LIFE DeNTreat

Decentralized innovative treatment of ammonium-rich urban wastewater

PN/ANAMMOX PROCESS LABORATORY ACTIVITIES

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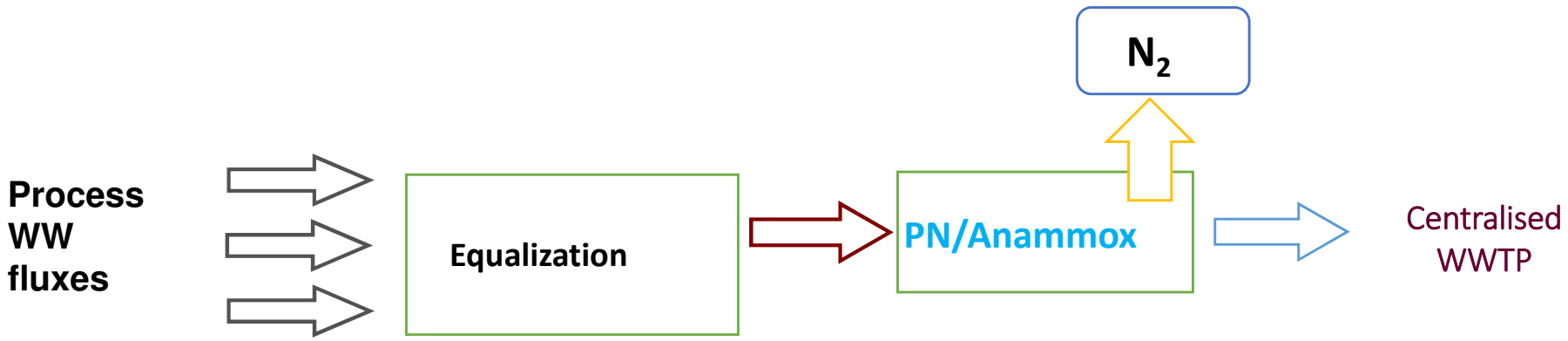
Politecnico di Milano - DICA – Environmental Section

LIFE DeNTreat INFO DAY

March 7th, 2018

SCR - Stamperia di Cassina Rizzardi

The concept


N_2
Process WW fluxes
Equalization
PN/Anammox
Centralised WWTP

Lab activity tests

PN/Anammox process

- **PN → partial nitratation**

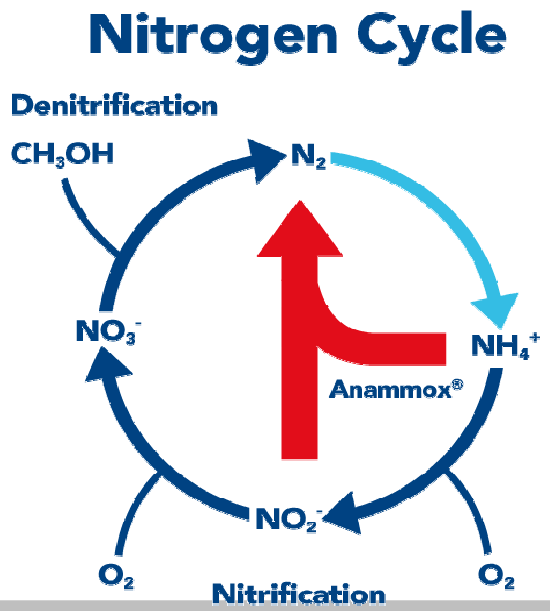
50% of N-NH_4^+ is converted

$$2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$$

- **Anammox**

Nitrogen gas

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



Max conversion efficiency = 88,8%
Reduced volume
Opex reduction due to:

- ✓ Low O_2 consumption
- ✓ COD dosing absent
- ✓ Lower sludge production

Lab activity tests

Batch tests for Anammox activity

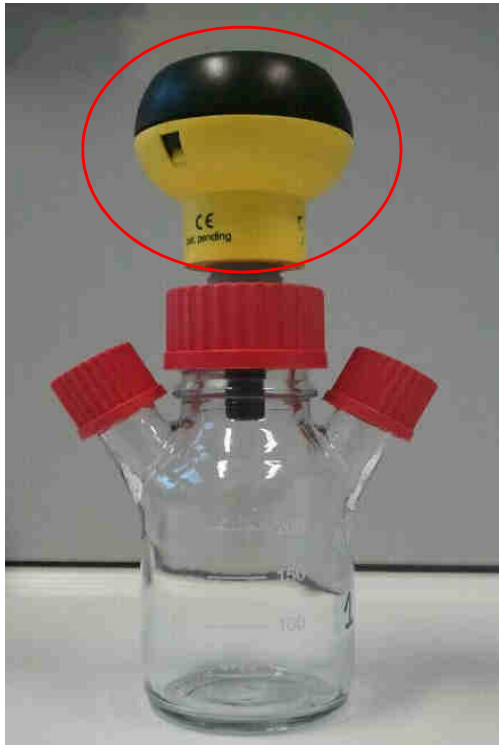
AOB activity testing by a pH/DO-stat titrator (left).
Manometric AAO activity testing (centre and right)

Lab activity tests

Batch test for Anammox activity

- Granular Anammox biomass
- Anoxic condition
- pH initial control
- Magnetic Thermal stirrer: 35°C, 160 rpm
- Periodic substrate feeding
- Substrate TSS and VSS measurment

Overpressure converted into Anammox activity
(*OxiTop®-C Measuring Head)*



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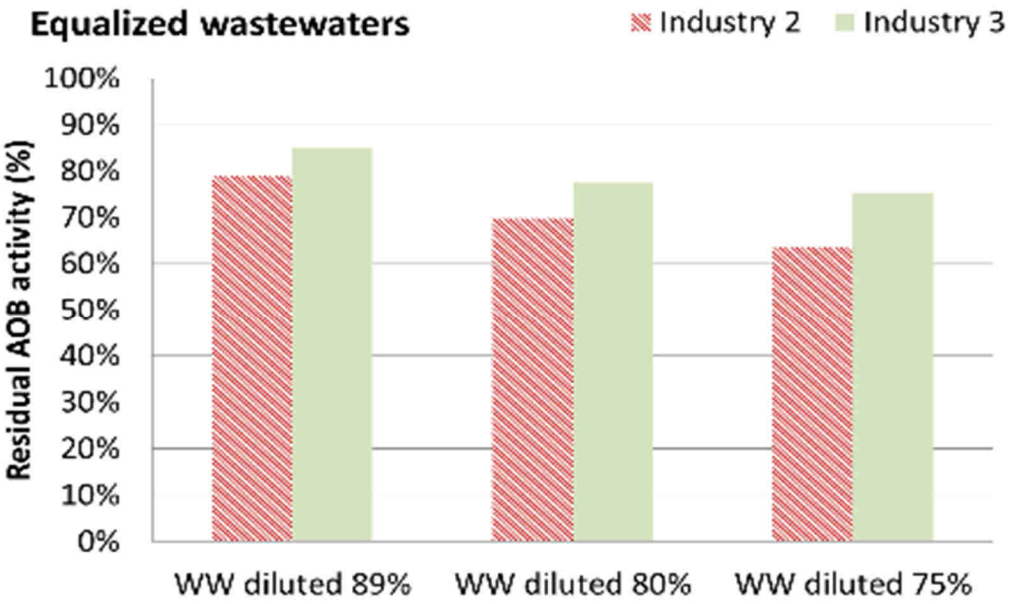
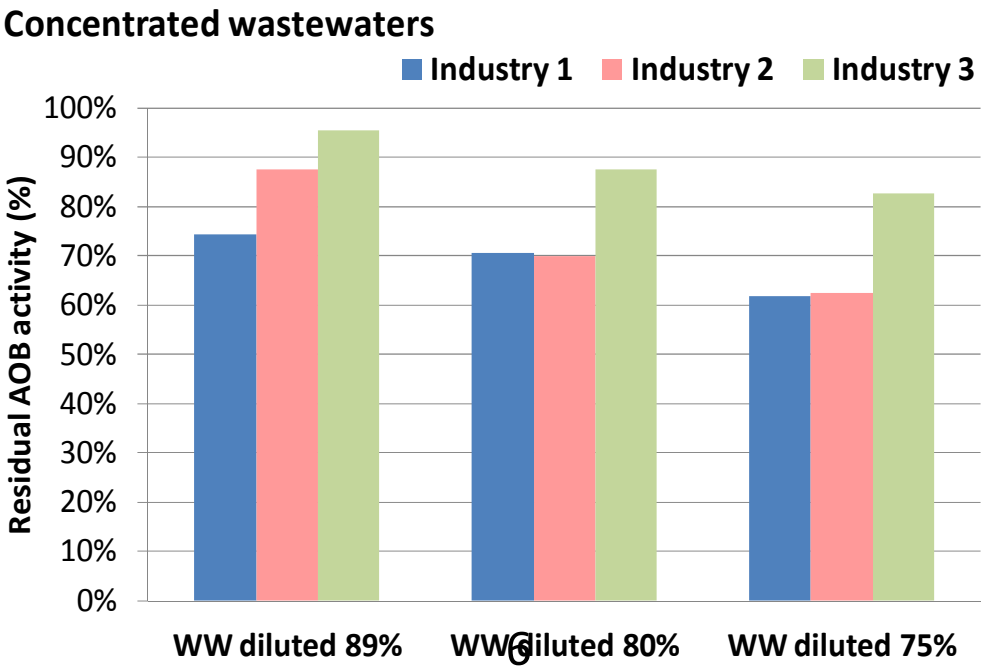
Lab activity tests

Application of "PN – Anammox" on both concentrate and equalized stream



AOB do not show significant inhibition

Dilution simulates real concentrations in the completely mixed reactor, with effluent concentration less than 25% of influent concentration



Lab activity tests

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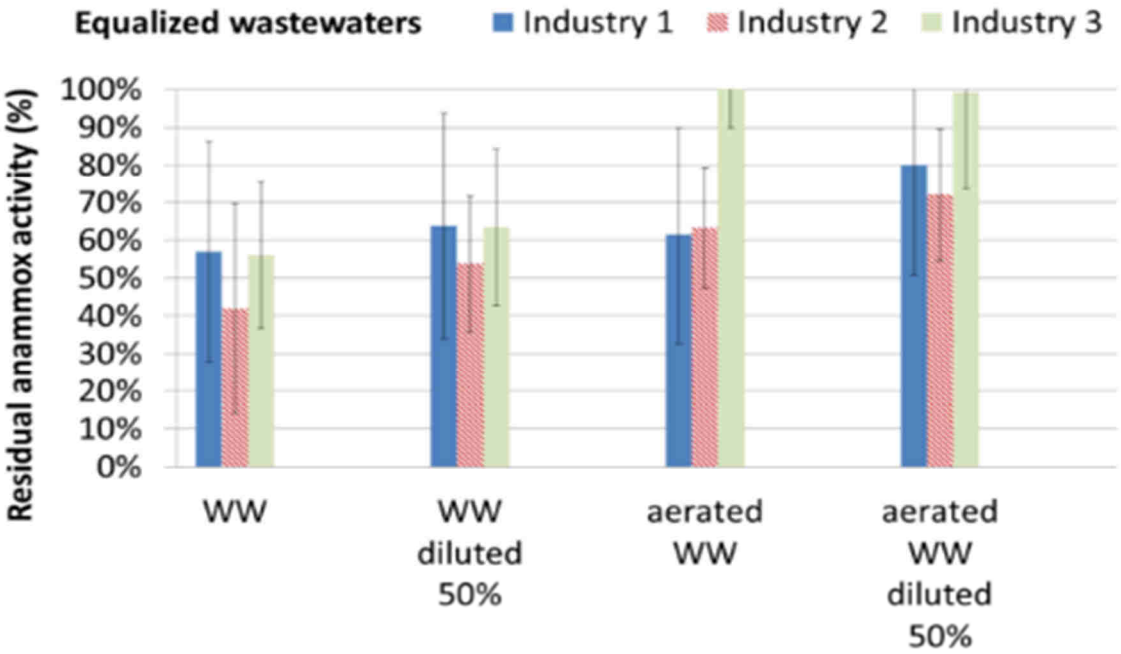
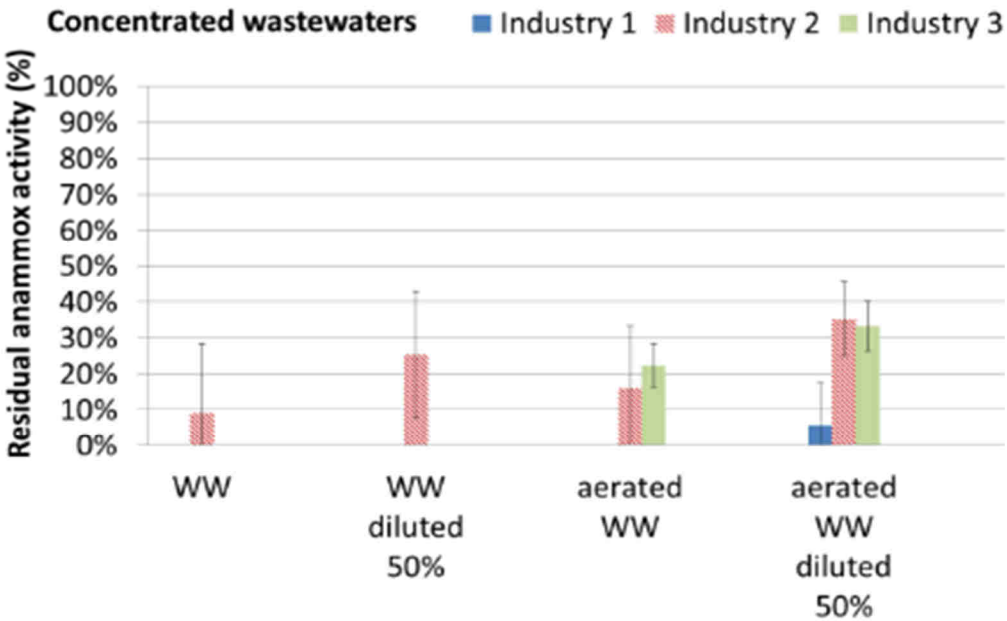
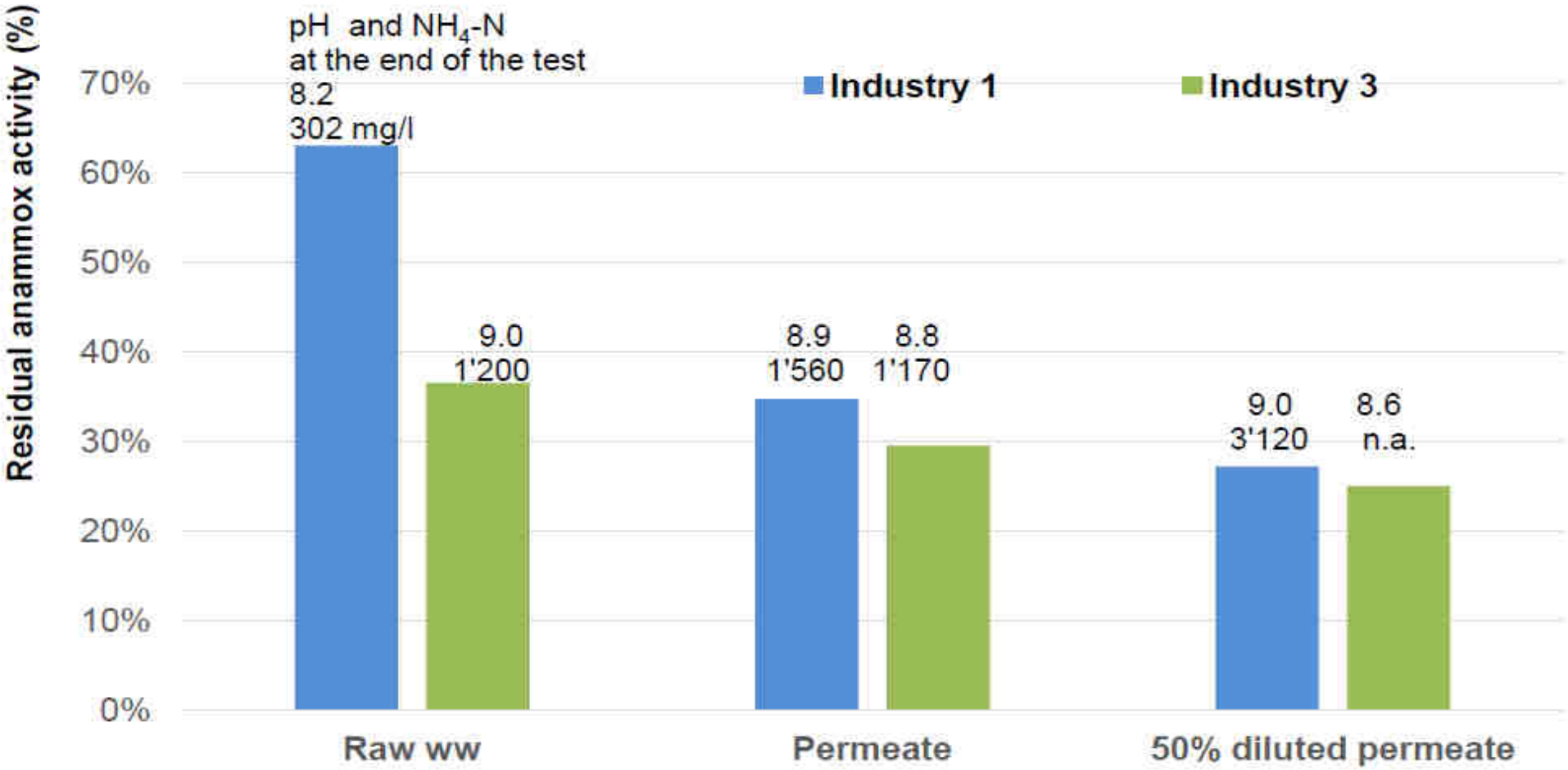


Anammox are OK in equalized WW, but reduce their activity severely if exposed to concentrated WW



Lab activity tests

Application of "PN – Anammox" on concentrated streams



- Urea is hydrolysed to NH_4-N in the batch tests.
- Accumulation of free ammonia is toxic
- Importance of testing ureolysis in high TKN/NK4-N streams 8

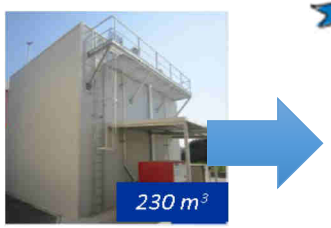
Lab activity tests - 2019

Standard | SatinSkin diluted 1:2 | SCR diluted 1:2

Samples	SatinSkin	SCR (7/9/2018)
pH	8.9	7.88
Conductivity (µS)	300	1001
COD tot (mg/L)	462	768
COD filt (mg/L)	390	677
TN (mg/L)	527	217
NH_4-N (mg/L)	41	182
NO_3-N (mg/L)	1.36	0.78
NO_2-N (mg/L)	0	0
PO_4 (mg/L)	2.5	5.8
TSS (mg/L)	33.3	186.7
VSS (mg/L)	33.3	170
Turbidity (NTU)	16.9	170

ELAN® anammox

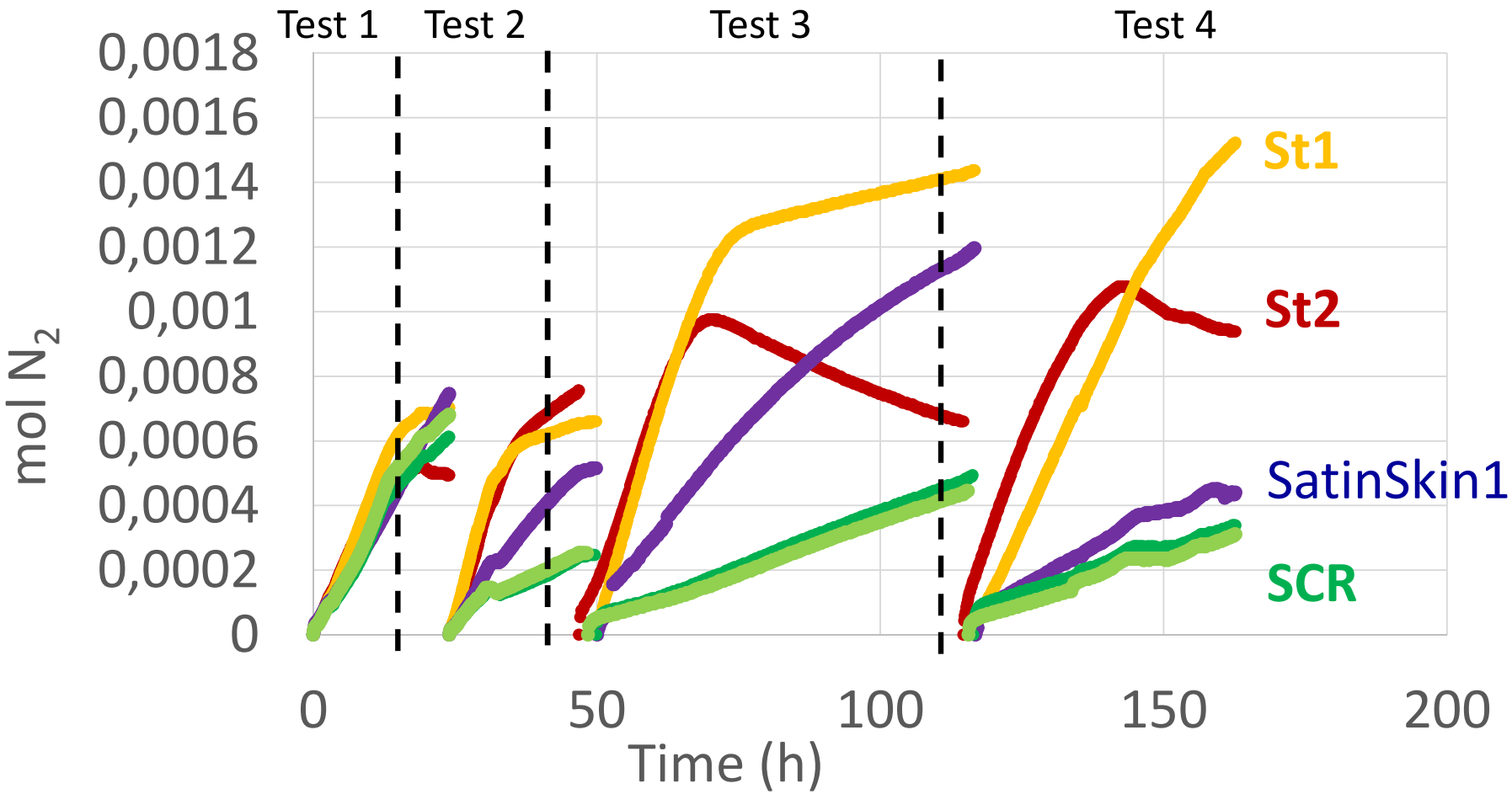
Aqualia granules arrived in September 2018



aqualia

Wet granules
8% TS
5.7% VS

Lab activity tests - 2019

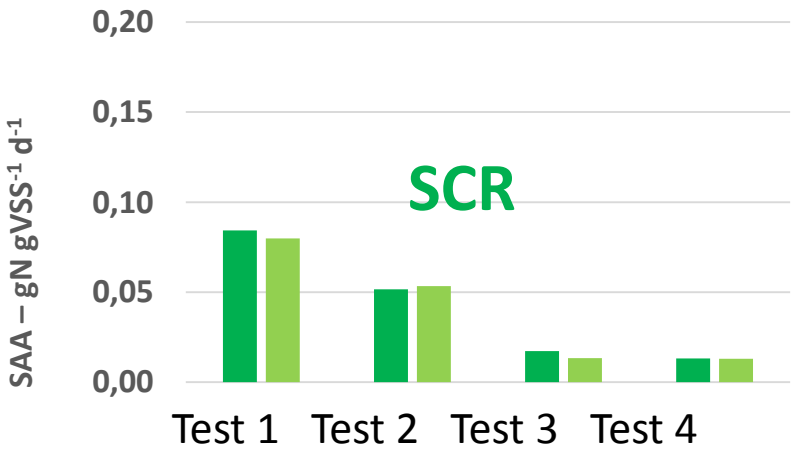


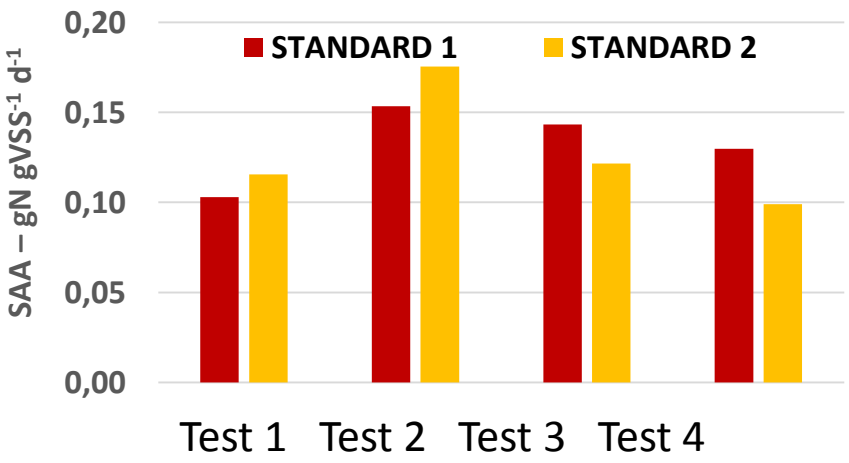
solution 50 mgN/l: Tests 1-2 = spike **1 ml;** Tests 3-4 = spike **2 ml**

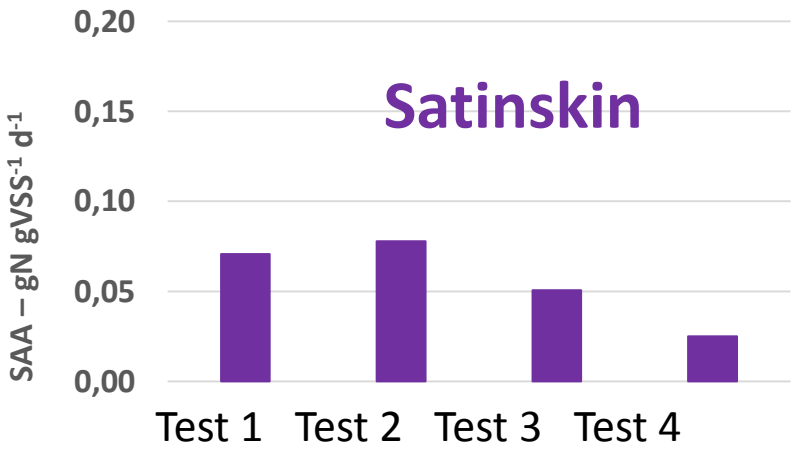
Lab activity tests - 2019

AMX activity

As spikes have been added without changing the liquid phase**, gradual decrease in activity** may be due to accumulation of inhibiting substrates and to pH increase due to ureolysis

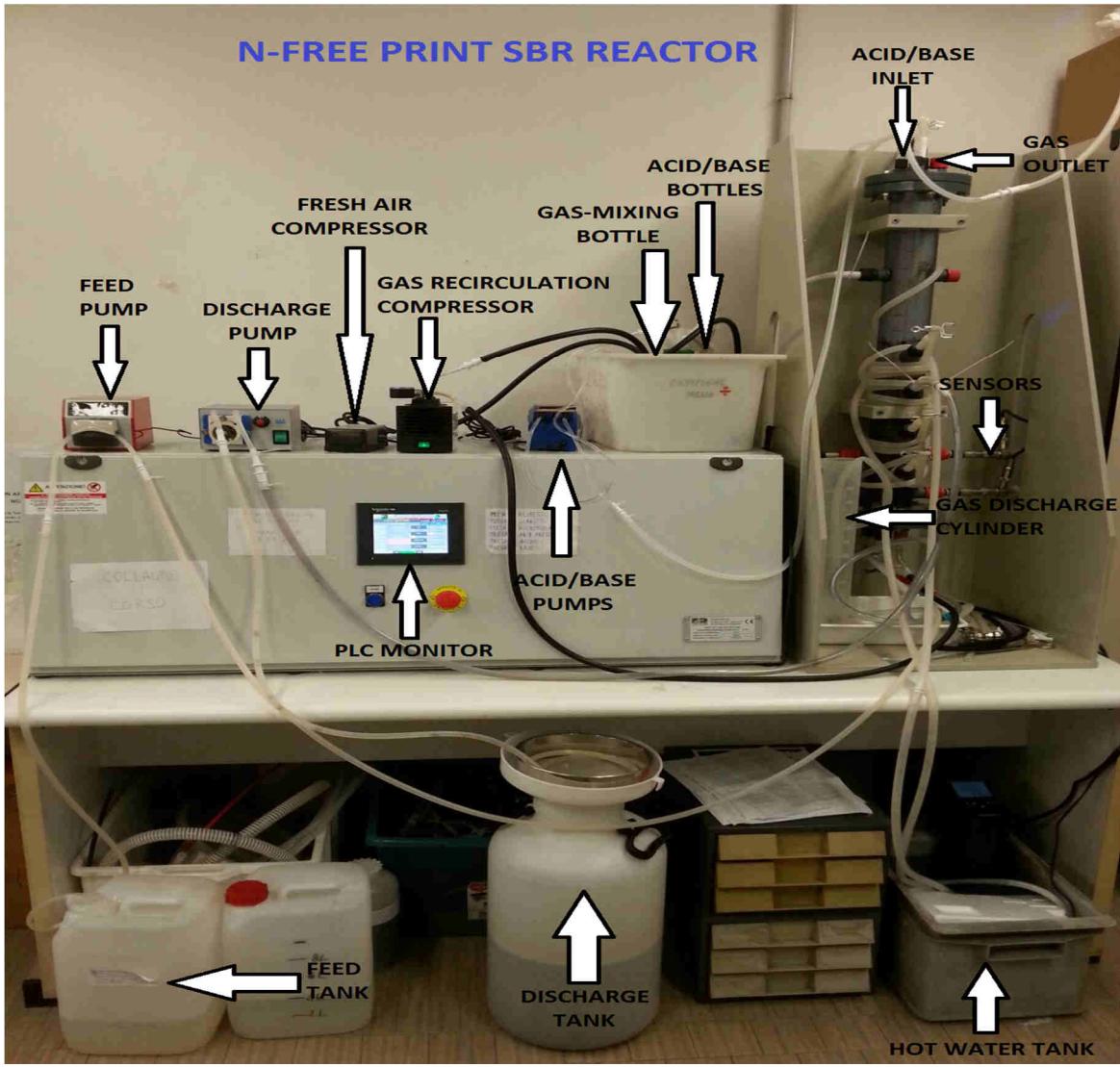






Bench-scale pilot plant

- **Gas-lift SBR**
- **PLC control panel**
- Monitoring probes (DO, conductivity, ORP, pH)
- pH control (acid/base dosing)
- Heating for keeping constant T = 30±1°C



Bench-scale pilot plant

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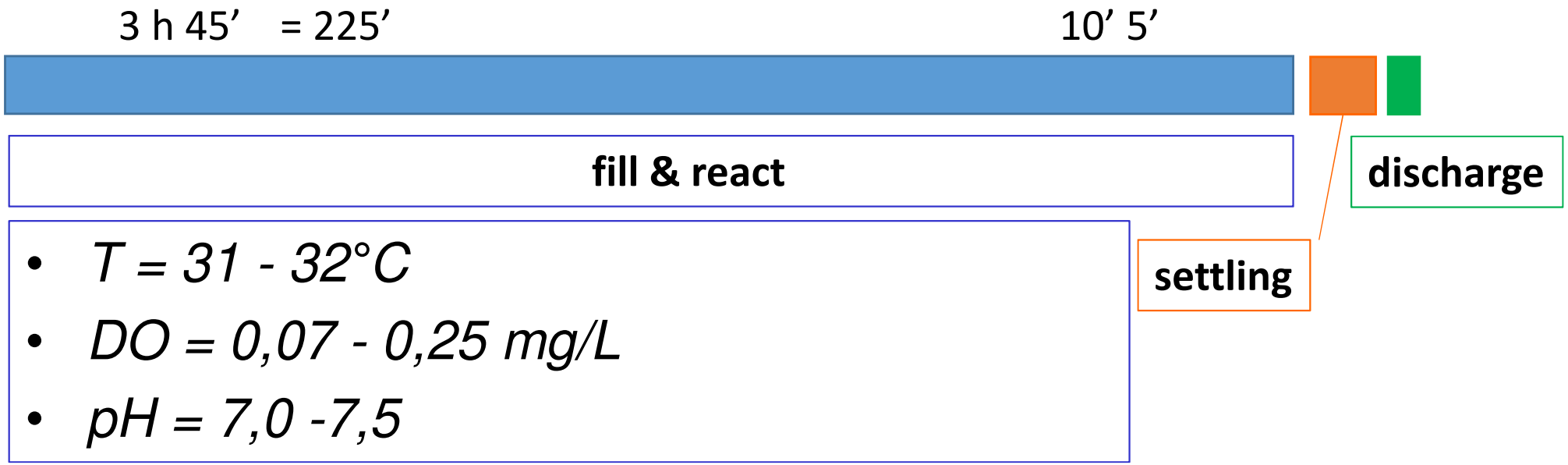
Bench-scale pilot plant – first trials (2015 - 16)

- 4 h cycle



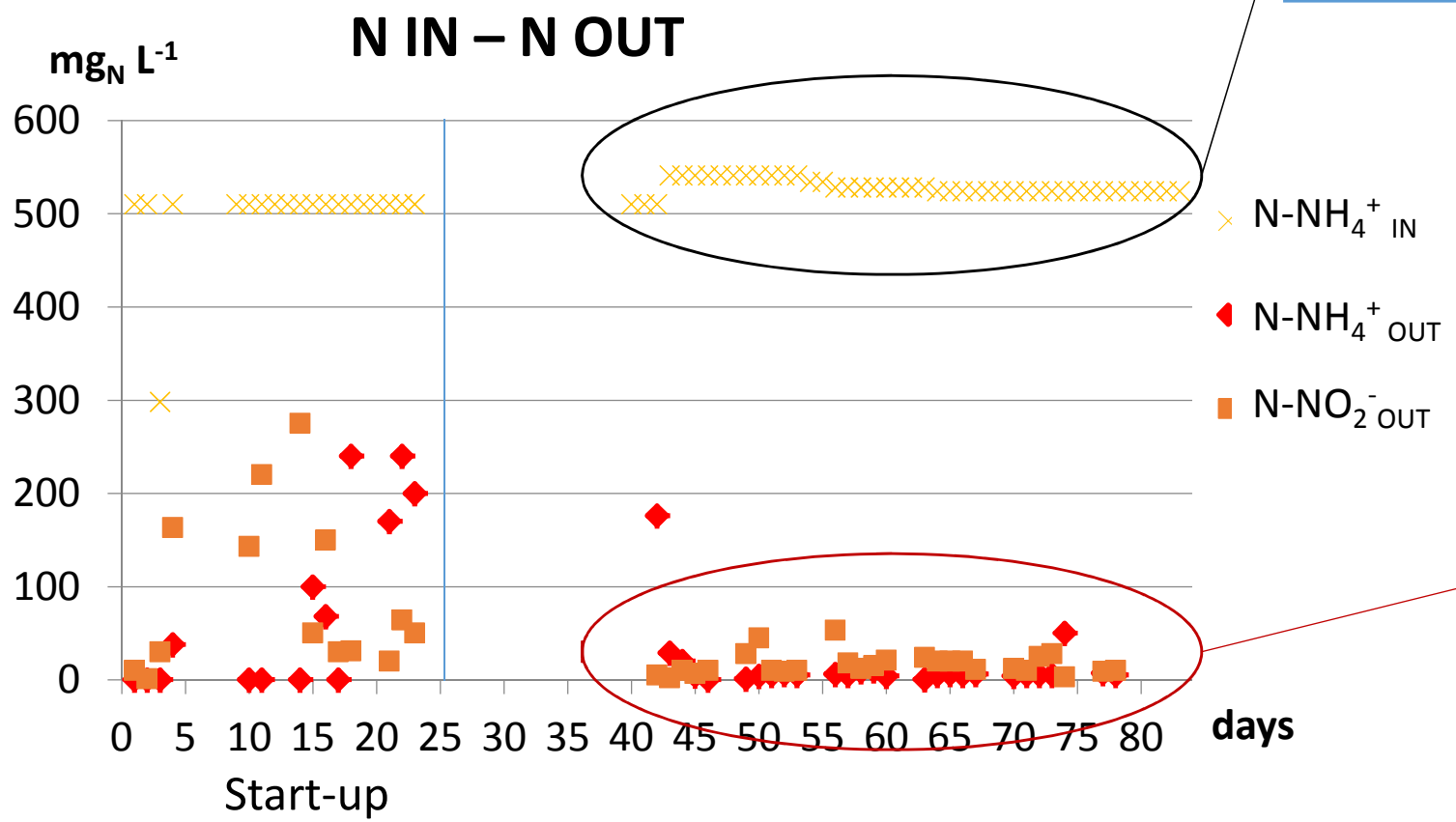
- *T = 31 - 32°C*
- *DO = 0,07 - 0,25 mg/L*
- *pH = 7,0 -7,5*

Active biomass: **3 - 6 g_{SSV}/L**

Bench-scale pilot plant – first trials (2015 - 16)

Equalized effluent (I)

Influent
Ntot ≈ N-NH_4^+ = 520 mg_N/L

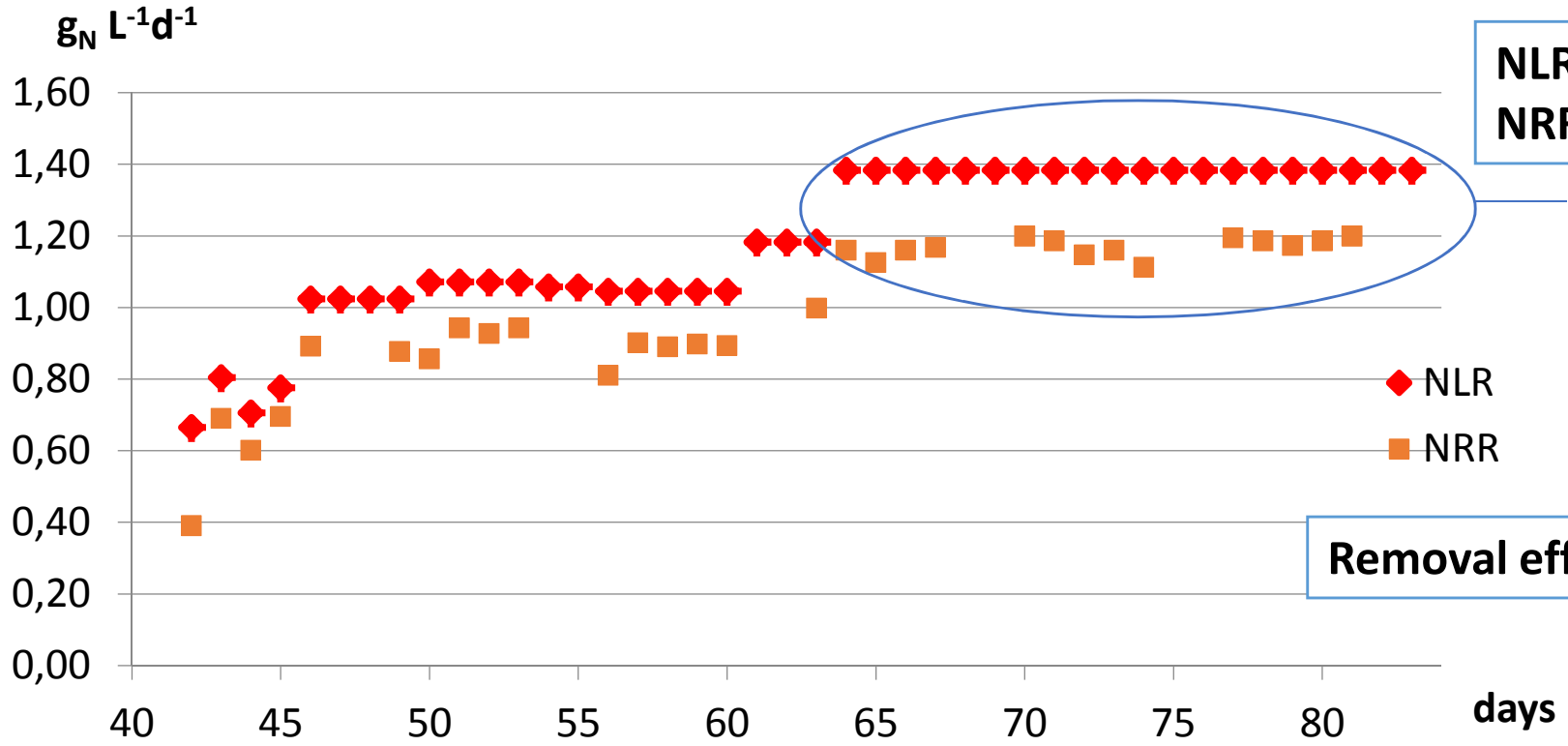


Effluent
N-NH_4^+ = 8 mg_N/L
N-NO_2^- = 16 mg_N/L
N-NO_3^- = 55 mg_N/L
N_{tot} = 79 mg_N/L

Bench-scale pilot plant first trials (2015 – 16)

Equalized effluent (II)

Volumetric N Loading rate (**NLR**) and N removal rate (**NRR**)



NLR = 1,38 g_N L^{-1} d^{-1}
NRR = 1,17 g_N L^{-1} d^{-1}

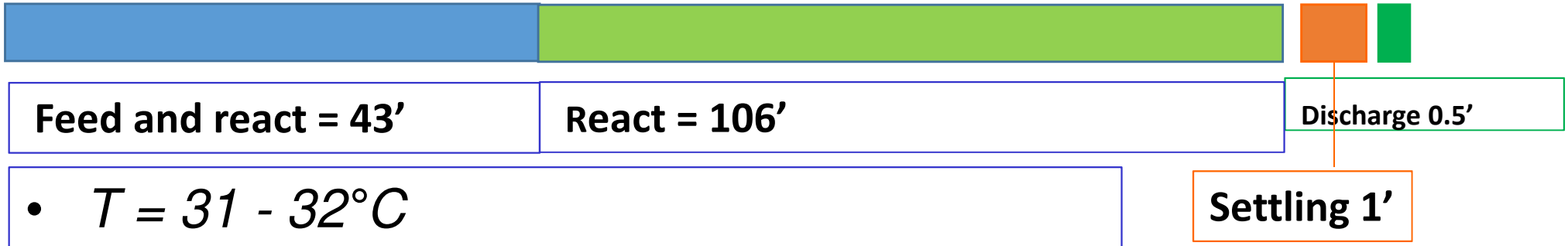
Removal efficiency = 85%

Bench-scale pilot plant start-up – Feb. 2019

Lab-scale pilot

Operating parameters as of 27th February 2019

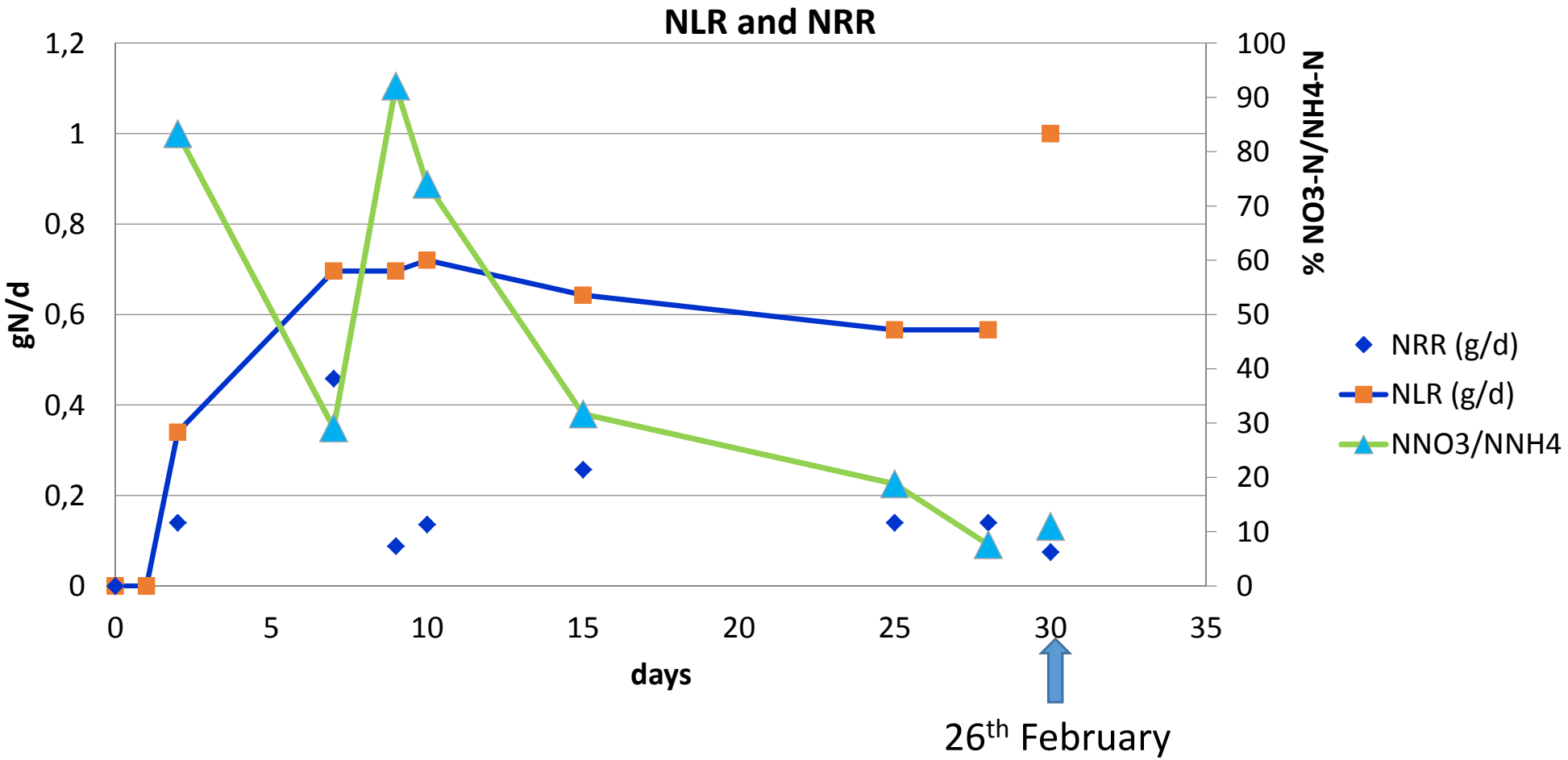
- After 20 days of start-up – first week: 8-h cycles
- From February 14th: Cycle duration = 2.4 h; exchange volume **0.2 l**
- From February 26th : Cycle duration = 2.4 h; exchange volume **0.5 l**



- *T = 31 - 32°C*
- *OD = 0,07 - 0,25 mg/L*
- *pH = 7,0 -7,5*

- Active biomass: **8 g_{SSV}/L**

Bench-scale pilot plant start-up – Feb. 2019



Thank you

CONTACT

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