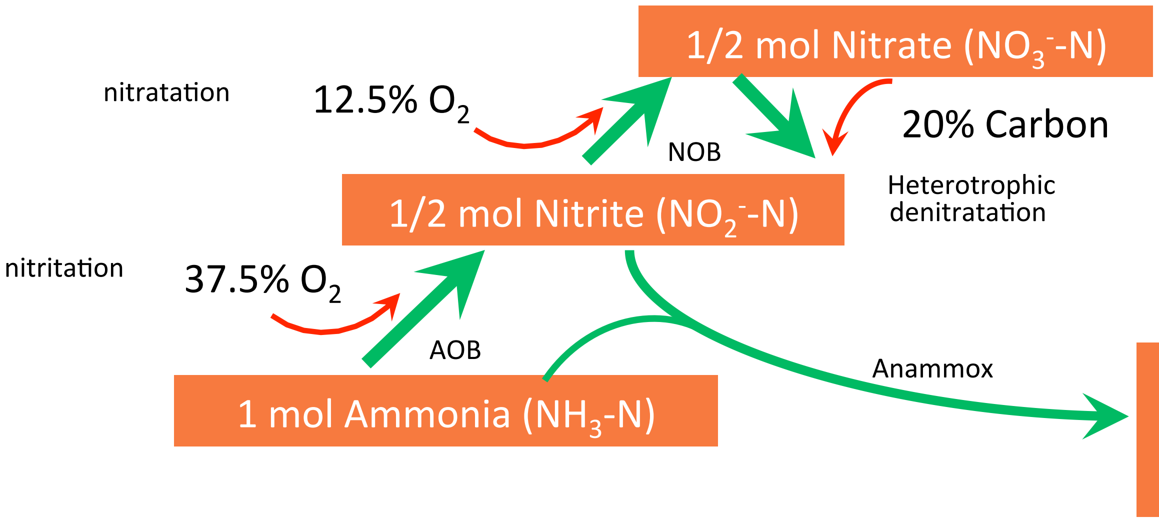
Can we implement similar technology in more cost effective manner?

Glycerol addition results in nitrite accumulation



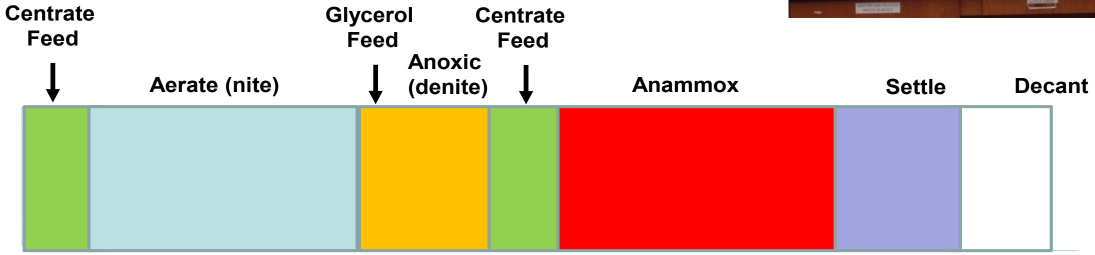
Simultaneous presence of nitrite and ammonia under anoxic conditions typically used in sidestream anammox systems

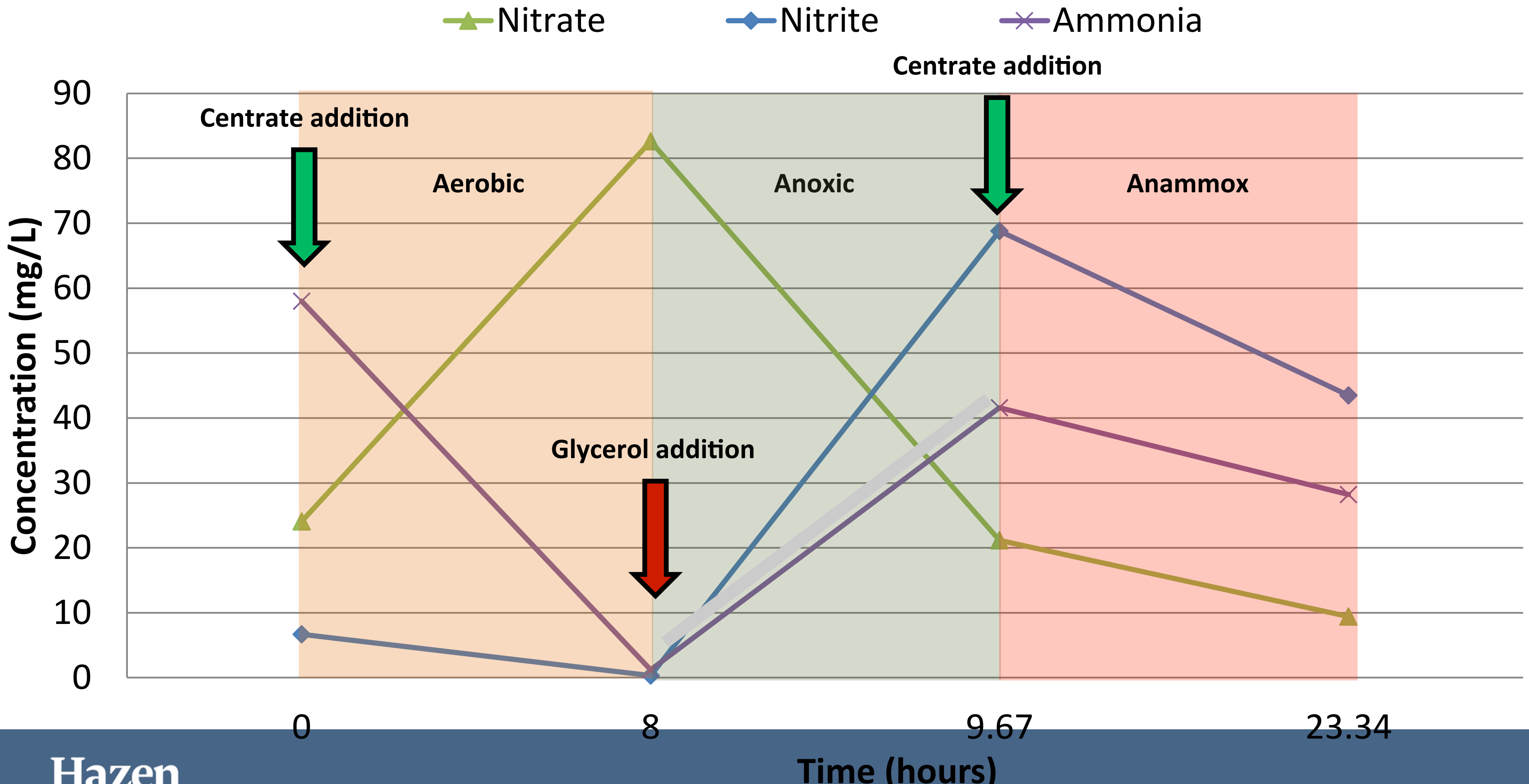
Revised approach for facilitating deammonification



- Full nitrification and denitratation of 50% centrate
- Revised approach can yield significant theoretical savings
  - 50% Oxygen
  - 80% Carbon

Proof of Concept

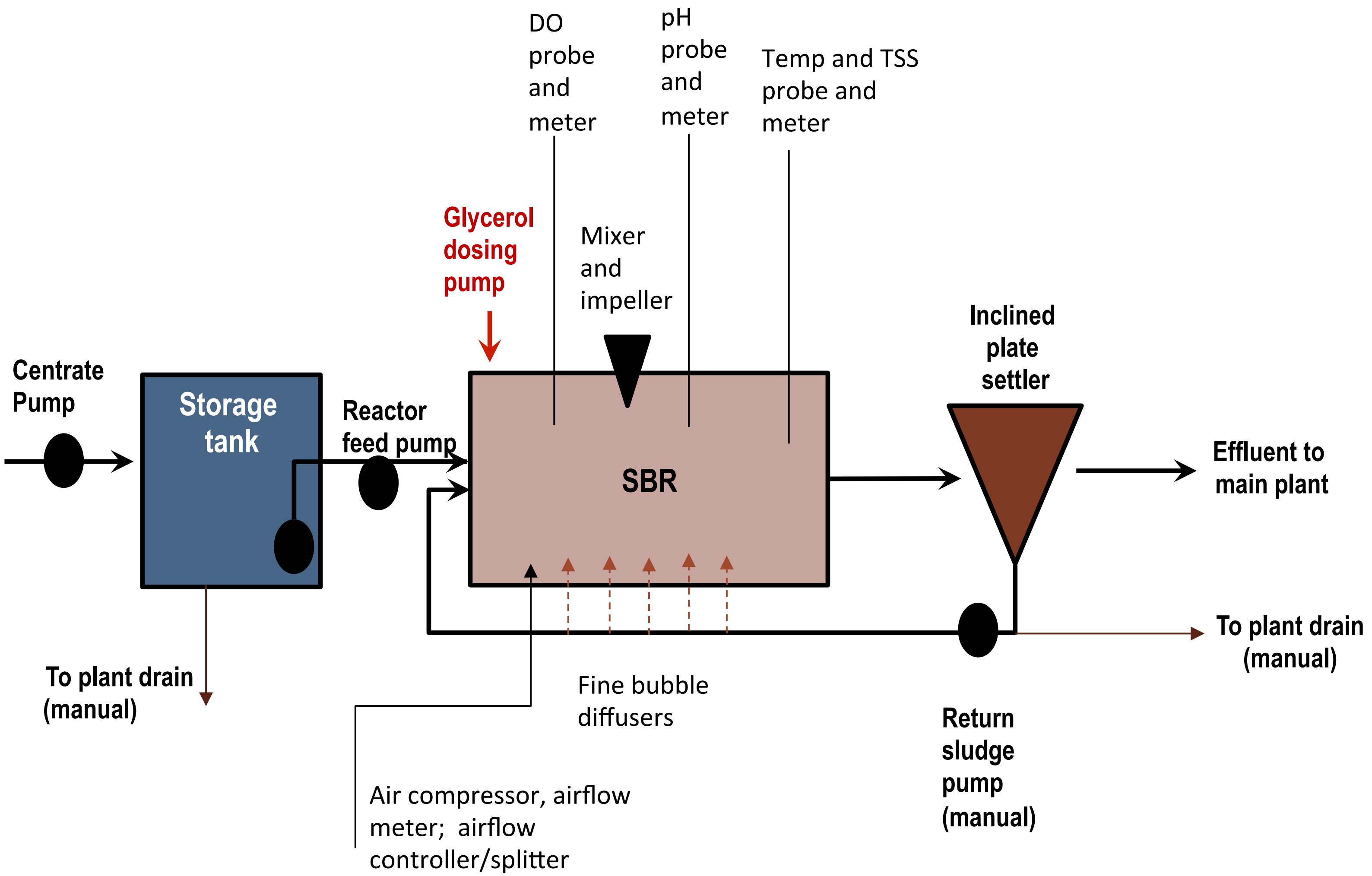




Current Progress

Hazen

Pilot setup



DO probe and meter
pH probe and meter
Temp and TSS probe and meter
Glycerol dosing pump
Mixer and impeller
Inclined plate settler
Centrate Pump
Storage tank
Reactor feed pump
SBR
Effluent to main plant
To plant drain (manual)
To plant drain (manual)
Fine bubble diffusers
Return sludge pump (manual)
Air compressor, airflow meter; airflow controller/splitter

Pilot setup

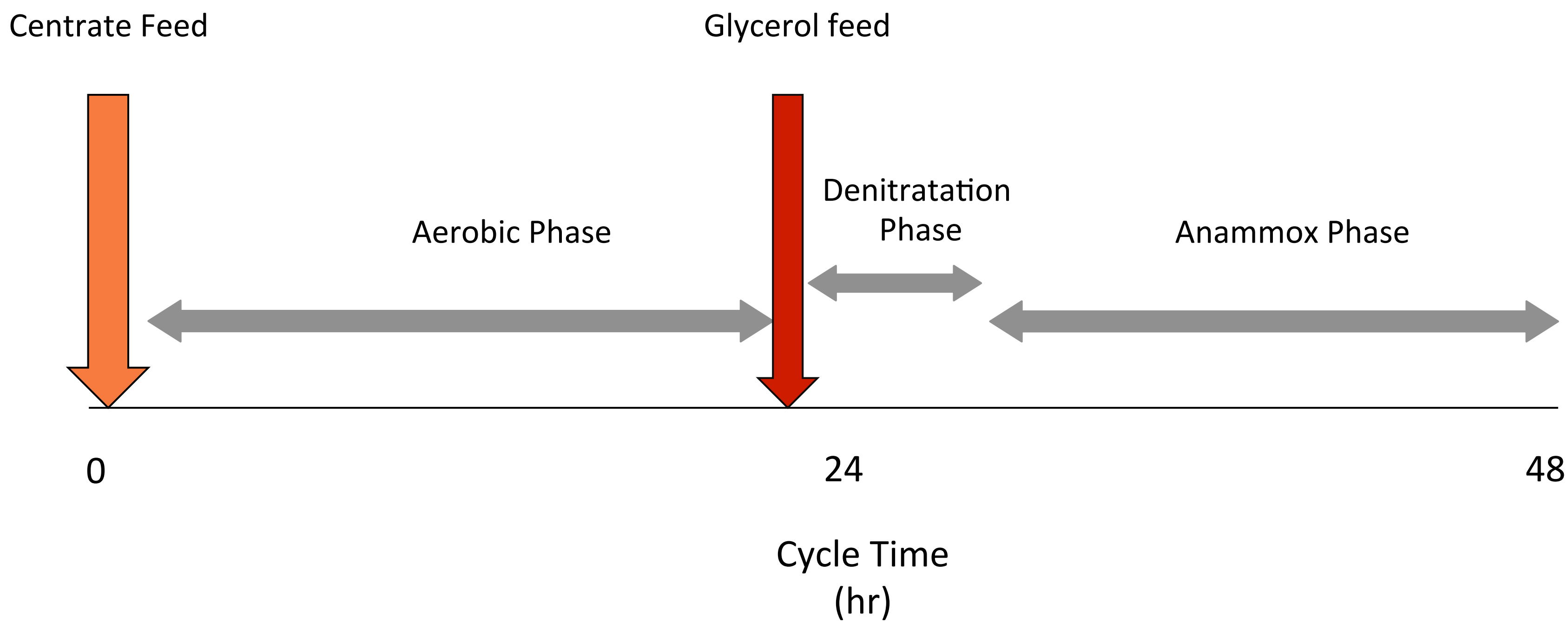
Reactor

Settler

Effluent from plate settler goes to drain

Underflow is piped to return sludge to the reactor

Basis of Operation



- During enrichment, no glycerol feed
- Aerobic phase varies from 8 to 24 hrs
- Deammonification phase varies from 24 to 42 hrs

Operational parameters

Key Parameters

- HRT = 48 hr (matches full-scale HRT)
- SRT > 50 day
- Target TIN loading ~ 0.25 kg N/m^3-day

Process control strategy

- Grab samples 5 days a week (NH3, NO2, NO3, ortho-P, alkalinity)
- Weekly activity tests
- Adjust airflow in response to grab samples
  - DO monitored; not used for control
- Adjust loading in response to activity tests
- pH monitored

Approach for Enrichment of Anammox

Weekly Anammox Activity Batch testing

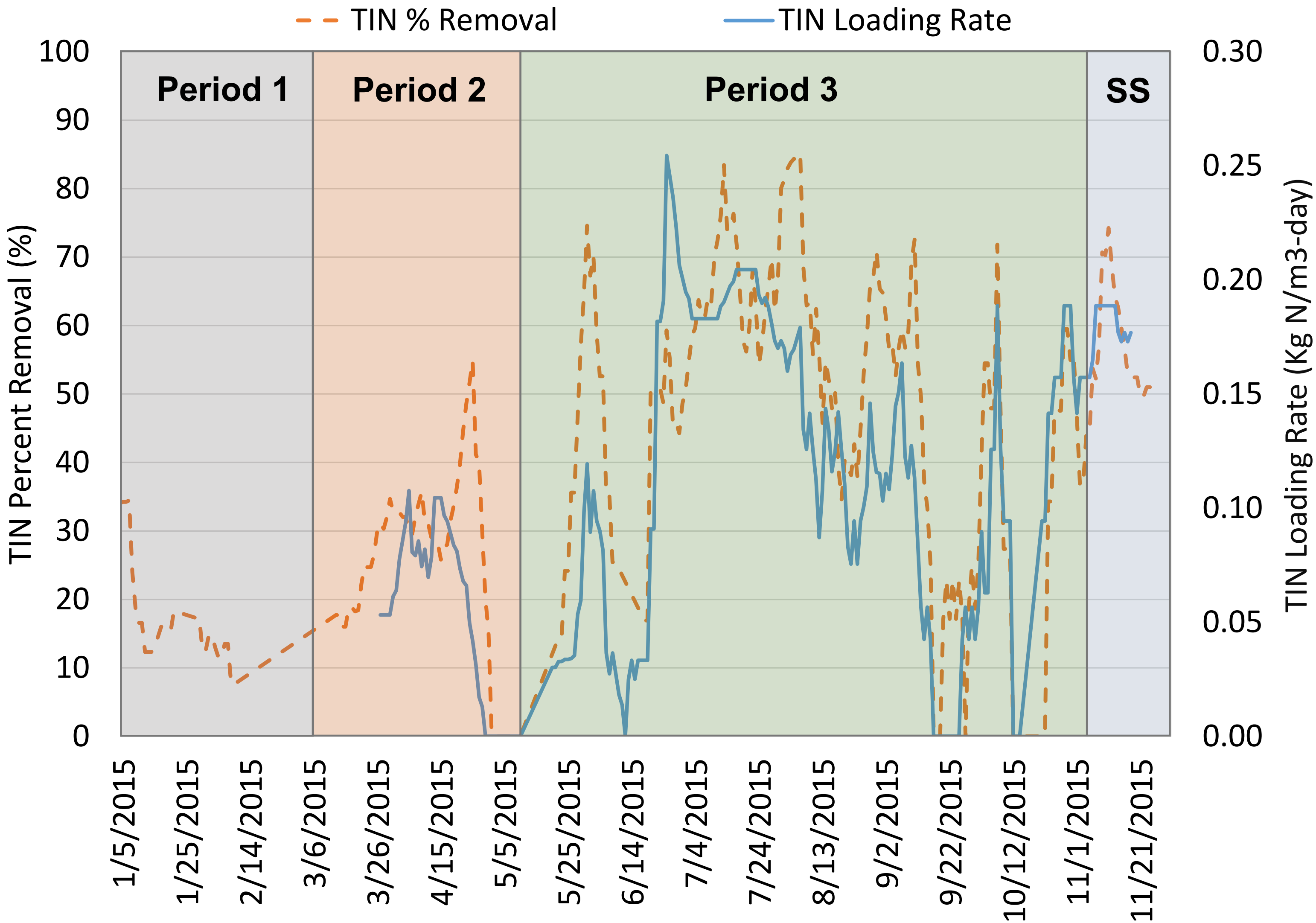
Maximum potential anammox activity

Manipulate N Loading Rate to Reactor

Target Loading N loading = 0.25 kg N/m^3-day

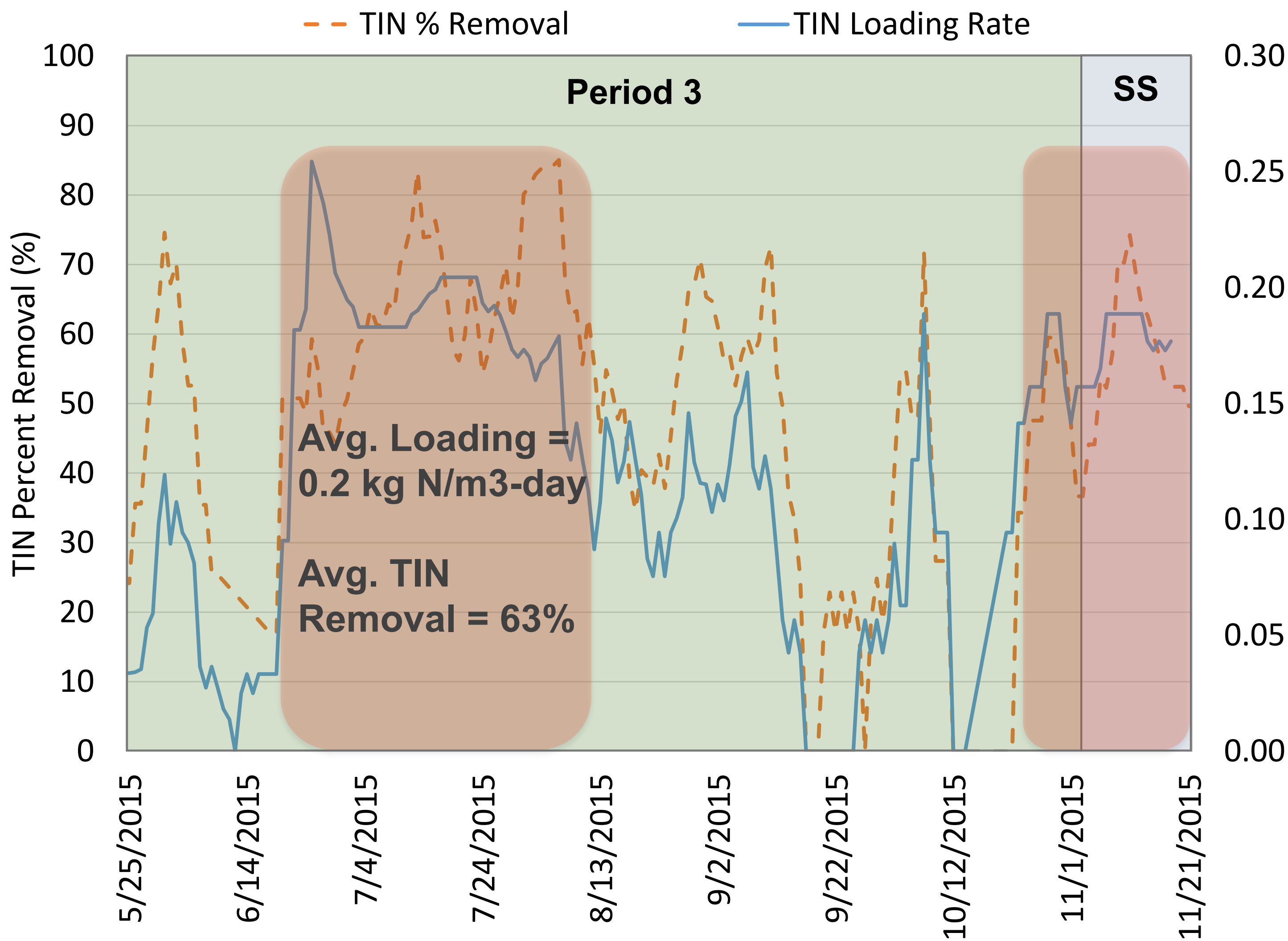
Monitor Effluent Quality

Overall progress

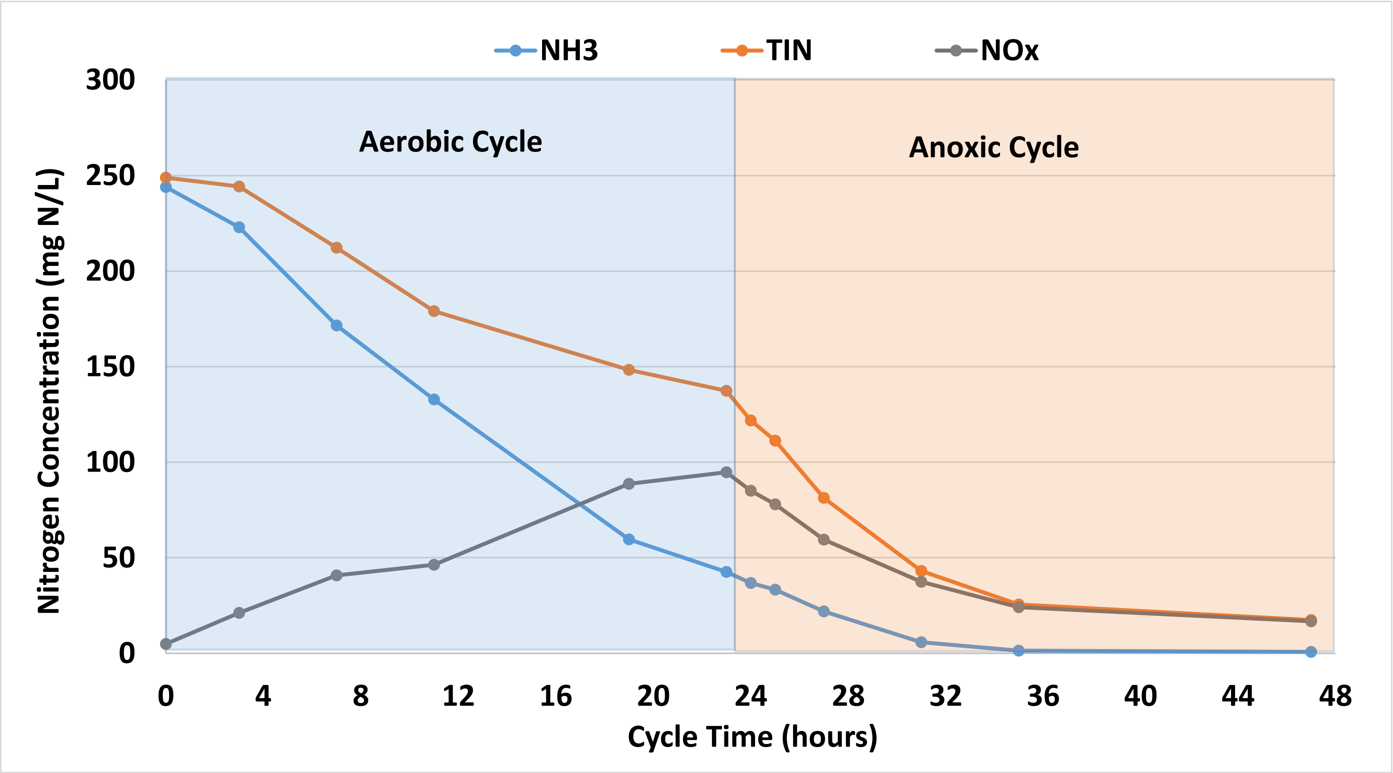


Hazen

Nitrogen Removal Performance



Nitrogen removal profile

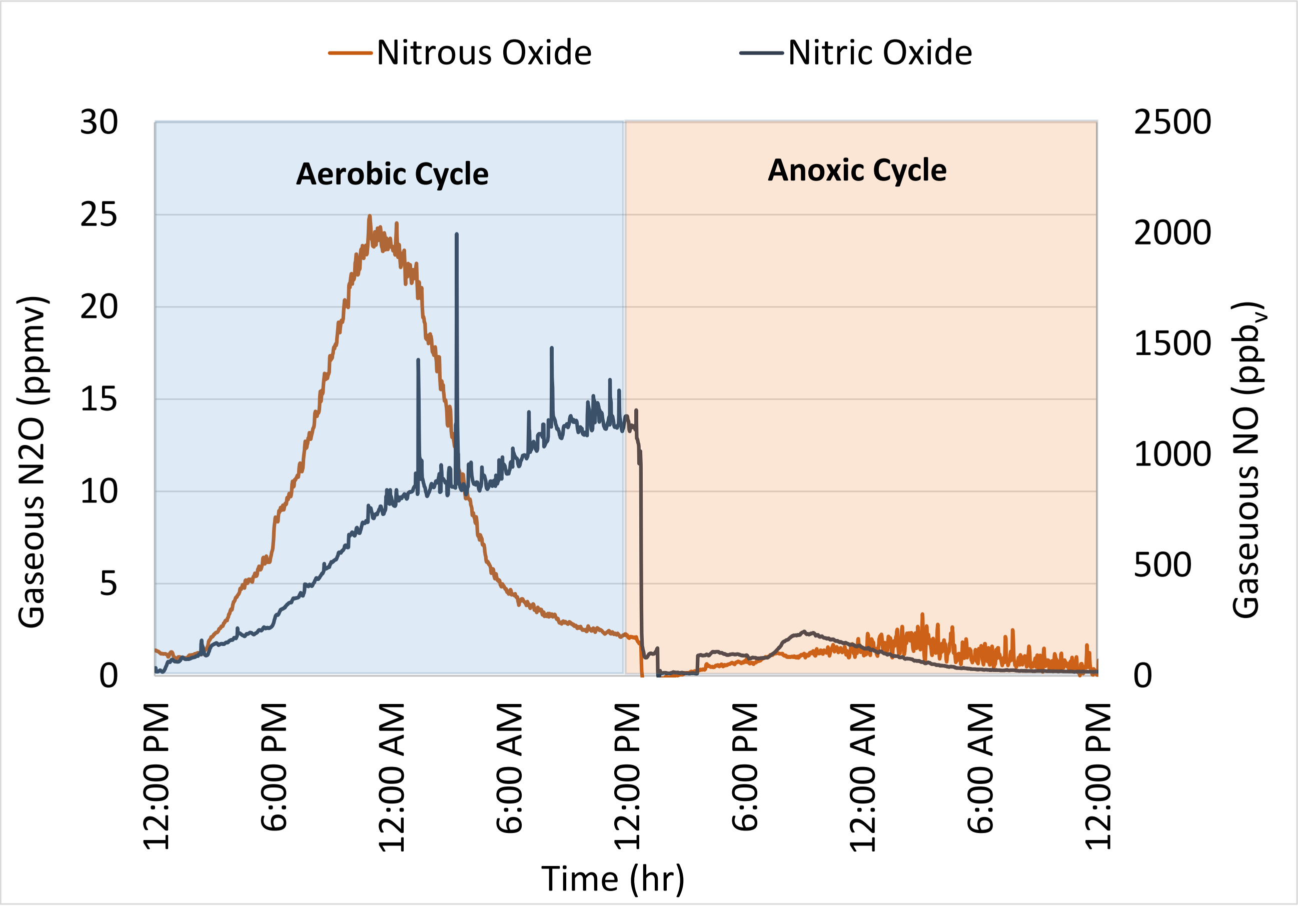


TIN removal occurring during the aerobic period…

Looking into:

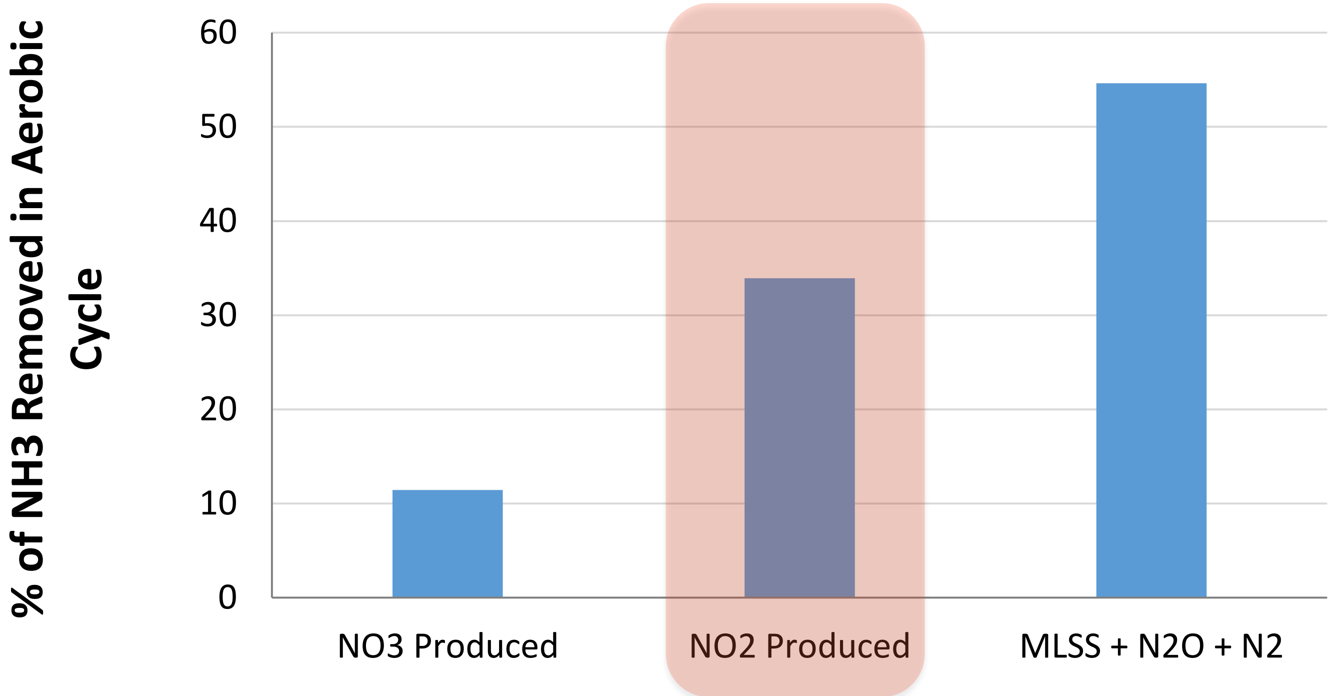
- Heterotrophic denitrification
- <u>Nitrous oxide production</u>
- Anammox (granule)

Nitrous Oxide Production



Results indicate that nitrogen oxide production is present and can account for ~3% of the total ammonia removed from the system

Aerobic Cycle

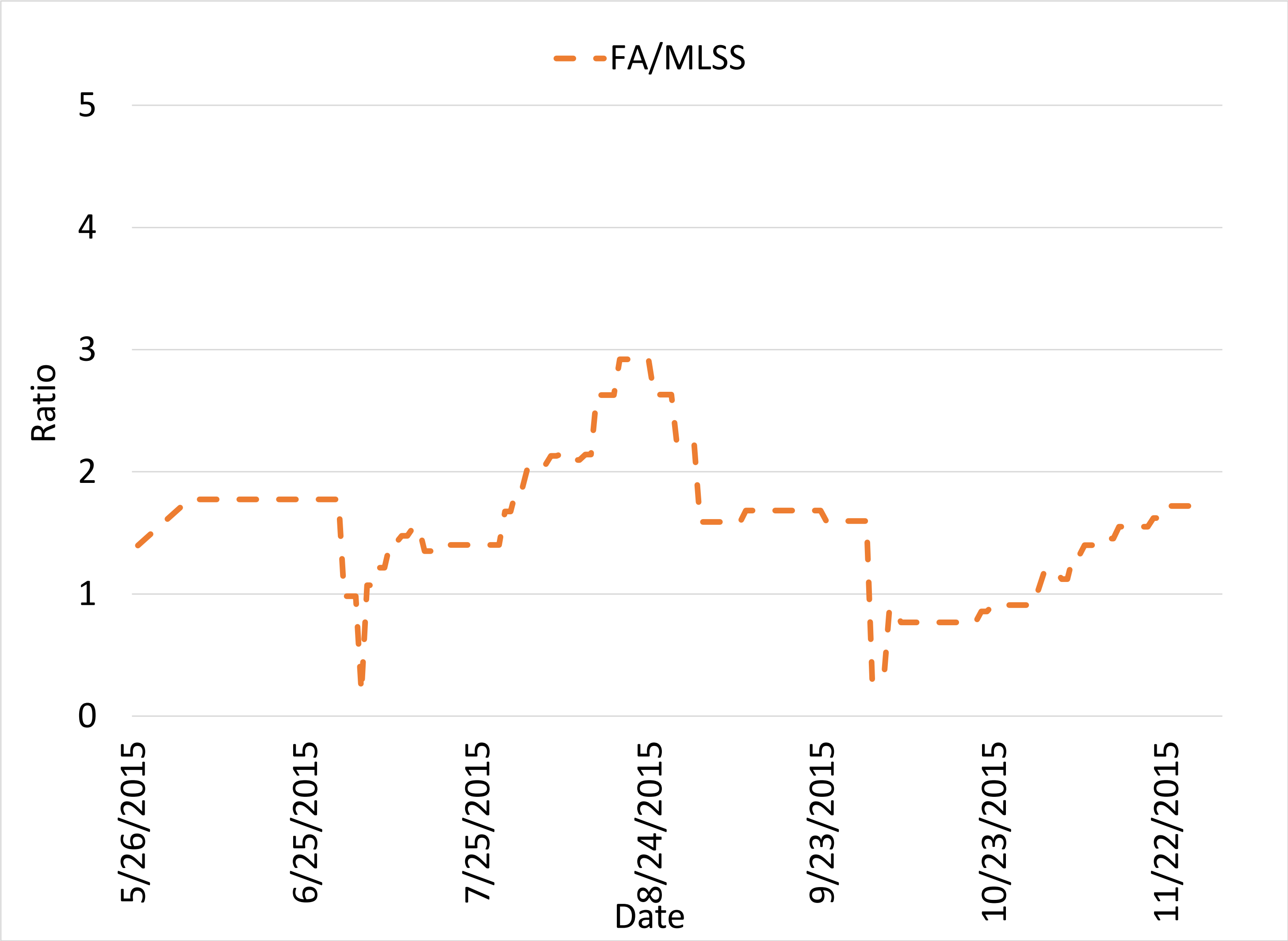


Nitrite production is significant

N loss occurs in aerobic cycle

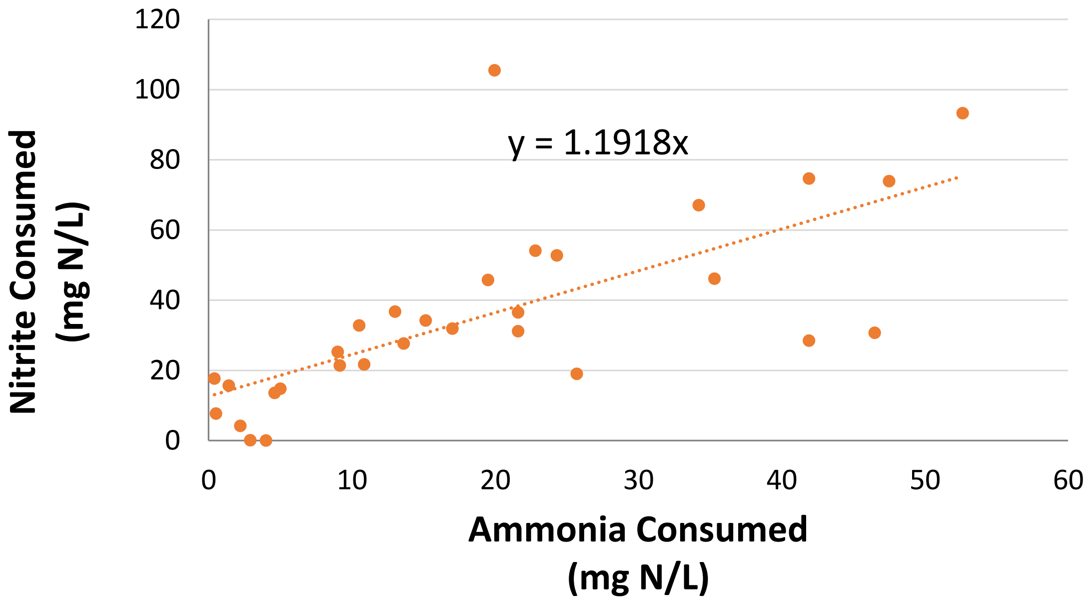
Free ammonia to MLSS =
1.8 mg Free ammonia as N/g MLSS

FA/MLSS



FA/MLSS
5
4
3
2
1
0
Ratio
5/26/2015
6/25/2015
7/25/2015
8/24/2015
9/23/2015
10/23/2015
11/22/2015
Date

Anoxic Cycle



Nitrogen removal driven by combination of anammox and denitrification

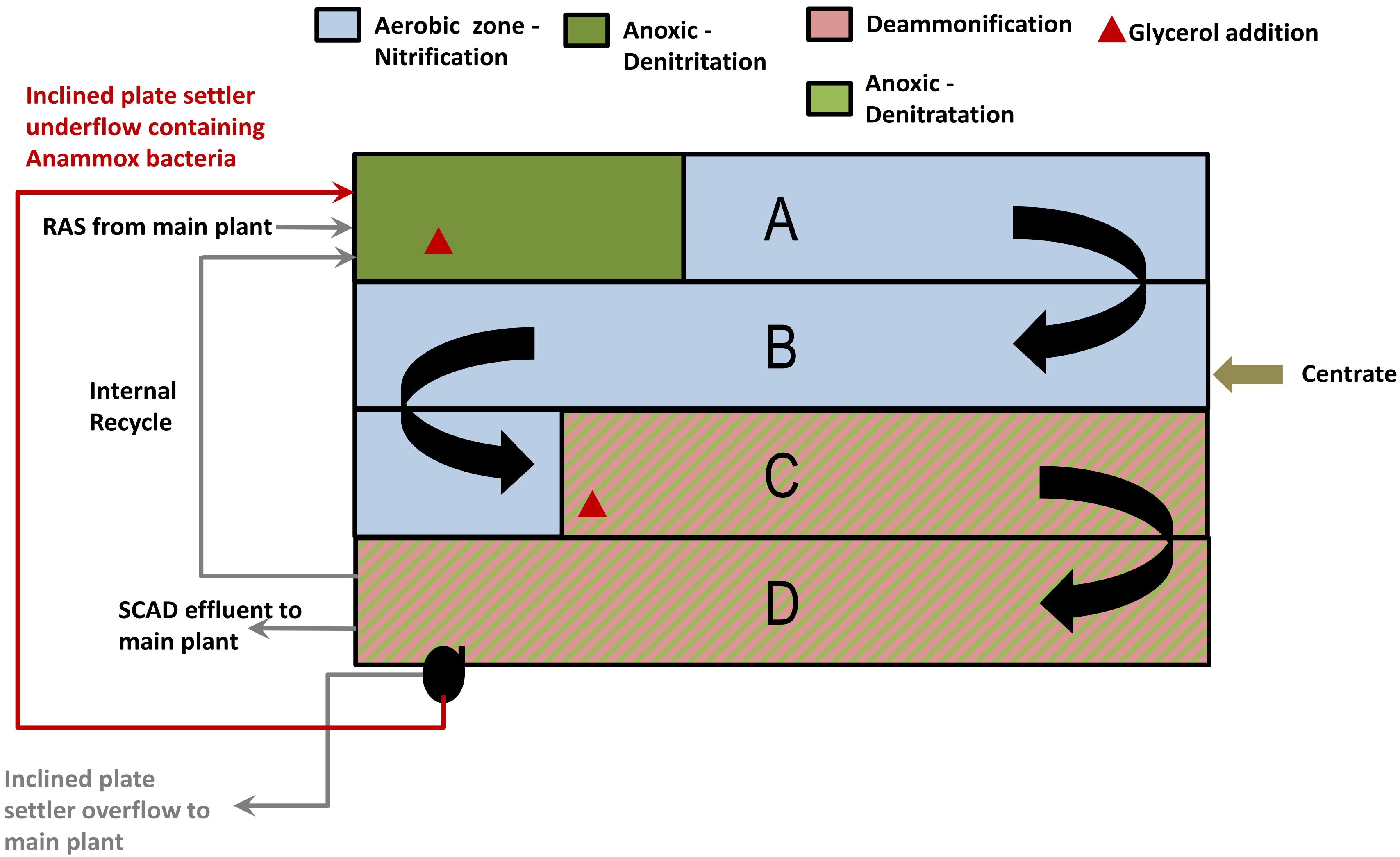
$$1.0\ NH_4^+ + 1.32\ NO_2^- + 0.066\ HCO_3^- + 0.13\ H^+ \rightarrow$$
$$\rightarrow 1.02\ N_2 + 0.26\ NO_3^- + 0.066\ CH_2O_{0.5}N_{0.15} + 2.03\ H_2O \qquad (6)$$

Strous et al. 1998

Lessons Learned

- Rapid heat loss suppresses anammox activity
- High operating DO (~2 mg/L) during enrichment speculated to suppress anammox activity
- Anammox can occur in low DO environments, increasing the overall nitrogen removal efficiency of the SCAD Process
- NOB repression is present – Although not desired, high free ammonia loading and strict airflow control resulted in NOB repression.
- Glycerol addition may benefit the process, however, is not required to achieve high removal rates

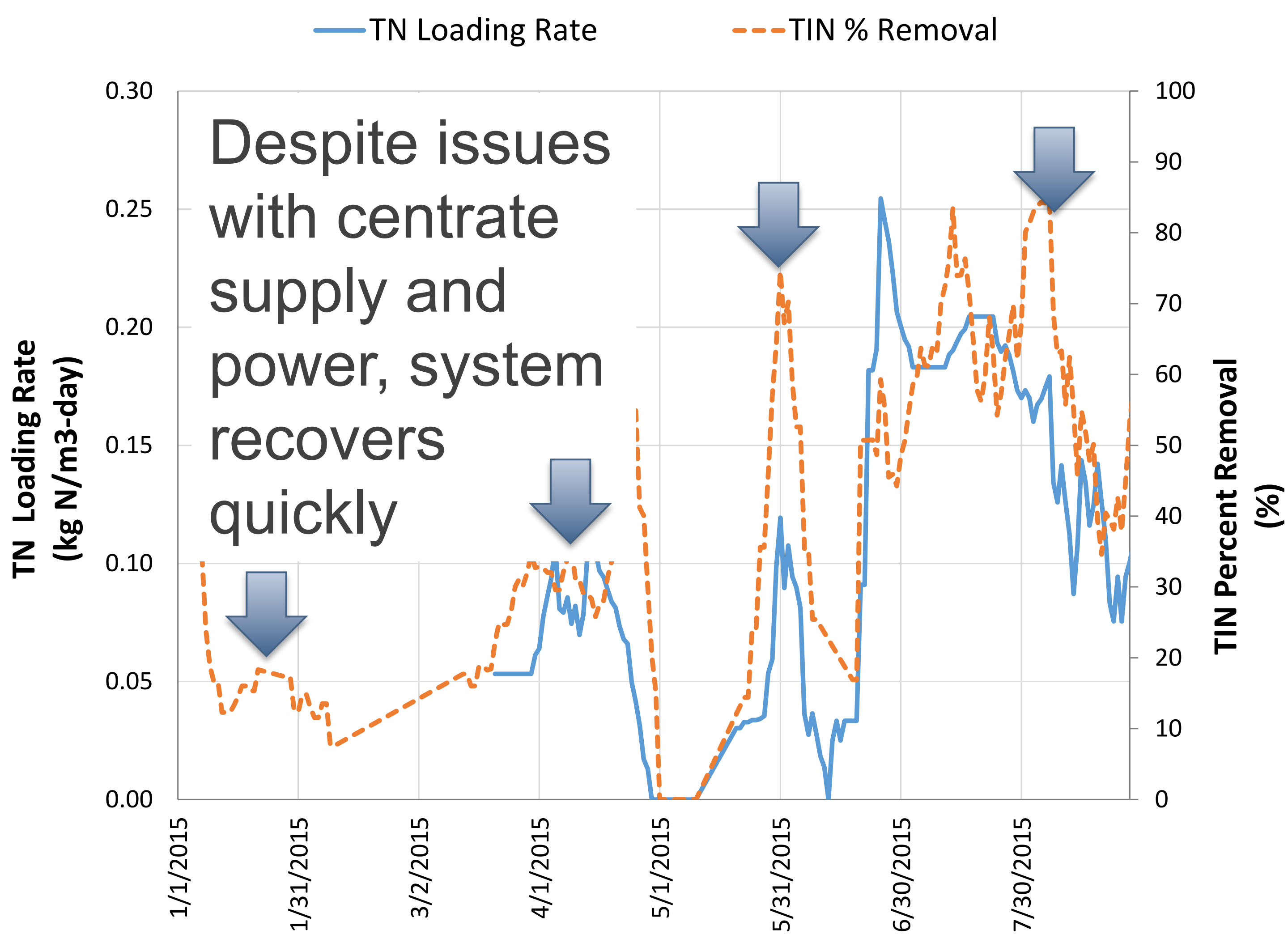
Conceptual strategy for promoting anammox growth in SCT



Current Status and Next Steps

- Molecular analyses
- Conceptual Design

Concluding thoughts



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N Removal Performance and Activity Methods