

Partial denitrification-anammox (PdNA) in deep-bed polishing filters: performance evaluation using methanol and glycerol and robustness through seasonal changes and backwashing shear

Table S1. Bump and backwash settings as well as runtime of methanol and glycerol filters at 4.9 m/hr.

	Units	Methanol	Glycerol
Bump settings			
valve opening to initiate bump	%	95	95
bumping time	min	3	3
bumping flow rate	m/hr	14.6	14.6
Backwash settings			
bump frequency to initiate backwash	hours	<4	<4
air scour time	min	3	3
air scour flow	m/min	1.5	1.5
concurrent time	min	9	14
concurrent air flow	m/min	1.5	1.5
concurrent water flow	m/hr	14.6	14.6
final rinse time	min	10	10
final rinse flow	m/hr	14.6	14.6
Runtime	days	4.7 ± 1.9	4.9 ± 2.1

Table S2. Influent characteristics at different loading rates with and without phosphorus addition. The steady state phase discussed in the main paper is the 4.9 m/hr with phosphorus addition

		4.9 m/hr without OP	7.3 m/hr without OP	4.9 m/hr with OP	7.3 m/hr with OP
Duration	days	60	19	102	56
Influent concentrations					
NH ₄ ⁺ -N methanol	mg N/L	4.7 ± 2.2	4.2 ± 2.6	5.1 ± 2.2	4.2 ± 1.5
NH ₄ ⁺ -N glycerol	mg N/L	5.4 ± 2.3	5.0 ± 2.6	5.3 ± 2.1	4.6 ± 1.5
NO ₂ ⁻ -N	mg N/L	1.57 ± 0.5	1.57 ± 0.5	0.77 ± 0.7	0.67 ± 0.2
NO ₃ ⁻ -N	mg N/L	5.4 ± 2.3	4.4 ± 2.7	7.0 ± 3.1	6.8 ± 1.8
TIN methanol	mg N/L	11.6 ± 4.0	10.1 ± 5.3	12.8 ± 4.9	11.6 ± 2.8
TIN glycerol	mg N/L	12.2 ± 4.1	11.0 ± 5.3	13.0 ± 4.8	12.0 ± 2.7
OP	mg P/L	0.16 ± 0.16	0.11 ± 0.04	0.70 ± 0.58	0.74 ± 0.42
TSS	mg TSS/L	7.0 ± 2.8	9.5 ± 3.3	7.7 ± 2.7	10.3 ± 3.3
AvN methanol		0.74 ± 0.35	0.71 ± 0.21	0.70 ± 0.32	0.58 ± 0.22
AvN glycerol		0.84 ± 0.35	0.87 ± 0.23	0.72 ± 0.34	0.64 ± 0.22
Loading rates					
Hydraulic	m ³ /m ² /h	4.9	7.3	4.9	7.3
NH ₄ ⁺ -N methanol	g N/m ³ /d	307 ± 142	408 ± 246	326 ± 139	396 ± 154
NH ₄ ⁺ -N glycerol	g N/m ³ /d	351 ± 151	485 ± 245	337 ± 136	432 ± 152
NO ₃ ⁻ -N	g N/m ³ /d	348 ± 156	427 ± 255	450 ± 201	636 ± 181
TIN methanol	g N/m ³ /d	749 ± 267	979 ± 508	819 ± 313	1090 ± 286
TIN glycerol	g N/m ³ /d	793 ± 280	1056 ± 508	830 ± 310	1125 ± 283
TSS	g TSS/ m ³ /d	456 ± 177	915 ± 320	493 ± 170	845 ± 453

Table S3. Backwash procedure applied to the filters during the backwash test. The flow settings were the same as Table S1. *Initial concurrent times in the methanol and glycerol filters were respectively 9 and 14 minutes.

Procedure	Unit	Air scour	Concurrent	Final rinse
Baseline	min	3	9/14*	10
three series of three backwashes in a row	min	3	14	10
increased air scour time	min	240	14	10
increased air scour and final rinse times	min	240	40	30

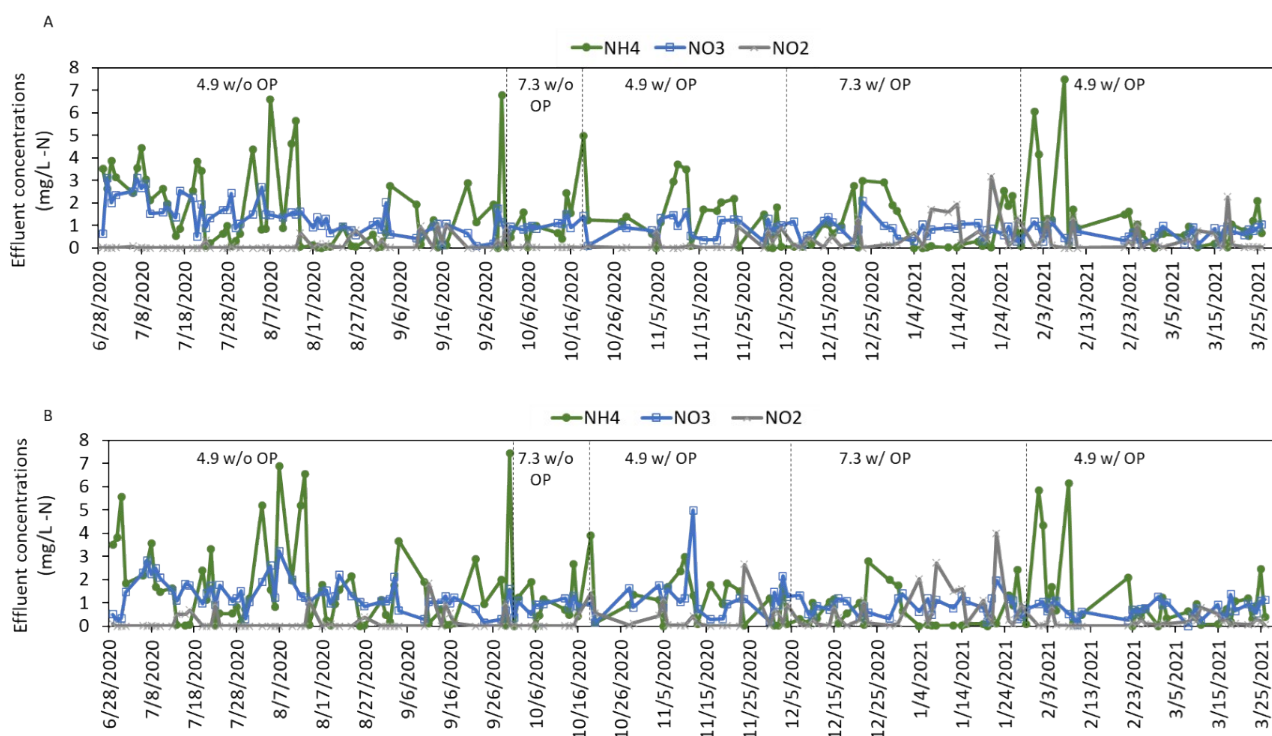


Figure S1. Effluent ammonium, nitrite and nitrate concentrations at 4.9 and 7.3 m/hr with and without phosphorus addition. A. Methanol filter, B. Glycerol filter. The steady state phase discussed in the main paper is at 4.9 m/hr with phosphorus addition.



Figure S2. Methanol and glycerol filters removal at 4.9 and 7.3 m/hr with and without phosphorus addition. A. Ammonium removal, B. Ammonium removal through AnAOB, C. nitrate removal, D. TIN removal. The steady state phase discussed in the main paper is at 4.9 m/hr with phosphorus addition

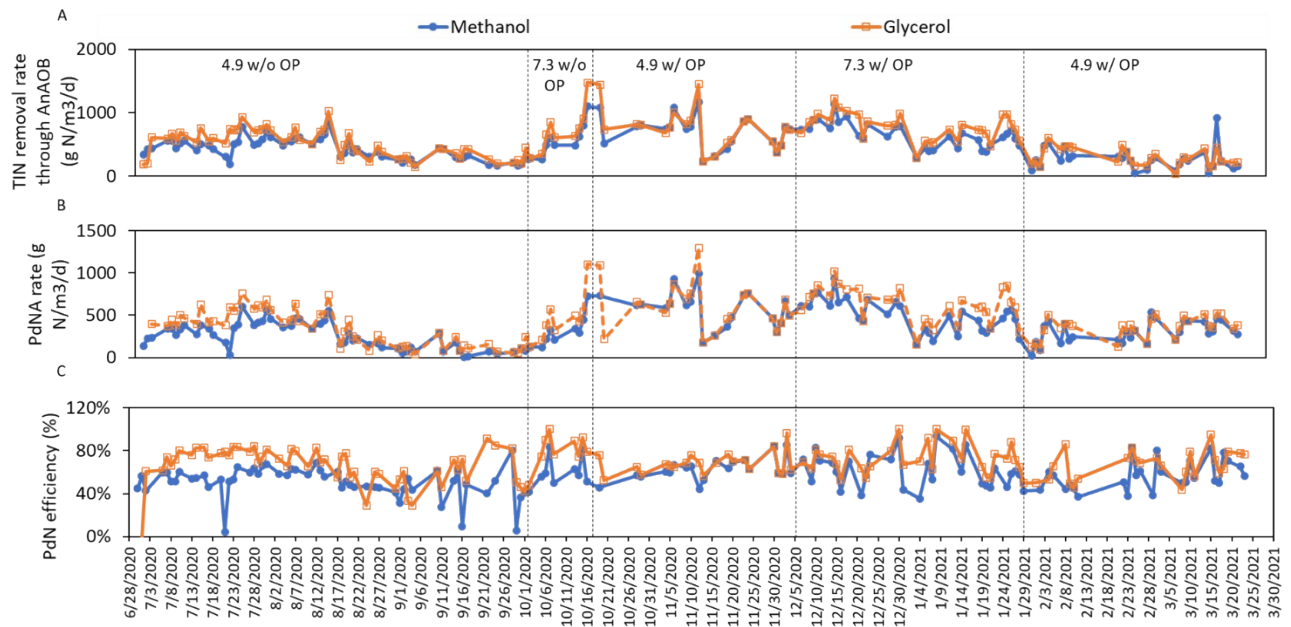


Figure S3. Methanol and glycerol filters performance at 4.9 and 7.3 m/hr with and without phosphorus addition. A. TIN removal rate through AnAOB, B. PdNA rate, C. PdN efficiency. The steady state phase discussed in the main paper is at 4.9 m/hr with phosphorus addition.

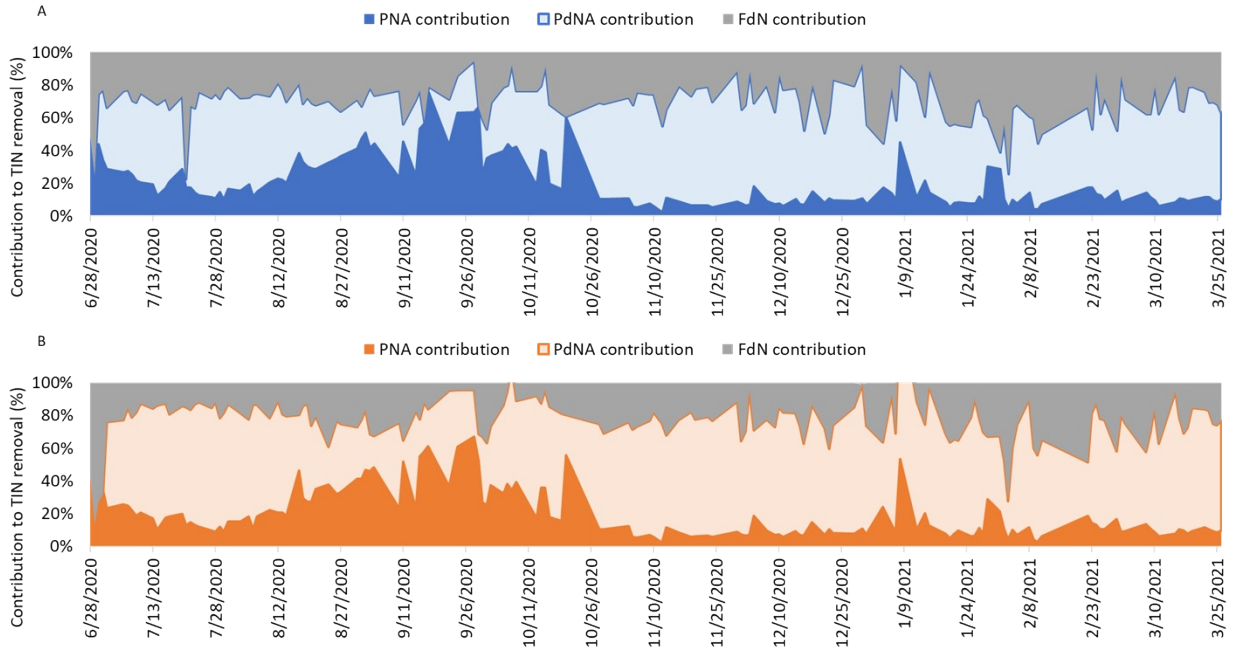


Figure S4. Contribution to TIN removal via incoming nitrite, PdNA and FdN routes for the methanol (A) and glycerol (B) filters.