

Piloting carbon-lean nitrogen removal for energy-autonomous sewage treatment

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Electronic Supplementary Information

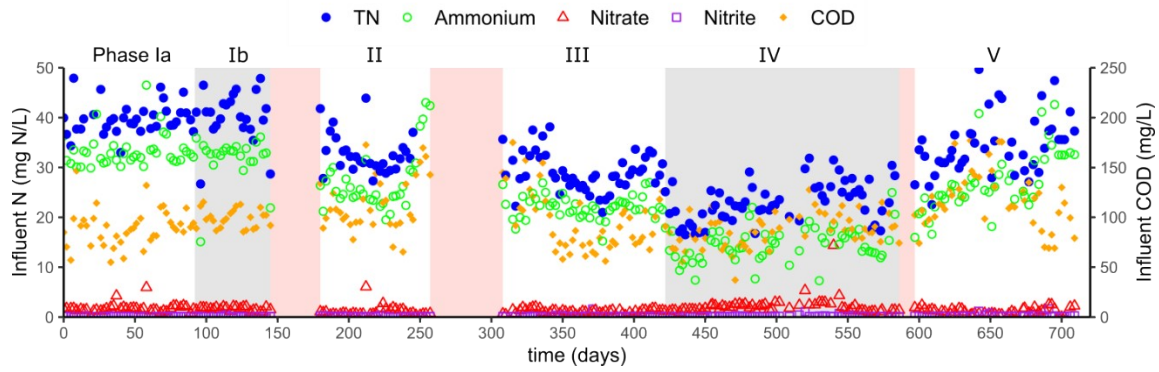


Figure S1 Composition of the pilot influent, consisting of on-site A-stage effluent spiked with ammonium bicarbonate and measured in an automatically grabbed and mixed sample over 48-72h (stored at 4°C). The additional dosing of ammonium carbonate and sodium nitrite to the anammox tank was not included in these reported values. Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

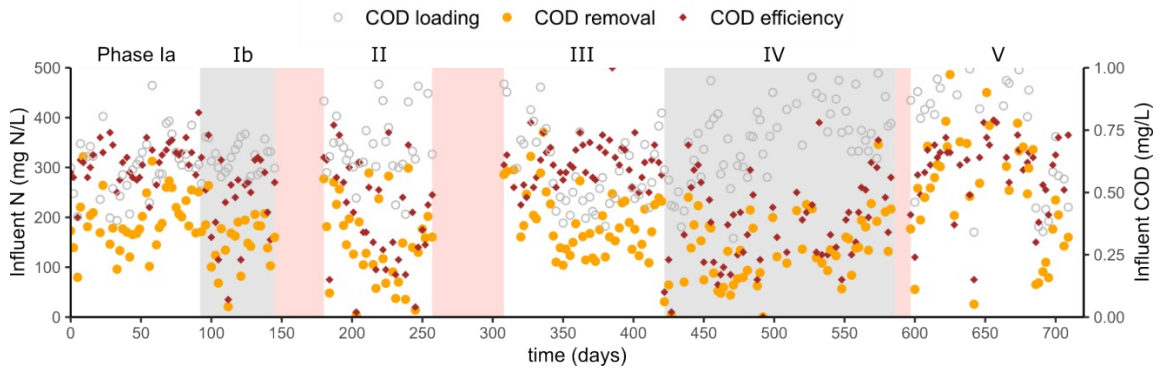


Figure S2 COD loading rate, removal rate and removal efficiency in the pilot reactor over time. Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

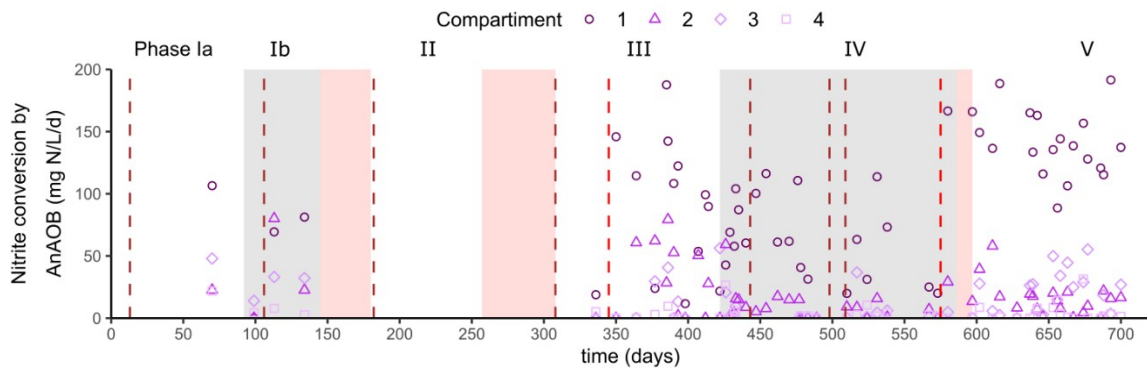


Figure S3 Nitrite consumption by AnAOB in the anammox tank, measured per compartment (1-4). Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

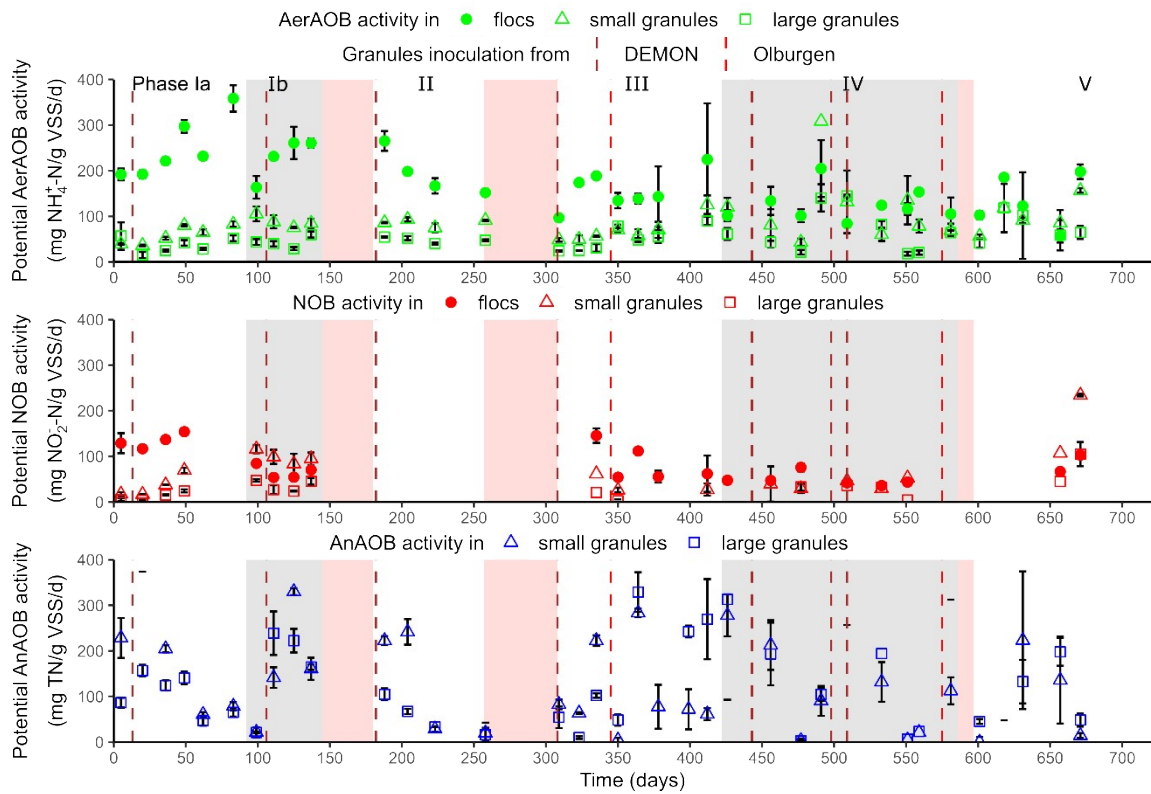


Figure S4 Potential activity of the AerAOB (top panel), NOB (middle panel) and AnAOB (bottom panel) per sludge fraction. All measured in ex-situ batch activity tests at 22±2°C, executed in duplicate or triplicate. An NH₄⁺-N:NO₂⁻-N conversion ratio of 1:1.23 was used for AnAOB to calculate TN removal rates based on NH₄⁺ measurements. Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

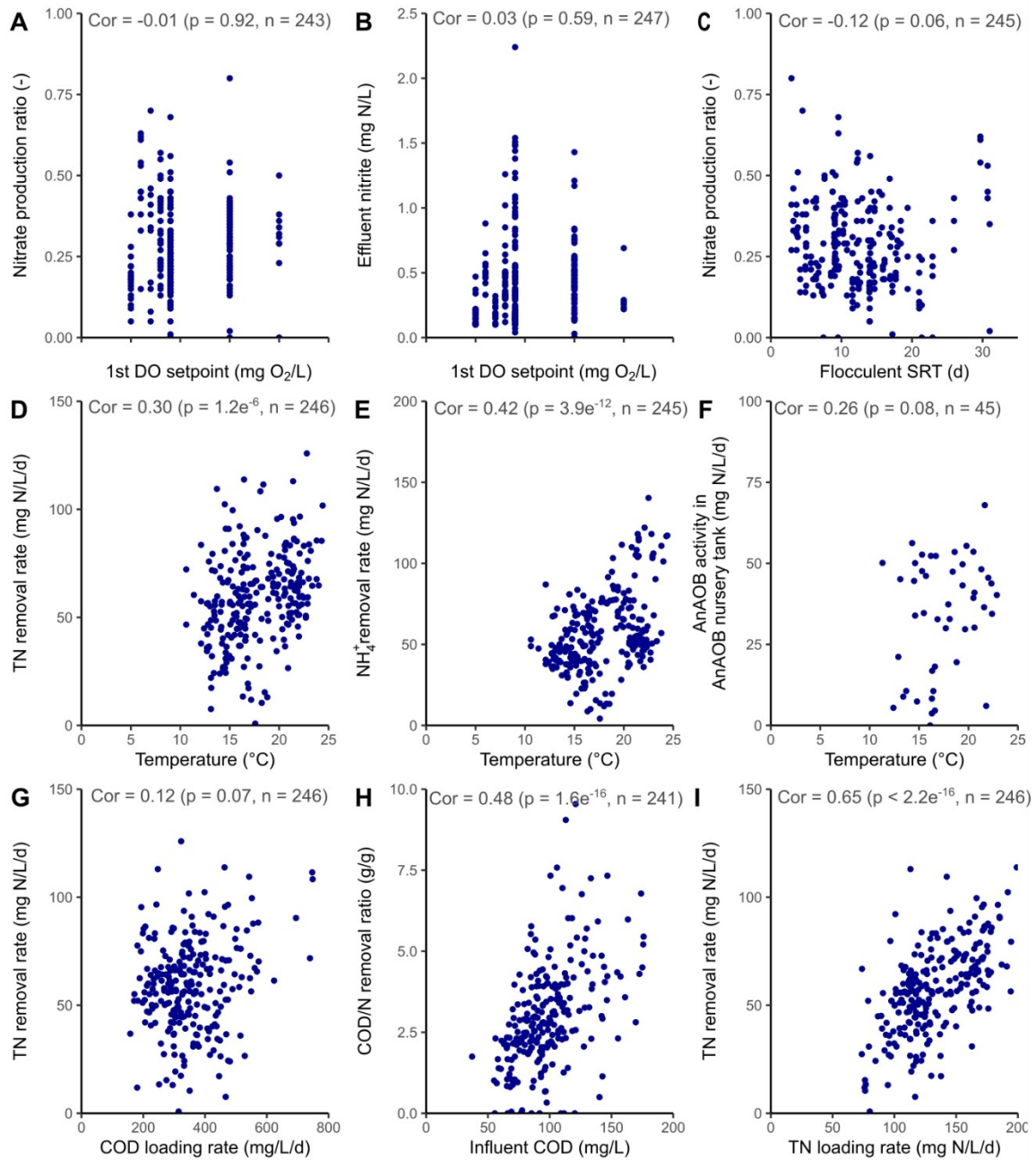


Figure S5 Correlation analyses of various parameters. The correlation coefficient (cor) was calculated using the Pearson method and shown on top of each panel, together with the p-value and sample size n.

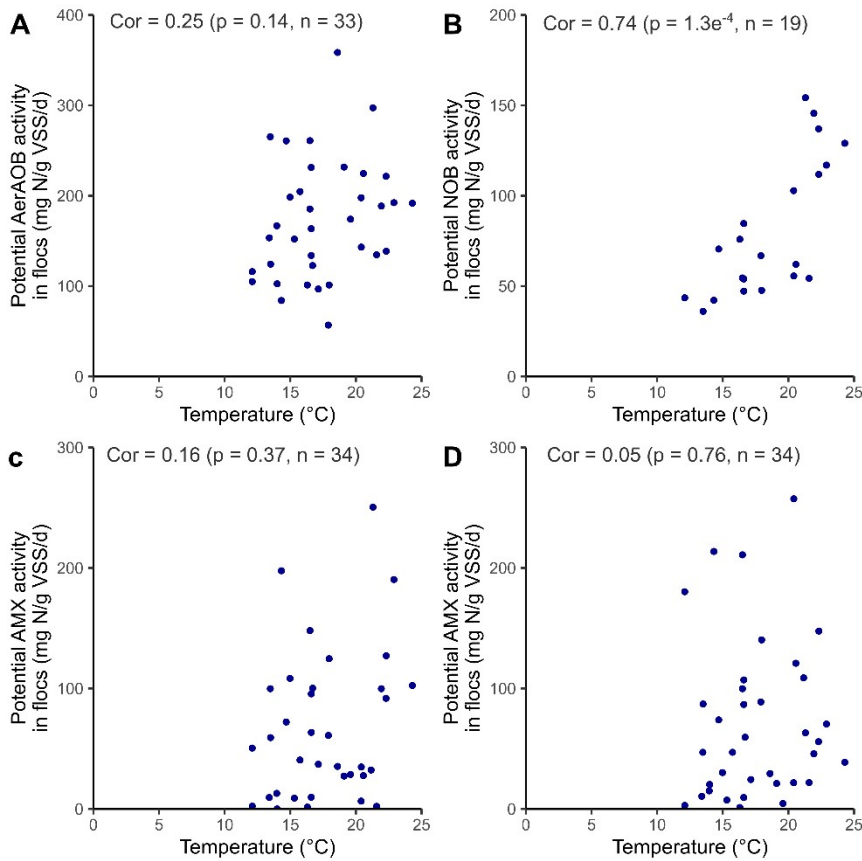


Figure S6 Correlation analyses of various parameters. The correlation coefficient (cor) was calculated using the Pearson method and shown on top of each panel, together with the p-value and sample size n.

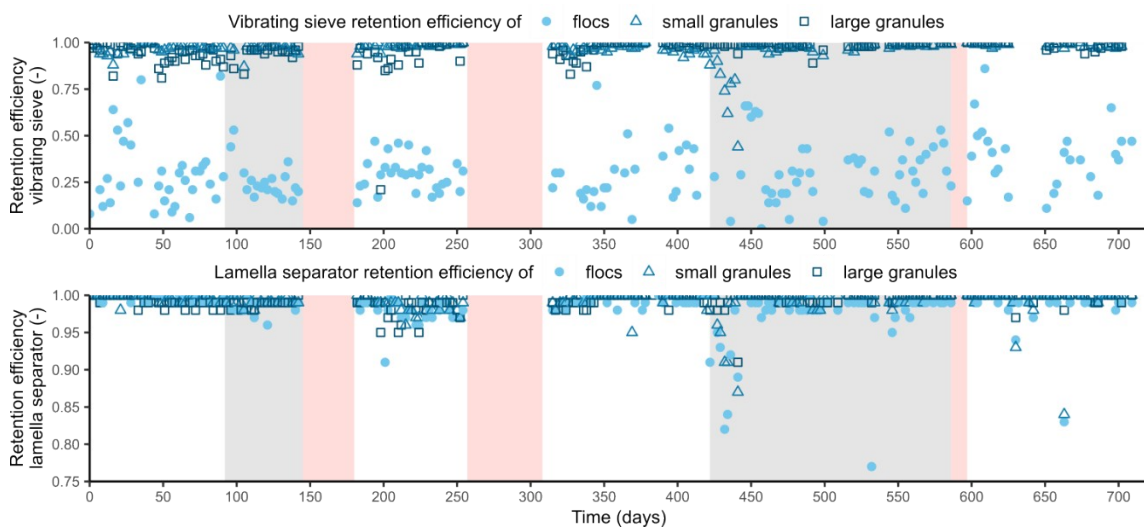


Figure S7 Retention efficiency of the vibration sieve (top panel) and lamella separator (bottom panel) over time and per sludge fraction, calculated as mass balance between the

incoming and outgoing stream(s). Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

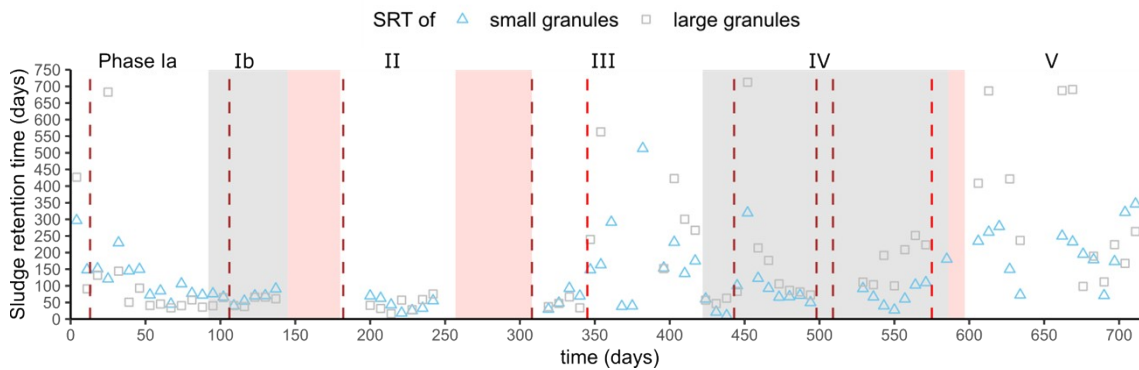


Figure S8 Sludge retention time (SRT) of the granules, calculated as average over 7 days (cumulated losses versus average concentration in the facultative aerobic tank). Alternating white and grey backgrounds distinguish operational phases, red background indicates pilot downtime.

Table S1 Overview of all inoculations and their origin: either from the on-site DEMON[®] reactor (STP Nieuwveer) or from ANAMMOX[®] reactor (Olburgen, the Netherlands) treating a mixture of mainly potato wastewater and sludge reject water. The pilot reactor was operated for 715 days.

Time (days)	Phase	PN/A process	Location
13	Ia	DEMON [®]	Nieuwveer
106	Ib	DEMON [®]	Nieuwveer
182	II	DEMON [®]	Nieuwveer
308	III	DEMON [®]	Nieuwveer
345	III	ANAMMOX [®]	Olburgen
443	IV	DEMON [®]	Nieuwveer
498	IV	DEMON [®]	Nieuwveer
509	IV	DEMON [®]	Nieuwveer
575	IV	ANAMMOX [®]	Olburgen

Table S2 Estimation of the TN and COD removal per tank, based on the frequent N measurements in the denitrification tank, anammox tank and the overall in- and effluent. COD/N removal ratio in the denitrification tank was assumed to be equal to 4 g COD/g TN removal. The same value was used in the anammox tank as well as 2.4 g COD/g TN for denitrification.

Days	Phase	TN removal (kg TN/d or %)				COD removal (kg COD/d or %)			
		DN tank	Anammox tank	intermittent aeration tank	Total	DN tank	Anammox tank	intermittent aeration tank	Total
385-426	III	0.24 31%	0.23 31%	0.33 38%	0.80 100%	0.97 43%	0.11 5%	1.20 53%	2.28 100%
611-700	V	0.30 29%	0.32 31%	0.50 40%	1.12 100%	1.19 42%	0.18 7%	1.99 51%	3.37 100%
385-700	III & V	0.28 30%	0.30 31%	0.45 39%	1.03 100%	1.13 42%	0.15 6%	1.77 52%	3.06 100%