water

Article

A Sequential Anammox Zeolite-Biofilter for the Removal of Nitrogen Compounds from Drinking Water

Stephan Eberle [1], Hilmar Börnick [1] and Stefan Stolte [1]*

[1] Institute for Water Chemistry, Technische Universität Dresden, 01062 Dresden, Germany
* stefan.stolte@tu-dresden.de, Tel. +49(0)351/463-32759

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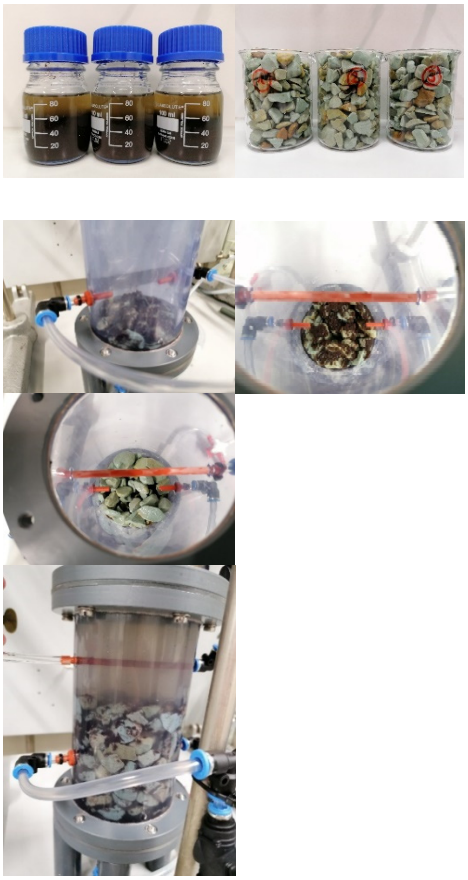
Supporting Information

S1 Inoculation of the Anammox zeolite-biofilter



Left:
90 mL sludge mixture per filter segment. Sludge from wastewater treatment plants from Rotterdam and Wansdorf.
Right:
473±1 g of zeolites per segment.

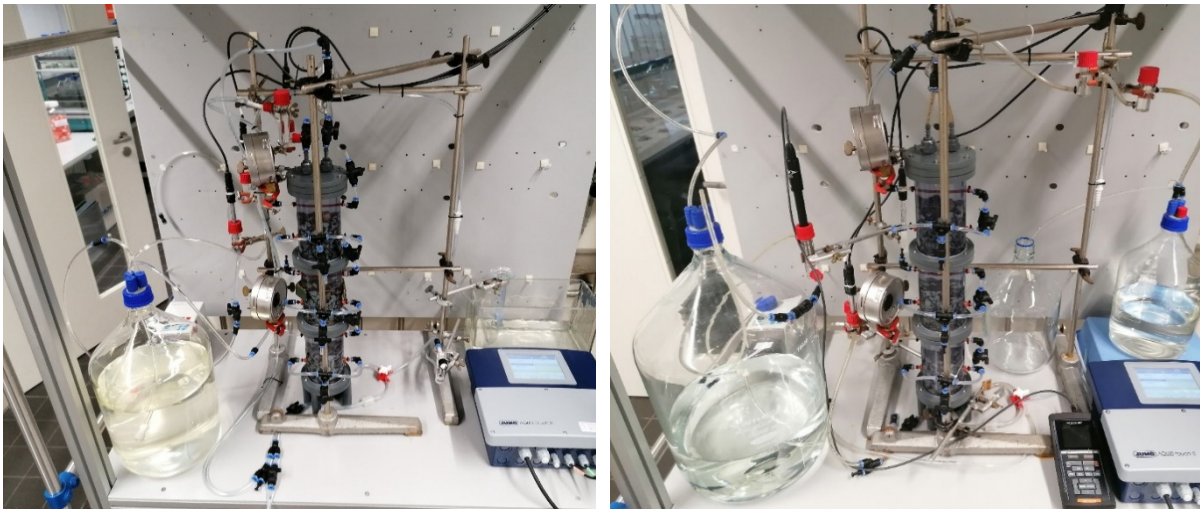
First Anammox zeolite layer. Side (left) and topdown (right) views.

Following 10 mL of sludge inoculum, a second layer of zeolites was added.

First segment completed and filled with oxygen free nutrient solution.
Segment 2 and 3 were completed using the same inoculation procedure.

Figure S1. Inoculation steps of the Anammox zeolite-biofilter.

S2 Completed Anammox zeolite-biofitler



(a) (b)

Figure S2. Completed Anammox zeolite-biofilter in circular flow (a); and (b) flow through operation mode.

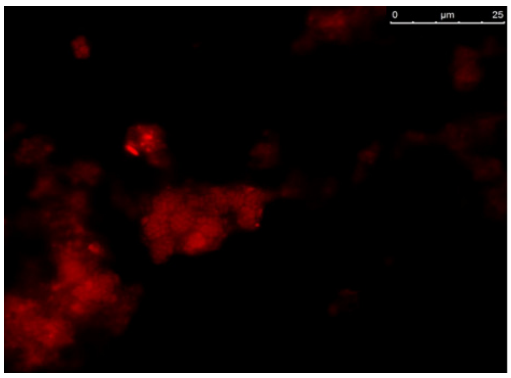


Figure S3-1. Qualitative detection of Amx in the inoculated sludge.

Table S1. Typical chemical composition of the Elbe-/tap water mixture used (1:10).

Na^+ (mg/L)	K^+ (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L	NH_4^+ (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	TN (mg/L)	DOC (mg/L)	HCO_3^- (mg/L)
10.57	1.95	17.63	8.75	4.16	5.56	2.41	5.46	2.53	77.40

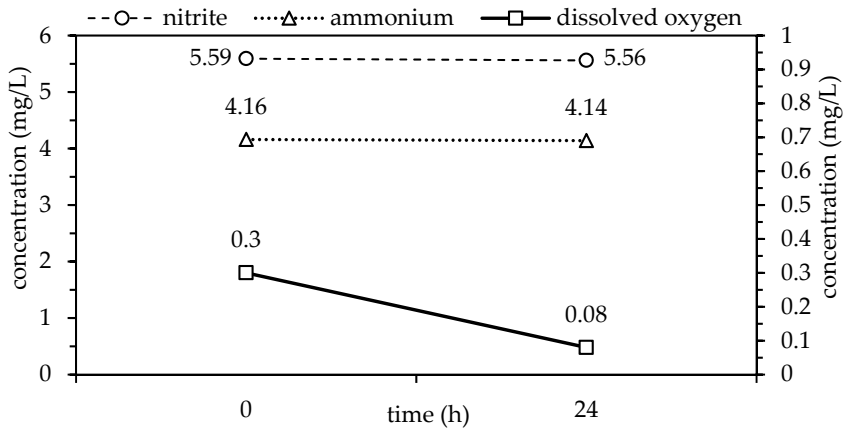


Figure S3-2. Substrate and dissolved oxygen concentrations in the receiving tank over a 24 h period.

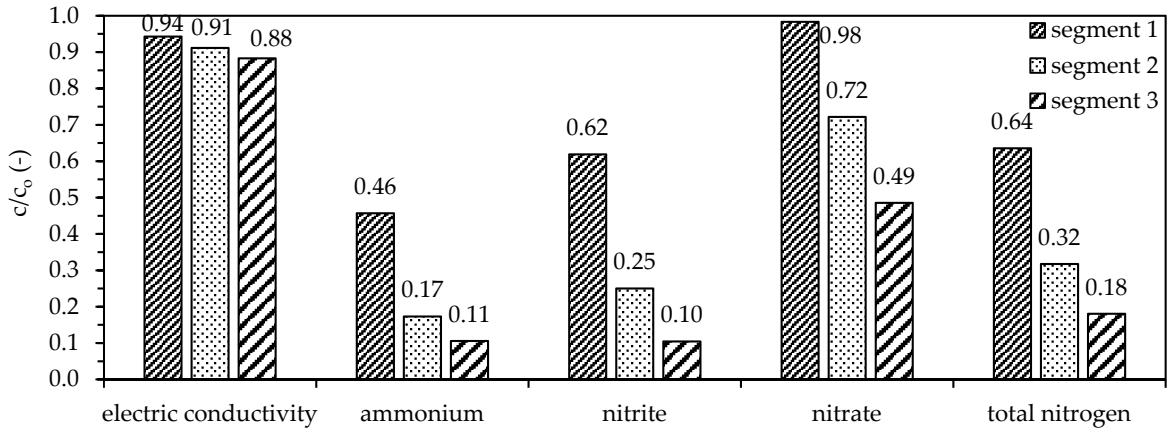


Figure S3-3. Nitrogen degradation efficiencies and decreasing electrical conductivity in each segment of the Anammox zeolite-biofilter for the first investigation after sludge inoculation at the starting point (matrix: Elbe-/

tap water (1:10); v_F = 0.032 m/h; $c_0(NH_4^+)$ = 4.3 mg/L; $c_0(NO_2^-)$ = 5.7 mg/L; c_0(DOC) = 2.5 mg/L; pH: 7.8; T = 22 °C; *n* = 1).

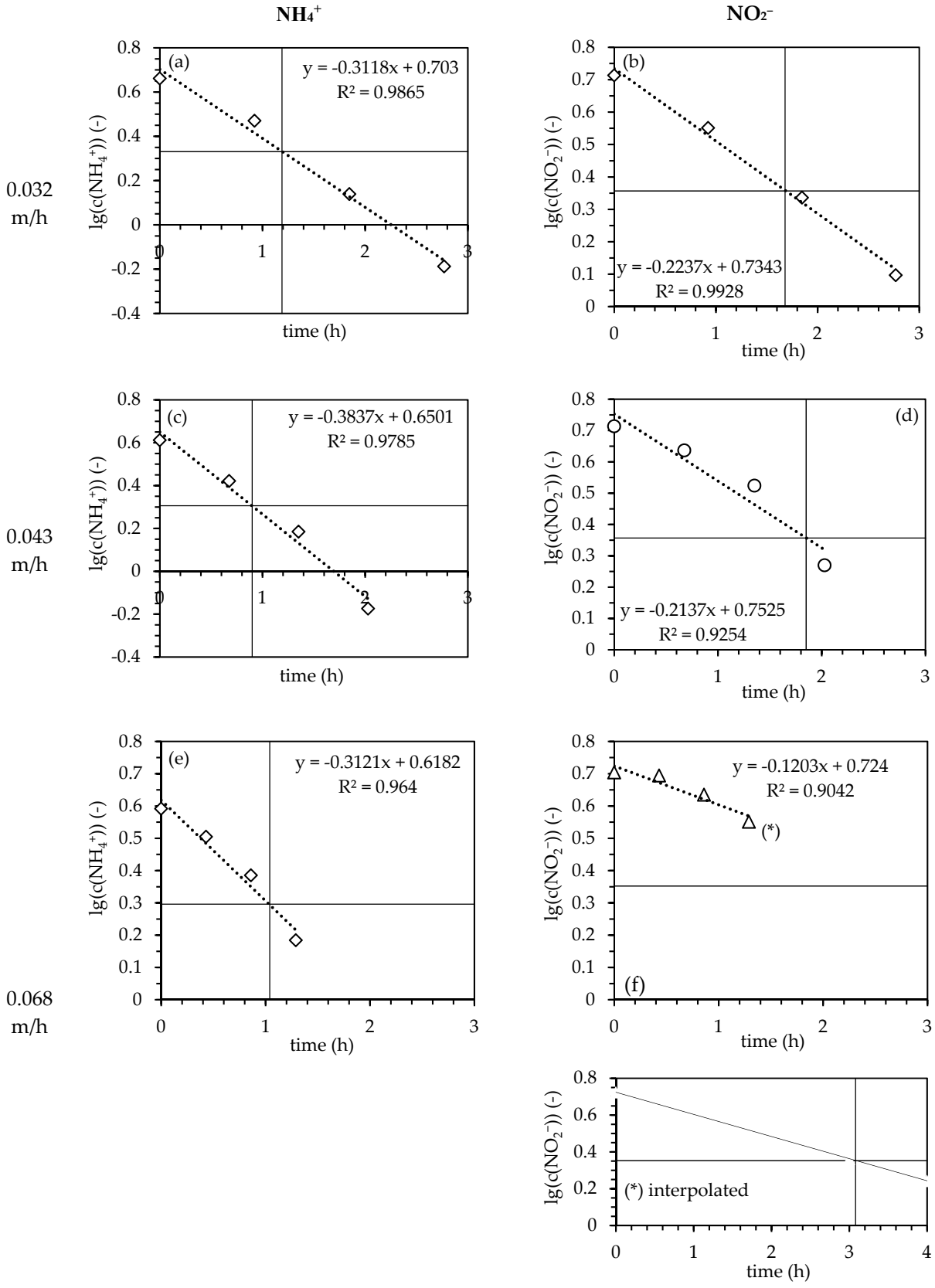


Figure S4. Determination of the half-life period of NH_4^+ and NO_2^- degradation and its dependence on filter velocity: (a), (b) for 0.032 m/h; (c), (d) for 0.043 m/h; and (e), (f) for 0.068 m/h.

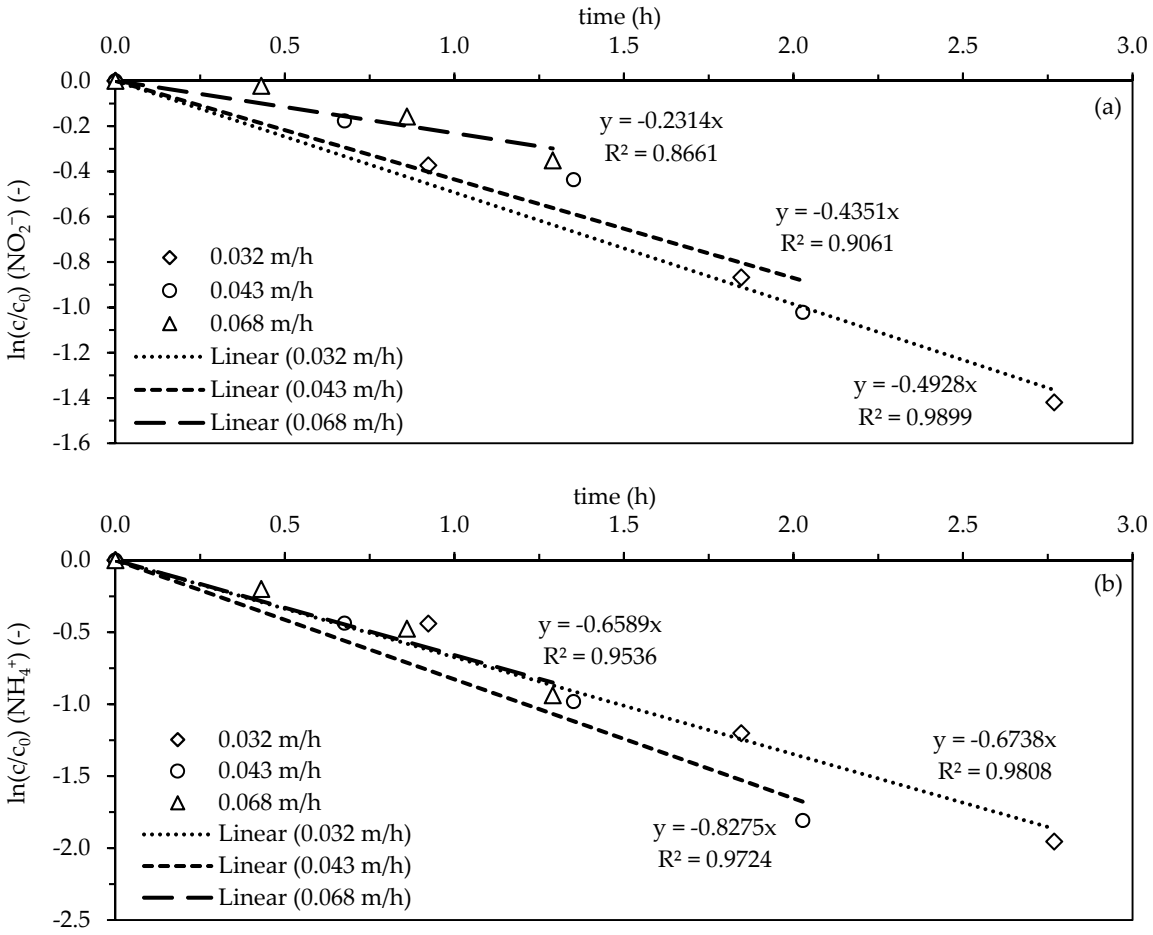
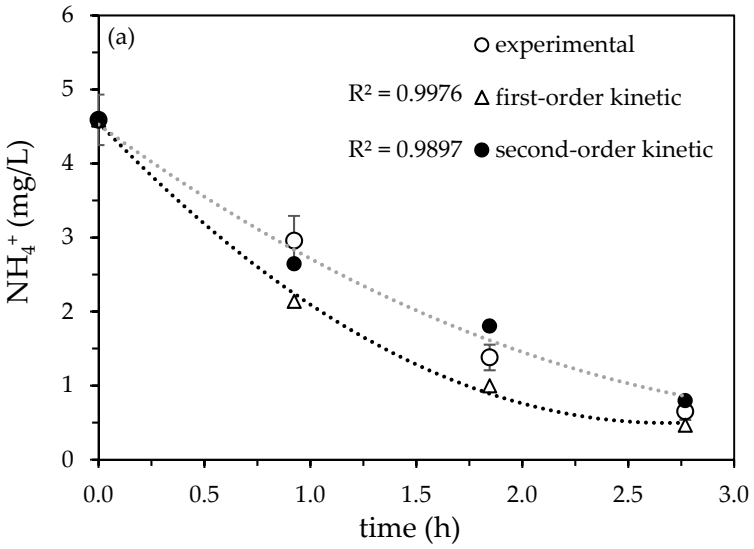
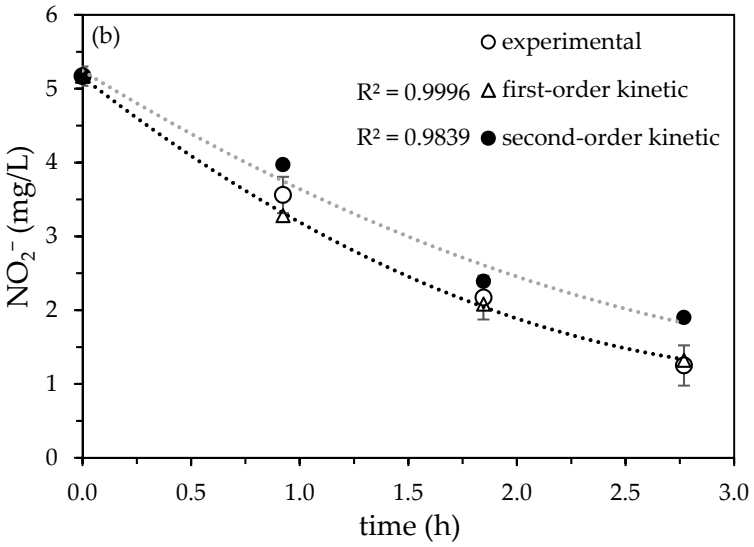
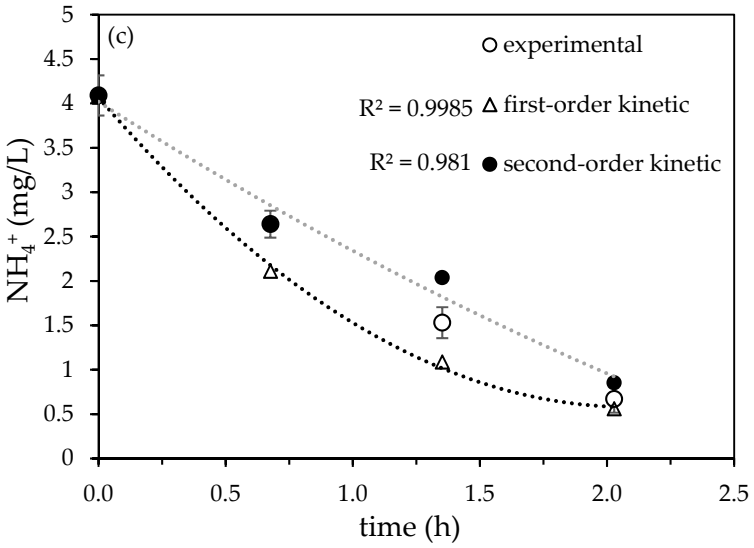


Figure S5. Determination of the reaction rate constant *k* for the pseudo first order. *k* determined by plotting the logarithm of the substrate concentration against the effective hydraulic retention time: (a) for NO_2^-; and (b) for NH_4^+.

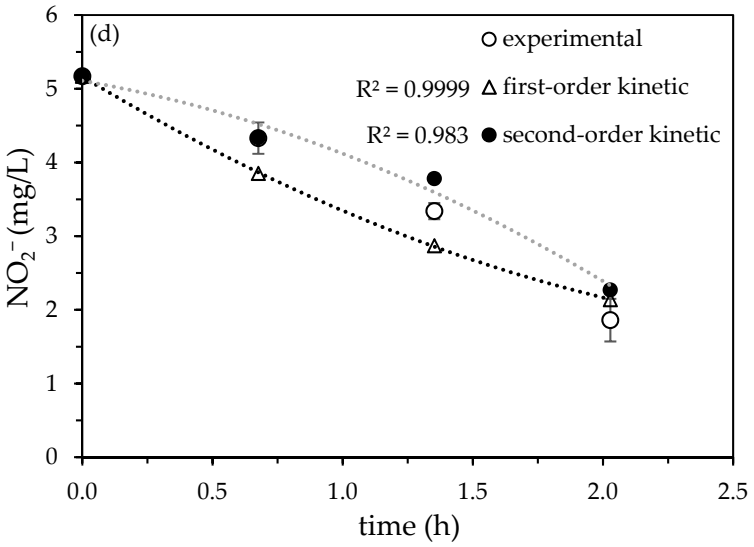

(a)
experimental
R² = 0.9976 first-order kinetic
R² = 0.9897 second-order kinetic
NH_4^+ (mg/L)
time (h)
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
2.5
3.0

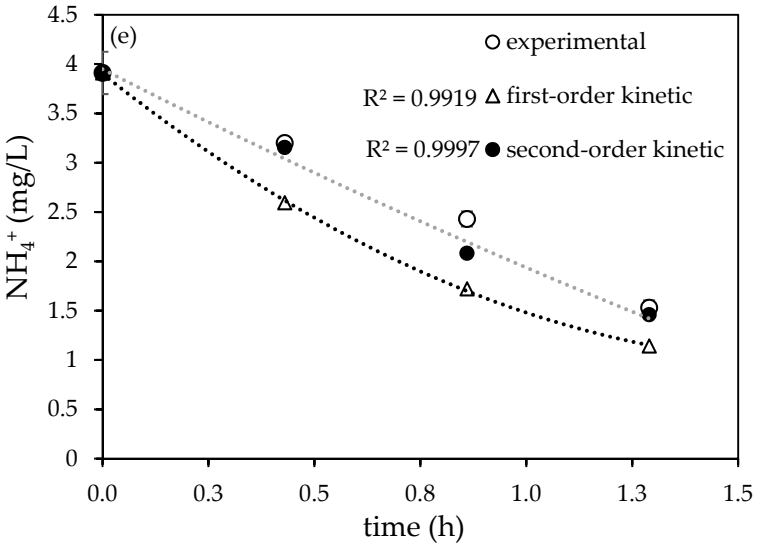
0.032 m/h


(b)
experimental
R² = 0.9996 first-order kinetic
R² = 0.9839 second-order kinetic
NO_2^- (mg/L)
time (h)
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
2.5
3.0



0.043 m/h





0.068 m/h

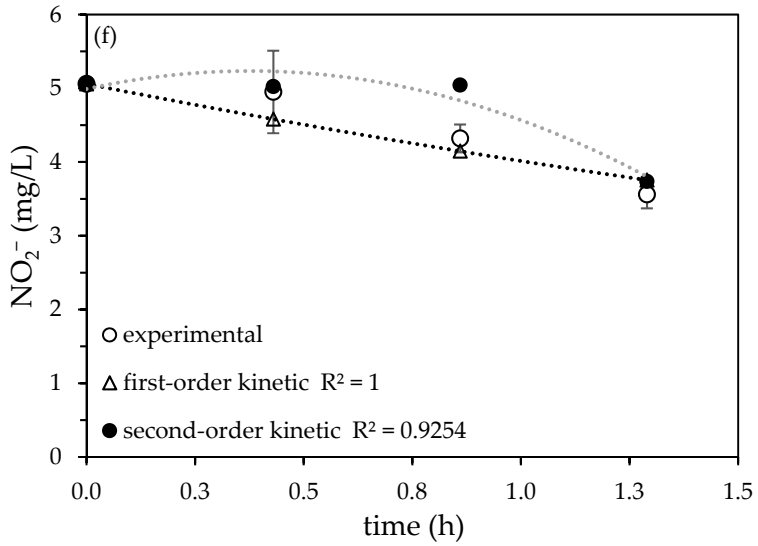
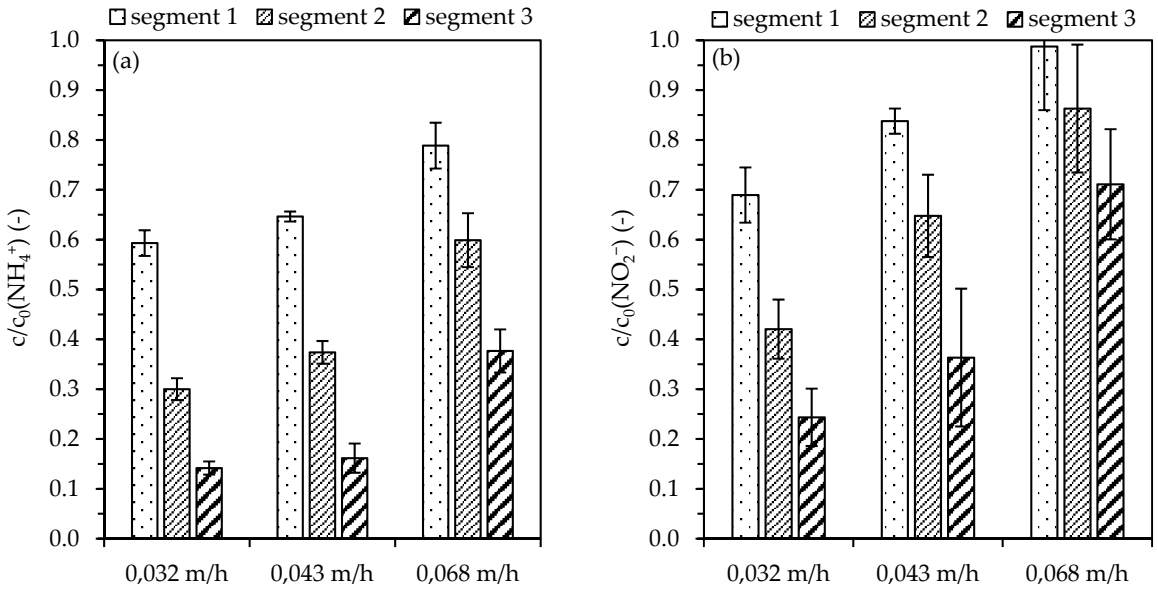


Figure S6. Calculated filter-velocity dependent reaction first-order and second-order for NH_4^+ and NO_2^- removal compared to experimental data: (a), (b) for 0.043 m/h; (c), (d) for 0.043 m/h; and (e), (f) for 0.068 m/h (matrix: Elbe-/tap water (1:10); v_F = 0.032, 0.043, 0.068 m/h; $c_0(NH_4^+)$ = 4.3 mg/L; $c_0(NO_2^-)$ = 5.7 mg/L; c_0(DOC) = 2.5 mg/L; pH: 7.8; T = 22 °C; *n* = 3).

S7 Degradation of Nitrogen Compounds



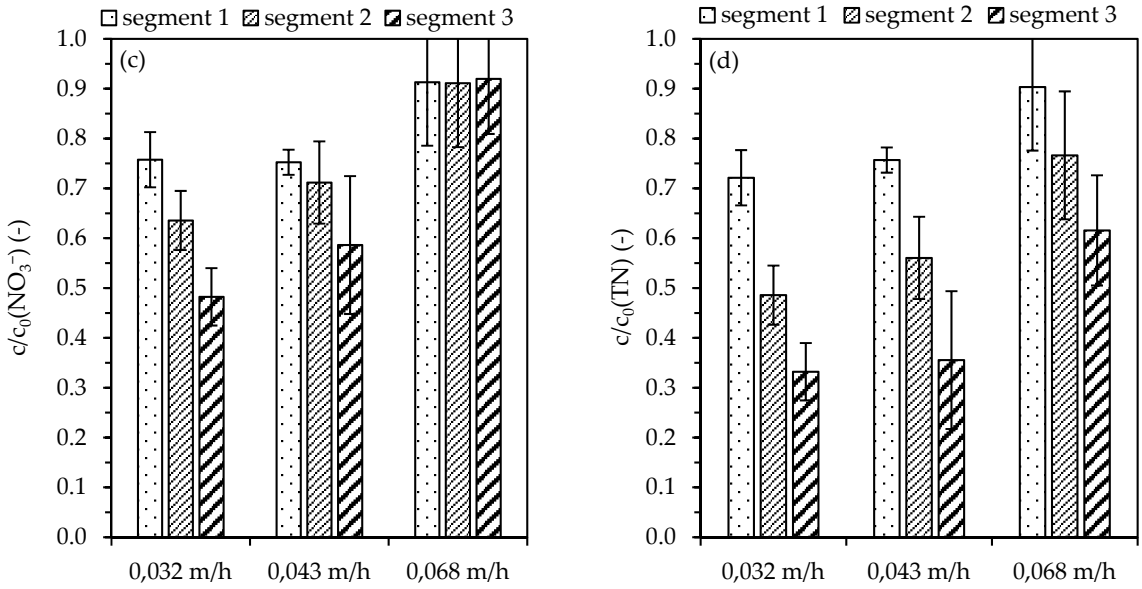


Figure S7. Degradation of nitrogen compounds depending on the filter velocity and Anammox zeolite-biofilter's height: (a) for NH_4^+; (b) for NO_2^-; (c) for NO_3^-; and (d) for TN.