



## High rate denitrification as an alternative process for energy and nutrient recovery

Tirkey, Vishal ; Goonesekera, Estelle M.; Smets, Barth F.; Dechesne, Arnaud; Valverde Pérez, Borja

*Publication date:*  
2021

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*

Tirkey, V., Goonesekera, E. M., Smets, B. F., Dechesne, A., & Valverde Pérez, B. (2021). *High rate denitrification as an alternative process for energy and nutrient recovery*. Abstract from 9th IWA Microbial Ecology and Water Engineering (MEWE) Specialist Conference of the International Water Association (IWA), Delft, Netherlands.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



 THE 9TH MICROBIAL ECOLOGY & WATER ENGINEERING (MEWE) SPECIALIST  
CONFERENCE OF THE INTERNATIONAL WATER ASSOCIATION (IWA)

18-20 OCTOBER 2021 - DELFT - NL

## High rate denitrification as an alternative process for energy and nutrient recovery

Vishal Tirkey<sup>1</sup>, Estelle M. Goonesekera<sup>1</sup>, Barth F. Smets<sup>1</sup>, Arnaud Dechesne<sup>1</sup>, Borja Valverde Pérez<sup>1\*</sup>

<sup>1</sup>*Department of Environmental Engineering, Technical University of Denmark; 2800 Lyngby, DTU, Denmark*

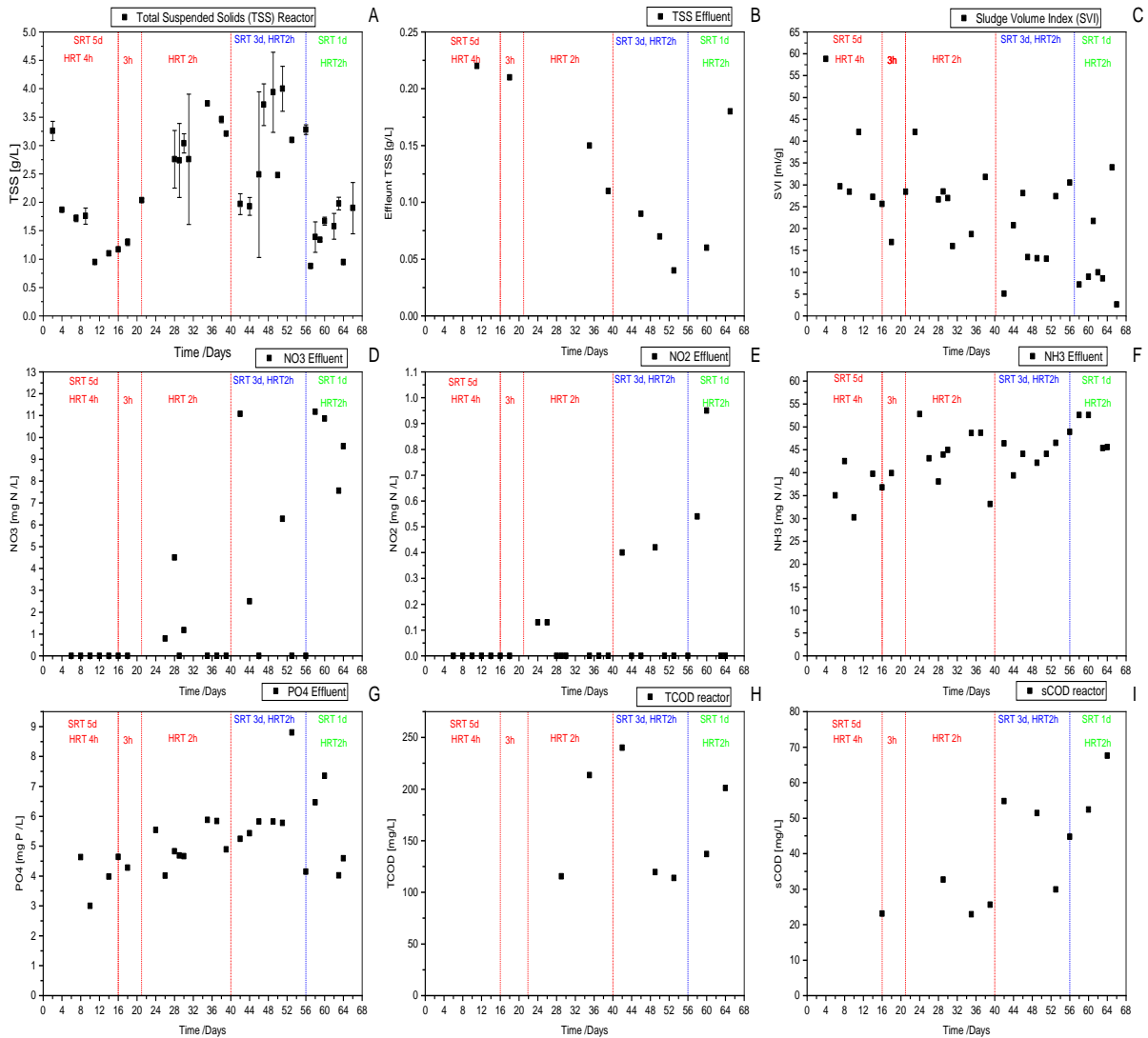
\* e-mail correspondence: bvape@env.dtu.dk

*Preferred topic #: Systems Microbiology and Process Engineering*

High rate activated sludge (HRAS) systems, which are aerobic, are used for redirecting organics for energy recovery. The HRAS works at low sludge retention time (SRT), very short hydraulic retention time (HRT) and a high food to microorganism ratio (F/M). Effluents from these systems have a low carbon level which makes them suitable for partial nitrification anammox (PN/A) treatment. However, unsuccessful nitrite oxidizing bacteria suppression and low ammonia concentrations prevent the implementation of mainstream PN/A in cold climates. Thus, a high-rate denitrification system is proposed as an alternative for simultaneous carbon recovery and nitrate removal as an A-stage, where the B-stage would be a nitrifying reactor whose clarified effluent is recycled to the A-stage for denitrification (i.e., mimicking pre-denitrification/nitrification). This study focuses on the A-stage, evaluating process stability at low SRTs, relating settleability to floc morphology and assessing the energy and nutrient recovery potential as biogas and microbial protein, respectively.

Denitrification rates ranged between 0.77-1.33 g-NO<sub>3</sub>-N/g-TSS/d, higher than reported for the pre-anoxic zones for domestic wastewater (0.04-0.25 gNO<sub>3</sub>-N/g-VSS/d). Phosphate removal averaged around 50%. Sludge volume index (SVI<sub>30</sub>) was below 50 ml/g, which is lower than for aerobic HRAS systems (typically ranging 50-300 ml/g), suggesting good sludge settling characteristics. Decreasing SRTs led to decreasing floc size, without compromising sludge sedimentation. The sludge yield ranged between 0.41-0.67 g-TSS/g-COD, similar to aerobic HRAS. Highest biomethane yield, 686 ± 82 ml-CH<sub>4</sub>/g-VS, was observed at SRT 3 days, which is considerably higher than yields for secondary sludge. Protein content was highest at the lowest SRT, 26.8% of dry weight, in the range observed for the aerobic HRAS. Protein contained all amino acids, although their balance was far from those of fish meal or soymeal

proteins. Given the low protein yield and the poor amino acid balance, biogas production seems a better option for sludge valorization.



**Figure 1:** Performance of the high rate denitrifying activate sludge process: a) total suspended solids in the reactor (g/L); b) total suspended solids in the effluent (g/L); c) sludge volume index (ml/g); d) nitrate (mg-N/L); e) nitrite (mg-N/L); ammonia (mg-N/L); g) phosphate (mg-P/L); h) total chemical oxygen demand in the effluent (mg-COD/L); I) soluble chemical oxygen demand in the effluent (mg-COD/L). The system was operated at three solid retention times (5, 3 and 1 days). The hydraulic residence time was adapted during the first period, at SRT 5 days, decreasing it from 4 to 2 h.