A retrofitted activated-sludge plant with sequential nitritation and anammox obtains dischargeable effluent

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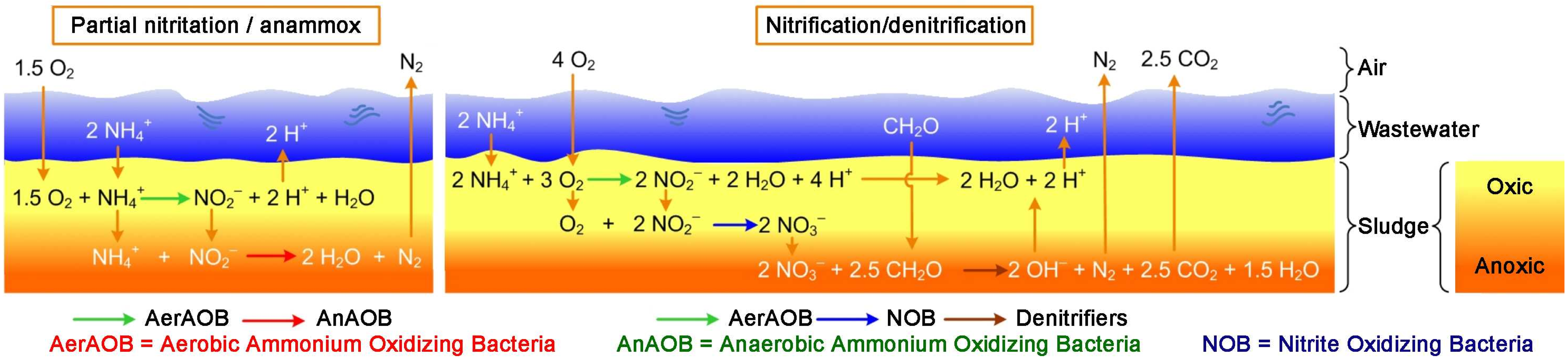
Introduction:

- New Activated Sludge (NAS®) represents a hybrid, floc-based nitrogen removal process
- process is based on solids control, retention times (SRT) and dissolved oxygen (DO) levels
- full-scale NAS® plant is examined (treating anaerobically digested industrial wastewater)
- serial anammox, denitrification and nitrification compartments are followed by a final settler
- in the anammox step 77% of the nitrogen is removed
- **overall nitrogen removal efficiency = 95% yielding a dischargeable effluent**

Figure 1: *Comparative representation of the catabolic reactions of the partial nitritation / anammox and the nitrification/de-nitrification steps*



Experimental approach:

- test location : full scale WWTP of a potato-processing plant
- N-removal plant was previously operated in conventional activated-sludge mode
- the system is retrofitted to a hybrid nitrogen removal process
- step 1 : anaerobic digestion and struvite precipitation (Anphos®)
- step 2 : nitrification/denitrification system
- full-scale nitrogen removal process discharges effluent to surface water
- WWTP control via DO setpoints and SRT

Figure 2*: Aerial view of WWTP at LWM, Bergen op Zoom (The Netherlands)*

Results and discussion:

Table 1: Water and nitrogen streams for partial nitritation, anammox, denitrification and nitrification reactors (averages ± standard deviations)

Partial Nitritation & Anammox				Denitrification			Nitrification			
PN +	RET →	REC1 +	AN	AN +	REC2 →	DN	DN →	REC2 +	OUT	Stream
2366	4080	36	6410	5601	4800	10401	10997	4800	6197	Q ($m^3\ d^{-1}$)
203±15	0.0±0.0	0.3±0.0	55±1	0.0±0.0	0.0±0.0	0.0±0.0	74±3	0.0±0.0	0.0±0.0	NH_4^+ (kg N d^{-1})
266±9	1.0±1.0	0.3±0.0	52±3	89±9	0.0±0.0	27±3	1.0±0.0	0.0±0.0	0.0±0.0	NO_2^- (kg N d^{-1})
79±8	10±3	0.1±0.0	21±4	20±4	24±2	13±3	27±1	45±3	58±4	NO_3^- (kg N d^{-1})

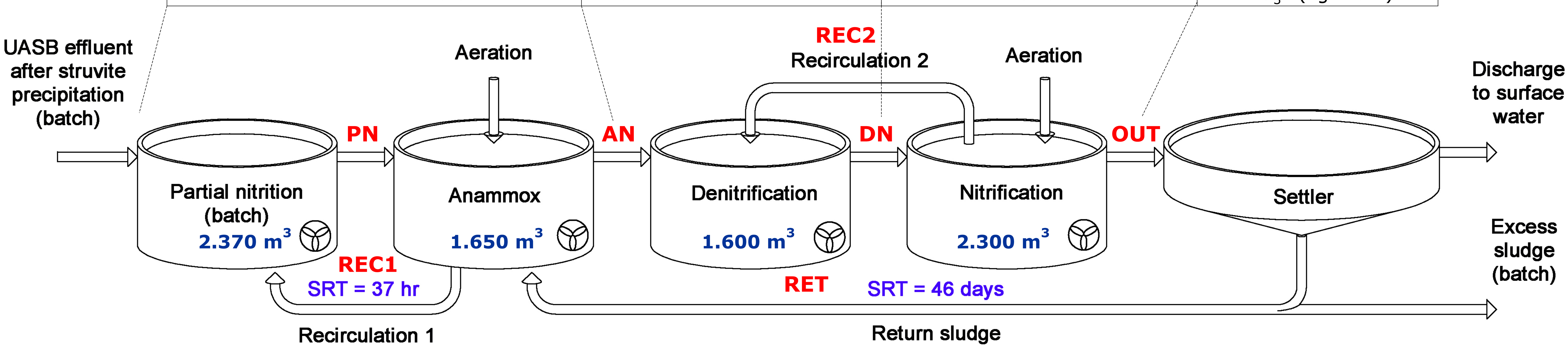


Figure 3: *Schematic overview of the examined WWTP hybrid nitrogen removal process*

Conclusions:

- An existing WWTP was successfully retrofitted to obtain a New Activated Sludge (NAS®) floc based N-removal process.
- The retrofit project of the Nitrification/Denitrification plant to new NAS® floc based process resulted in 30% less energy consumption & 50% less sludge production.
- N-oxidation (nitritation) of the residual N results in the formation of NO_2^- (45-47%) & NO_3^- (13-15 %).
- In the anammox stage ~77% of all Nitrogen is converted. The biomass in the anammox stage consists for 3 % out of *Kuenenia* species, while they are responsible for the conversion of 70% of the Nitrogen.
- The overall nitrogen removal efficiency over all steps = 95%.
- Dischargeable effluent is obtained with Nitrogen concentration < 10 mg N x L^{-1}.
- More efficient WWTP's can now be designed, which will allow the construction of more compact installations with higher loading rates.

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