Generation of an Anammox-optimal nitrite:ammonium ratio with SHARON process: Usefulness of process control?

Eveline I.P. Volcke[1], Stijn W.H. Van Hulle[1], Mark C.M. van Loosdrecht[2] and Peter A. Vanrolleghem[1]

[1] Ghent University, Department of Applied Mathematics, Biometrics and Process Control (BIOMATH), Coupure Links 653, B-9000 Gent, BELGIUM

[2] Delft University of Technology, Department of Biochemical Engineering, Julianalaan 67, NL-2628 BC Delft, THE NETHERLANDS

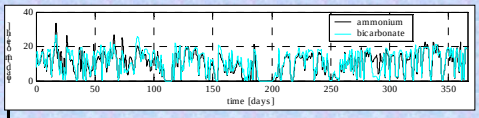
Objective

To examine the need for controlling the SHARON process for coupling with an Anammox reactor under realistic influent conditions

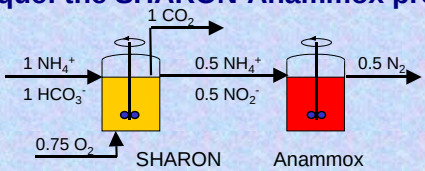
Goal: to treat sludge digestion reject water

in order to still meet effluent N-requirements
although main WWTP has limited aeration capacity

Realistic influent file (Rotterdam, NL)



Technique: the SHARON-Anammox process

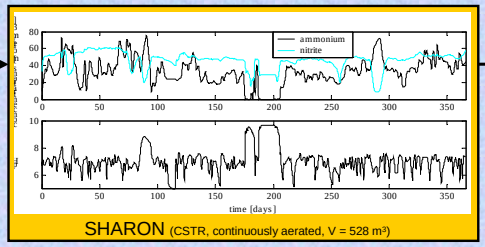


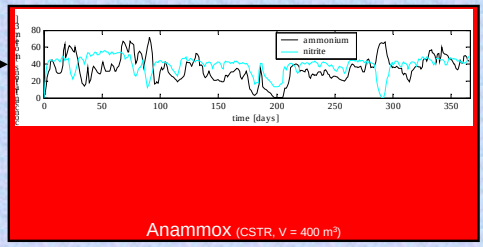
35°C, short SRT
⇒ wash-out of nitrite oxidizers
⇒ ammonium is oxidized to nitrite, no nitrate formation

optimal nitrite:ammonium ratio to feed Anammox (1:1 in theory) should be produced by SHARON process

Simulation results

Operation mode 1: SHARON reactor without control



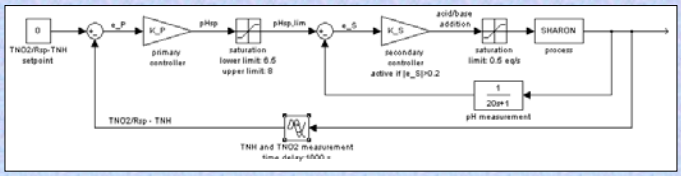


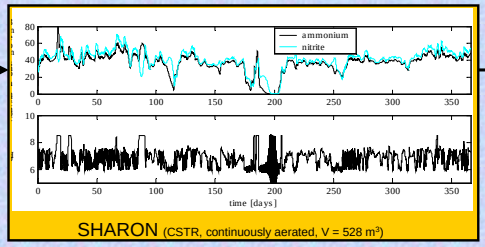
⇒ strong inhibition of the Anammox process caused by unfavourable nitrite:ammonium ratio produced in the SHARON reactor

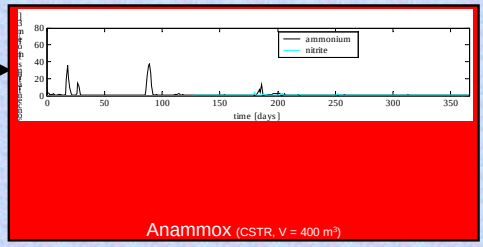
Operation mode 2: SHARON reactor with control

Proposed strategy:

cascade feedback control of nitrite:ammonium ratio
measured in SHARON process
via pH control through acid/base addition







⇒ constant optimal nitrite:ammonium ratio produced by the SHARON process, resulting in good overall N-removal efficiency

But at what cost?

Operating Cost Index (OCI): $OCI = \gamma_1 \cdot EQ + \alpha_{acid} \cdot \Phi_{acid} + \alpha_{base} \cdot \Phi_{base}$

includes weighed operating cost factors that are different fot the two operating modes under study:
effluent ammonium quality (EQ), acid/base addition (Φ_{acid}, Φ_{base})

no control: OCI = 222032 €/year
with control: OCI = 47787 €/year

⇒ cost savings of 174245 €/year by implementing control warrant investment costs

TAKE HOME MESSAGE

Control of the nitrite:ammonium ratio produced in the SHARON reactor
- is crucial to avoid toxic nitrite concentrations, inhibiting the Anammox conversion
- warrants investment costs for the control system

However, results depend strongly on the inhibition kinetics of Anammox process, of which further research is encouraged

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eveline.volcke@biomath.ugent.be - http://biomath.ugent.be