Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS

AdvIQwater

Anaerobic ammonium oxidation process for nitrogen and pharmaceuticals removal from wastewater, heavy metal treatment of composts by white rot fungi

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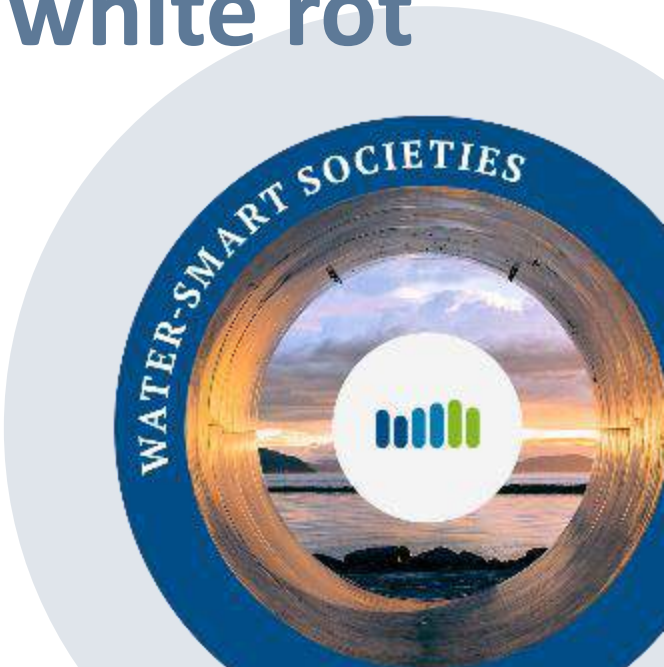
Ivar Zekker

interreg-baltic.eu/project/adviqwater/



University of Tartu

„Improving quality of BSR waters by advanced treatment processes”

- The project AdvIQwater tests fungal treatment and biofilms methods to efficiently clean wastewaters from pharmaceuticals.
- Environmental pollution by hazardous substances has become a serious problem in the Baltic Sea Region. Among them, pesticides, pharmaceuticals, industrial chemicals, and heavy metals are of emerging concern studied in project.

Outline

- Denitrification alone may not be a feasible avenue to meet stringent effluent quality
- Challenge for ANAMMOX technology to treat mainstream wastewater with low ammonium content/fluctuated pharmaceuticals.
- Simultaneous removal of ammonium, pharmaceuticals from sidestream at moderate temperature
- Pregrowth/adaptation of biomass for Pharmaceutical removal is necessary

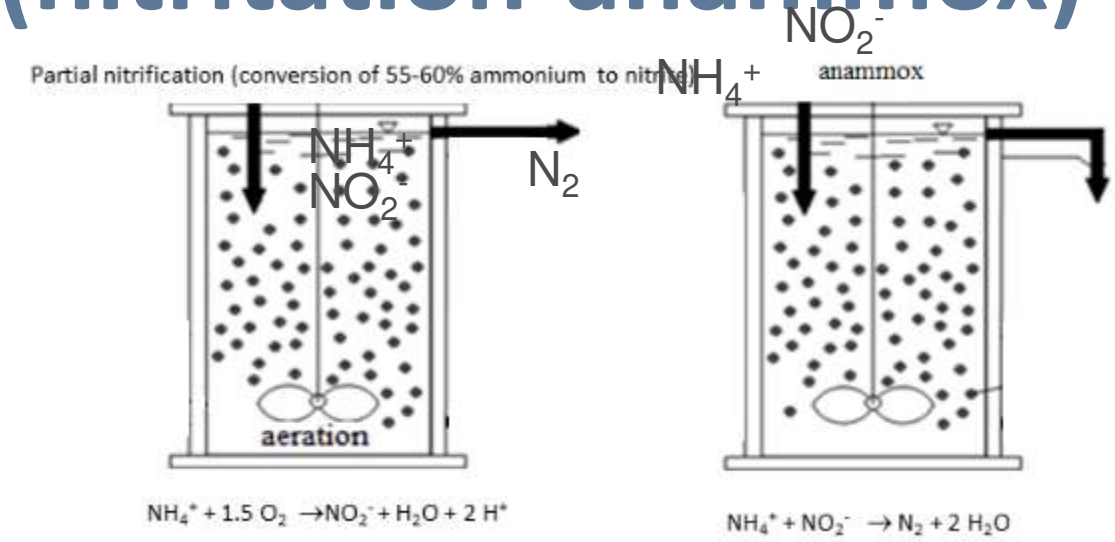
Research aims

- To compare aerobic and anoxic phases differences in pharmaceutical and nitrogen compounds removal. In general, the anoxic phase of anammox predominantly relies on anammox bacteria and their related activities, such as sorption, biotransformation, and microbial reduction processes.
- Investigating how variables like starvation and non-starvation affects pharmaceuticals (PHACs) removals (ciprofloxacin, norfloxacin, ofloxacin, sulfamethaxazole, sulfadimethoxine).
- Within the use of starvation phases, external organic carbon sources utilization could be enhanced by autotrophic nitrogen removal mechanisms relying on the biofilm.

Our 20 L lab Deammonification and anammox systems (nitritation-anammox)

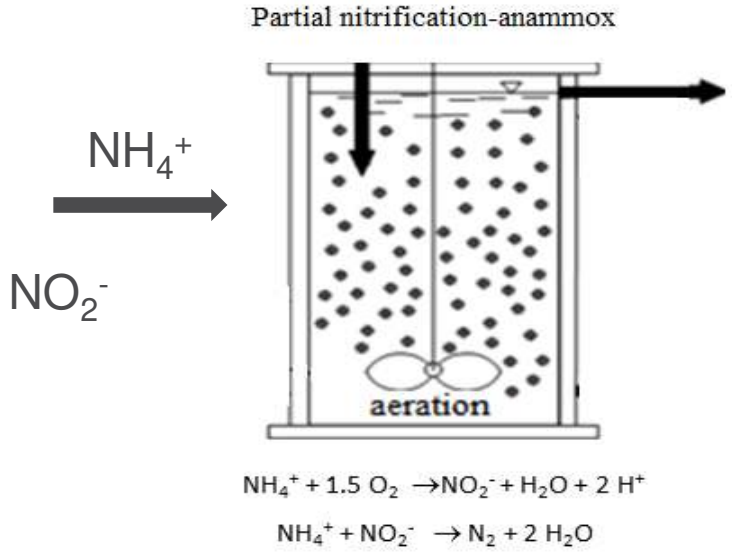
Deammonification, anammox MBBR

NH_4^+

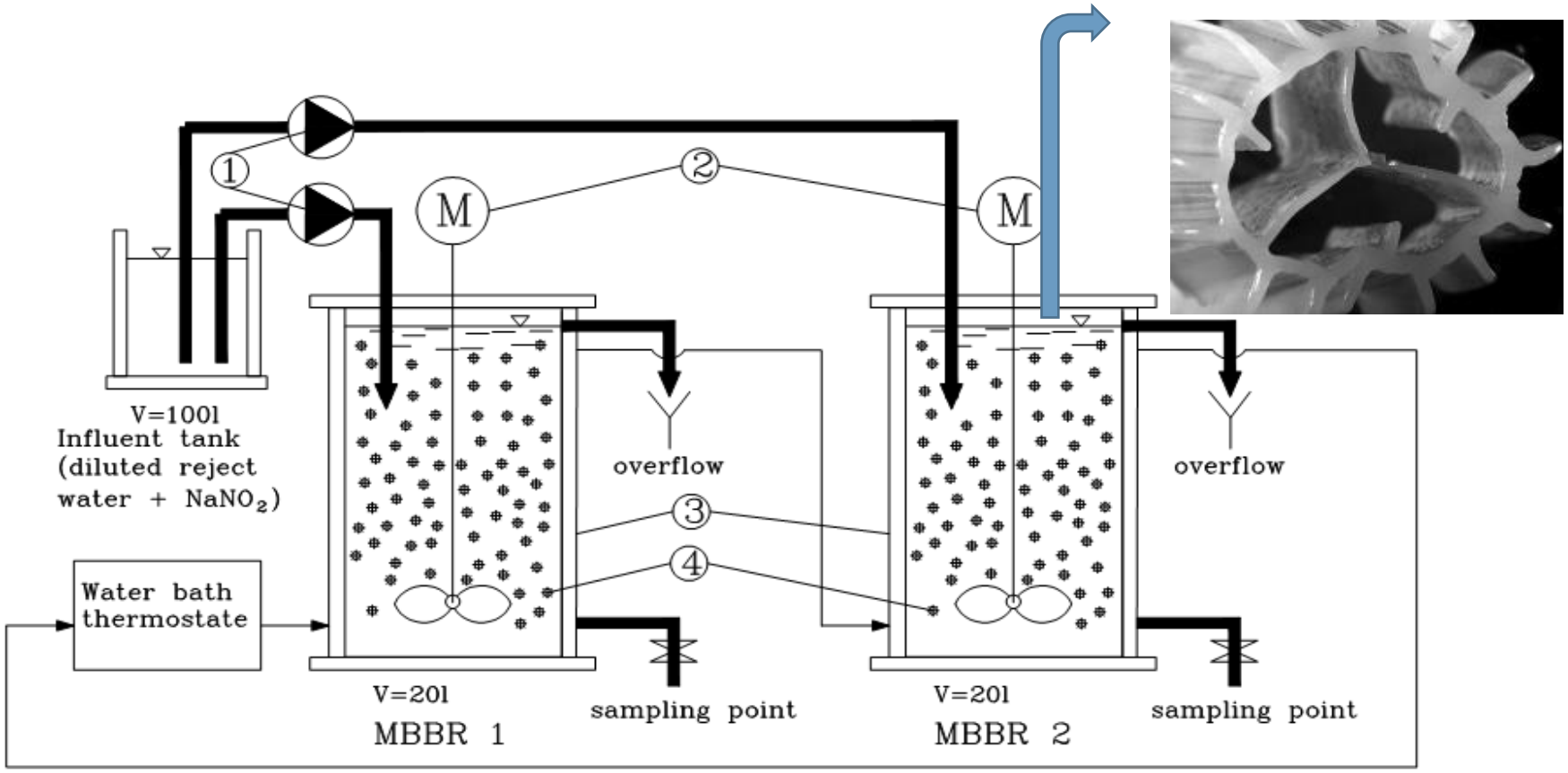


-Intermittent aeration 45 min aeration/ 15 non-aeration DO<1 mg/L.
-Reject water feed.

Anammox SBR



Anammox biofilm reactors (MBBR)
Analyses: NH_4^+, NO_2^-, NO_3^-, COD, pH, DO, flow rate, HRT, conductivity

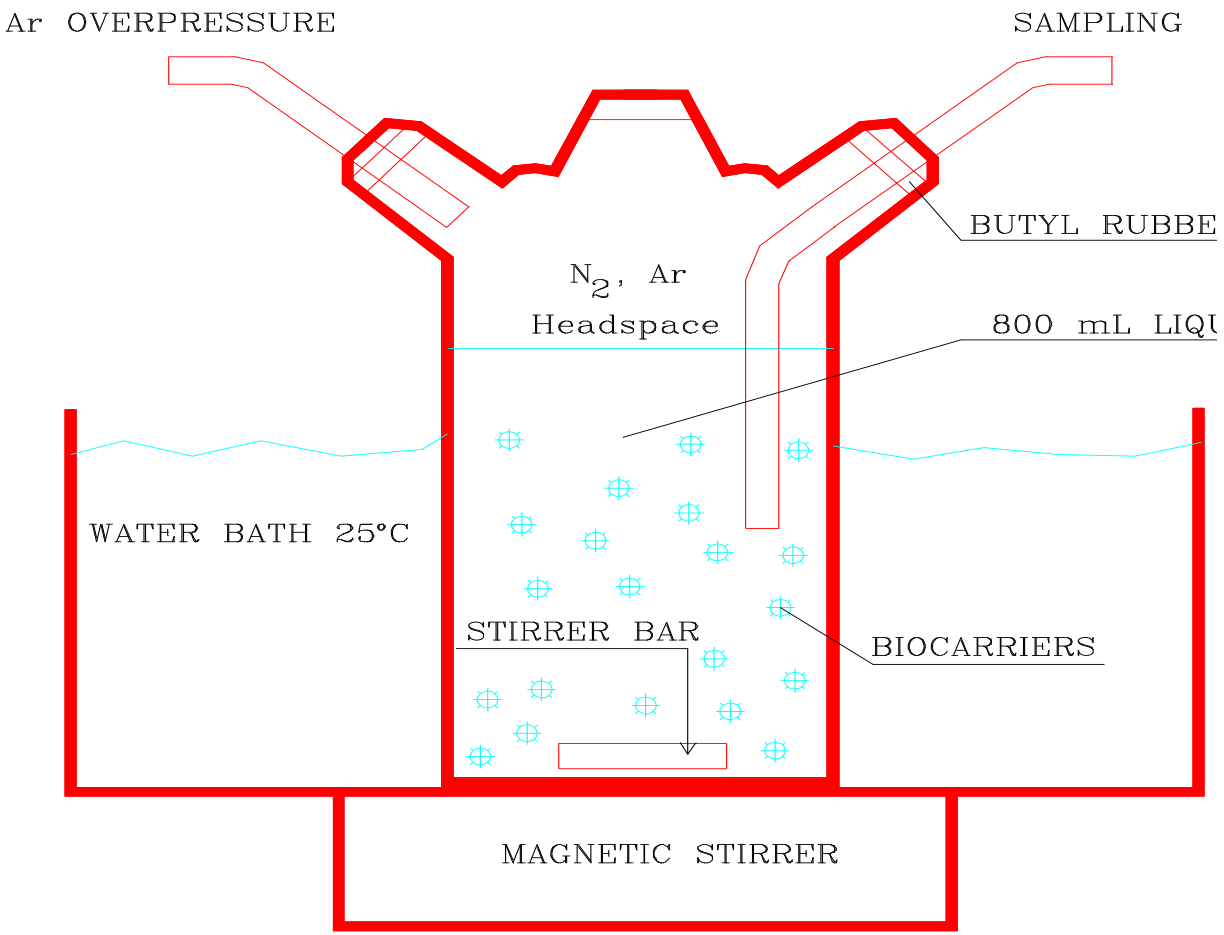


Full-scale Anammox Biofilm carriers

Batch analyses 6h

- 800 mL medium
- 200 carriers

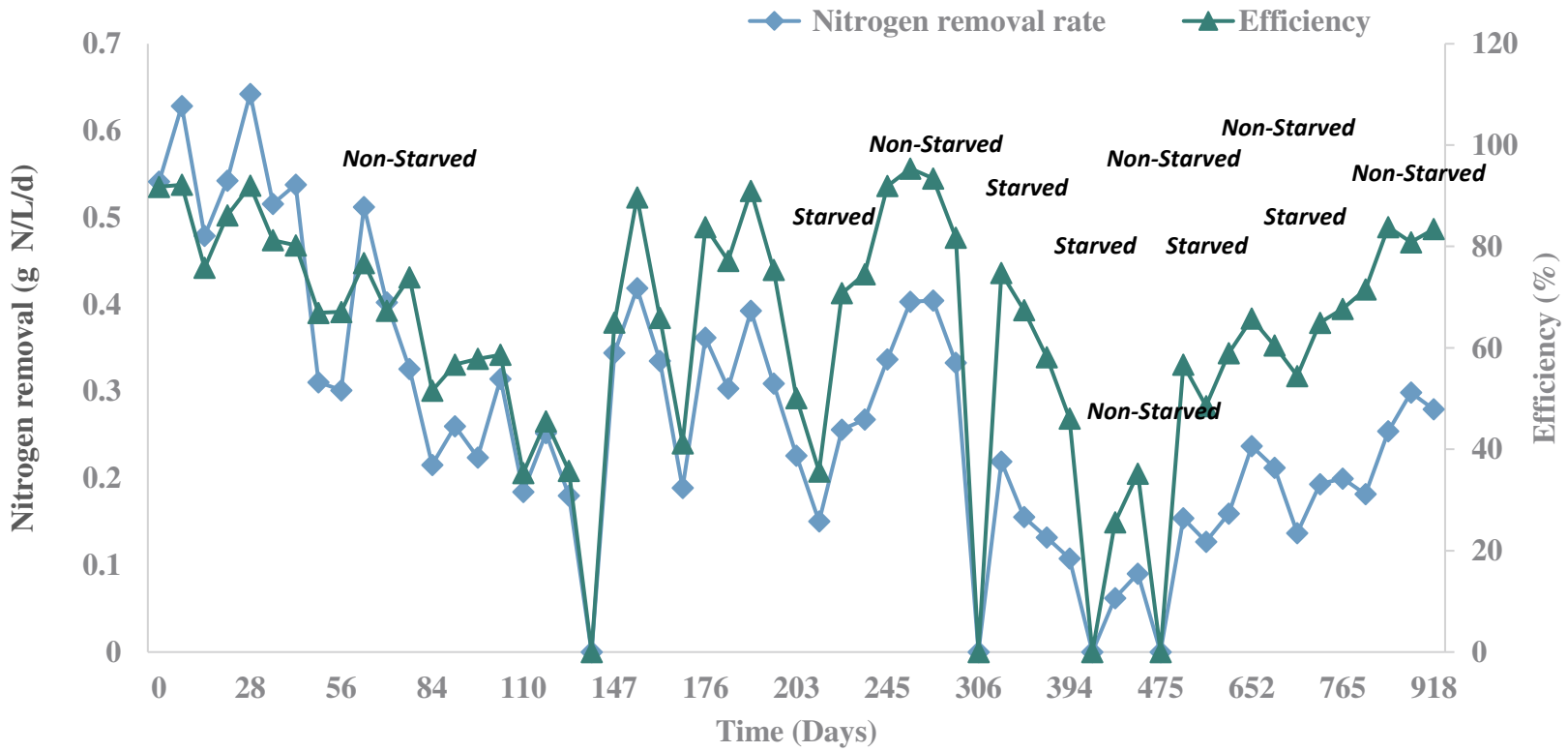
- Sampling every 2h
- Measure NH_4^+,
- NO_2^-, NO_3^- ,PHACs



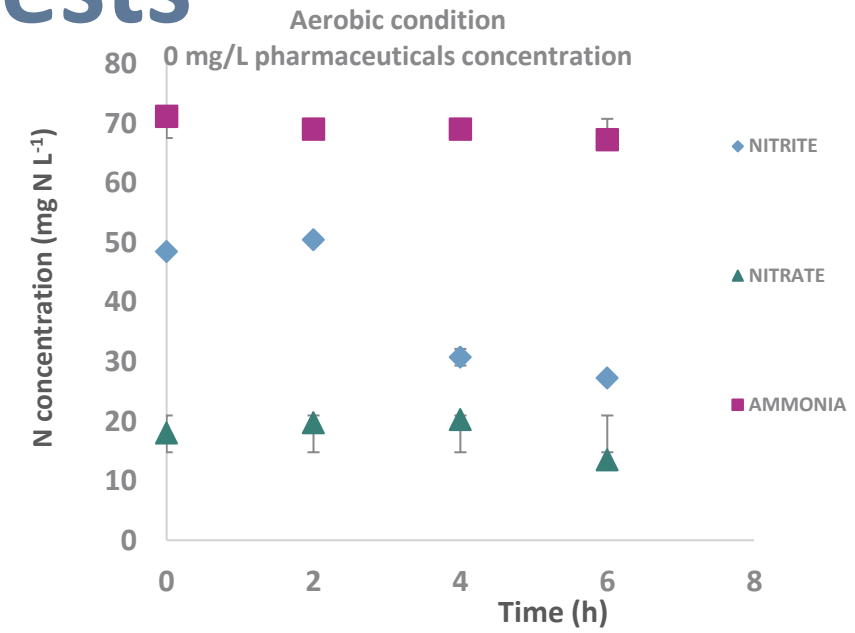
Batch tests

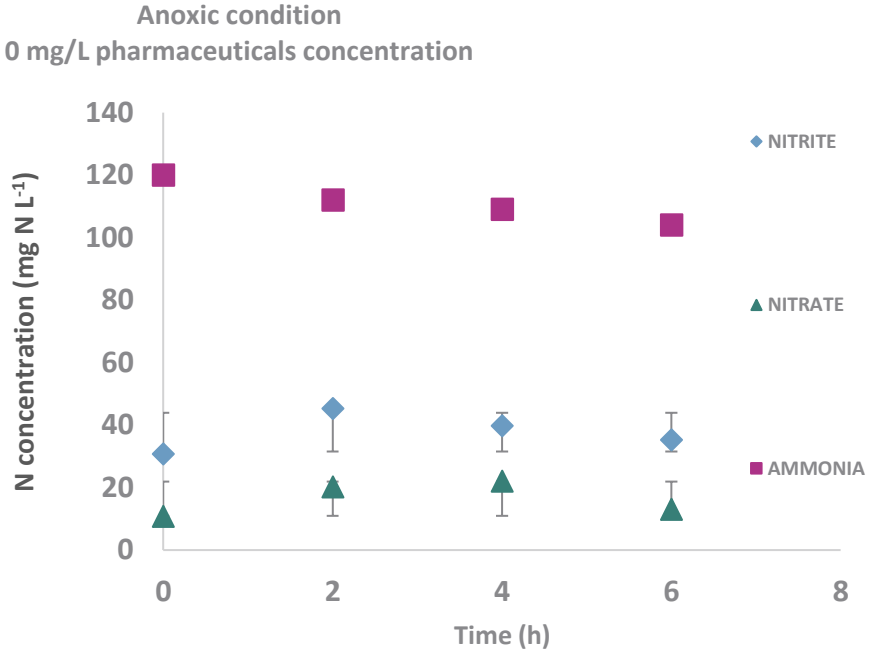
- The total nitrogen removal rate was tested in batches to determine at pharmaceuticals concentrations of 0.03, 0.206, 0.432, 1.000, 1.753, 2.506, 3.506 mg/L.
- Antibiotics stock solutions were used ciprofloxacin (50.05 mg/l), norfloxacin (40.09 mg/l), ofloxacin (20.09 mg/l), sulfamethaxazole (10.07 mg/l), and sulfadimethoxine (5.03 mg/l).
- 200 biofilm carriers, 1 h anoxic/1 h aerobic vs 6 h anoxic tests at 25 ℃.
- TSS concentration on 1 carrier was 3.74 mg
- The following components were added to the test cells in addition to the biomass:
- 2 mL $NaNO_2$, 2 mL NH_4Cl, 0.4 g H_2CO_3, 1 mL BOD feed solution for phosphate buffer, 1 mL BOD medium $MgSO_4 * 7H_2O$, 1 mL BOD medium $CaCl_2$, 1 mL $FeCl_3 * 6H_2O$, 1 mL alkaline and acidic trace element solution (Zhang et al., 2012).

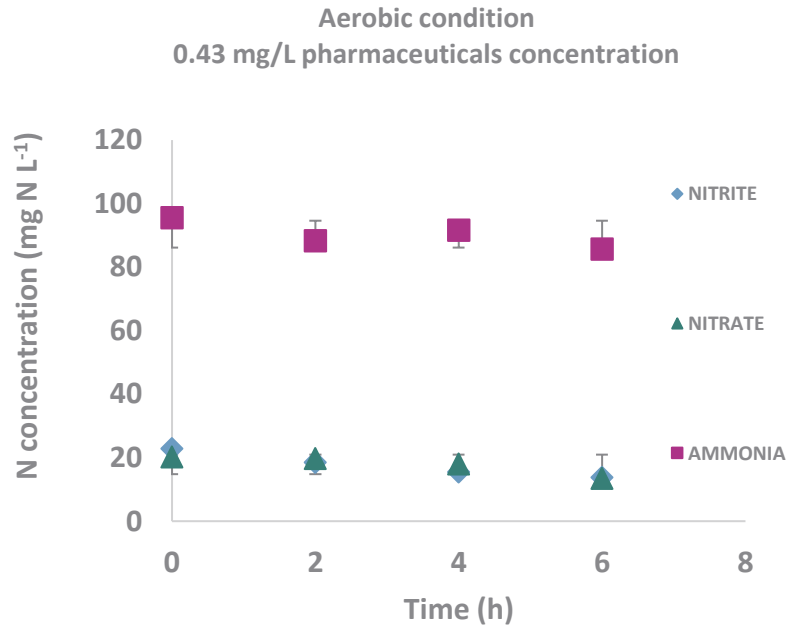
MBBR operation

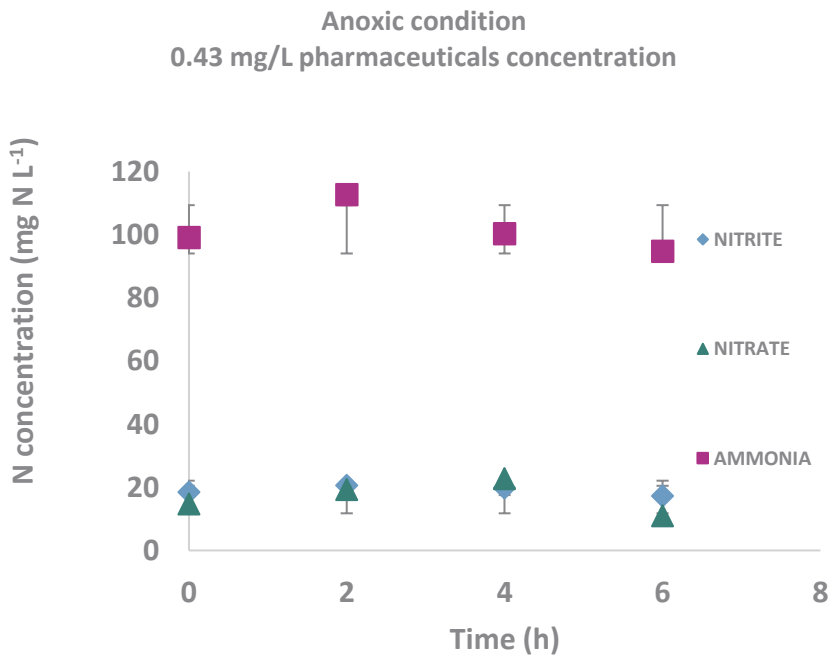


Batch tests

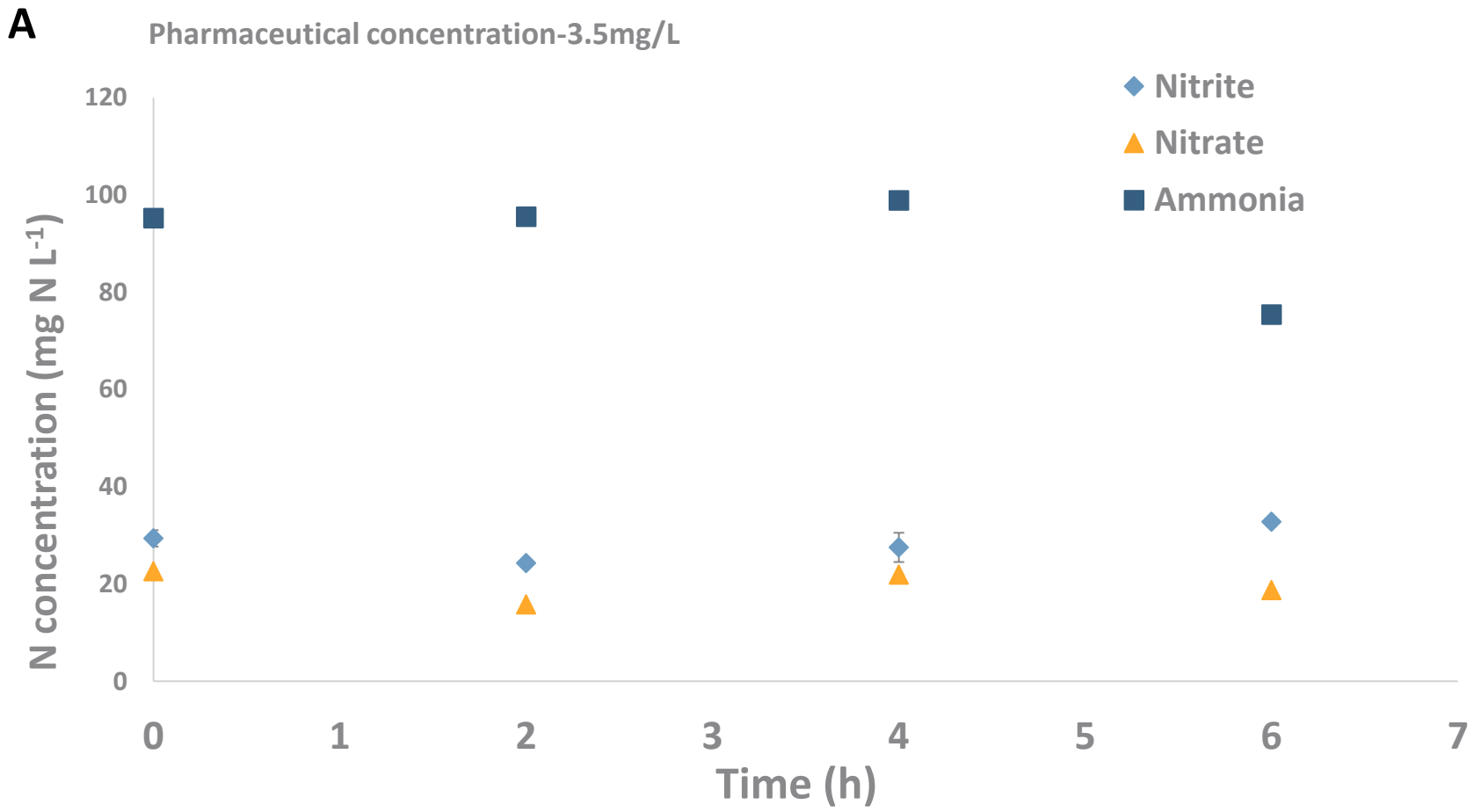

Aerobic condition
0 mg/L pharmaceuticals concentration
N concentration (mg N L-1)
Time (h)
NITRITE
NITRATE
AMMONIA


Anoxic condition
0 mg/L pharmaceuticals concentration
N concentration (mg N L-1)
Time (h)
NITRITE
NITRATE
AMMONIA

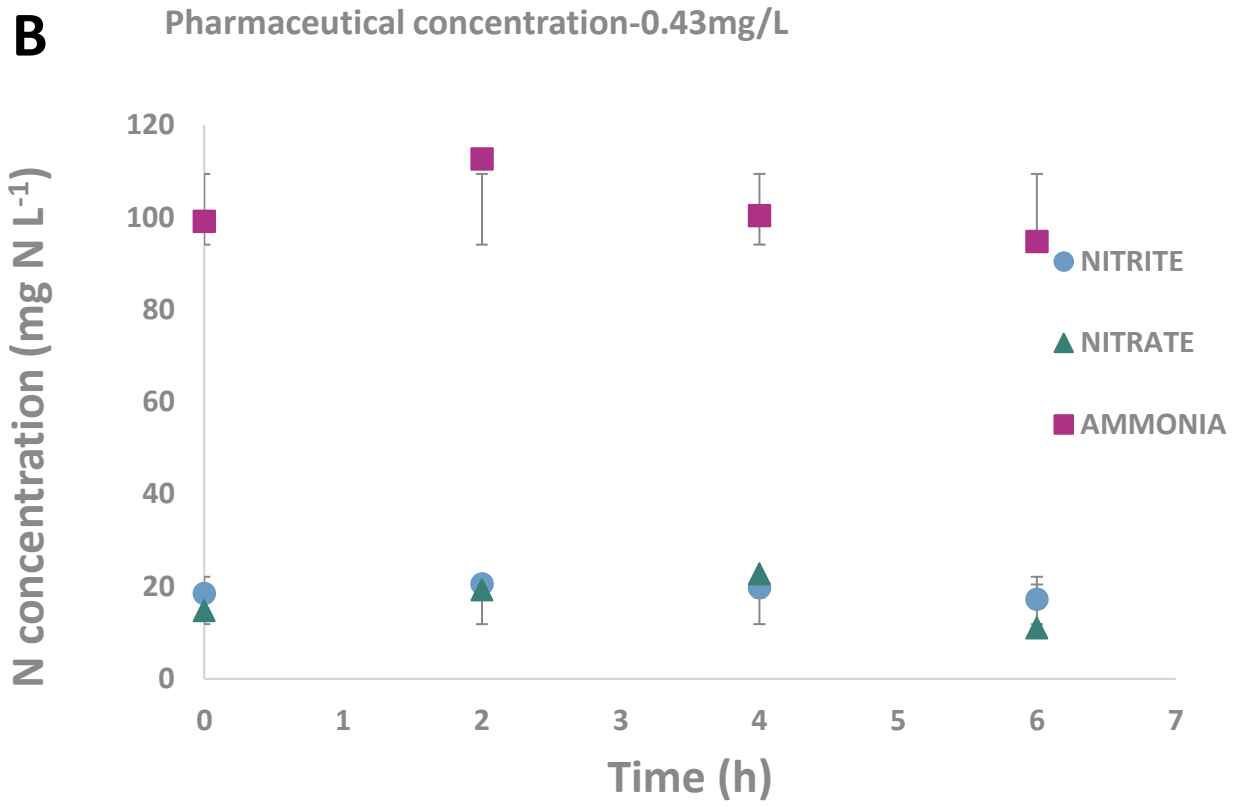

Aerobic condition
0.43 mg/L pharmaceuticals concentration
N concentration (mg N L-1)
Time (h)
NITRITE
NITRATE
AMMONIA


Anoxic condition
0.43 mg/L pharmaceuticals concentration
N concentration (mg N L-1)
Time (h)
NITRITE
NITRATE
AMMONIA

Batch nitrogen removal rates

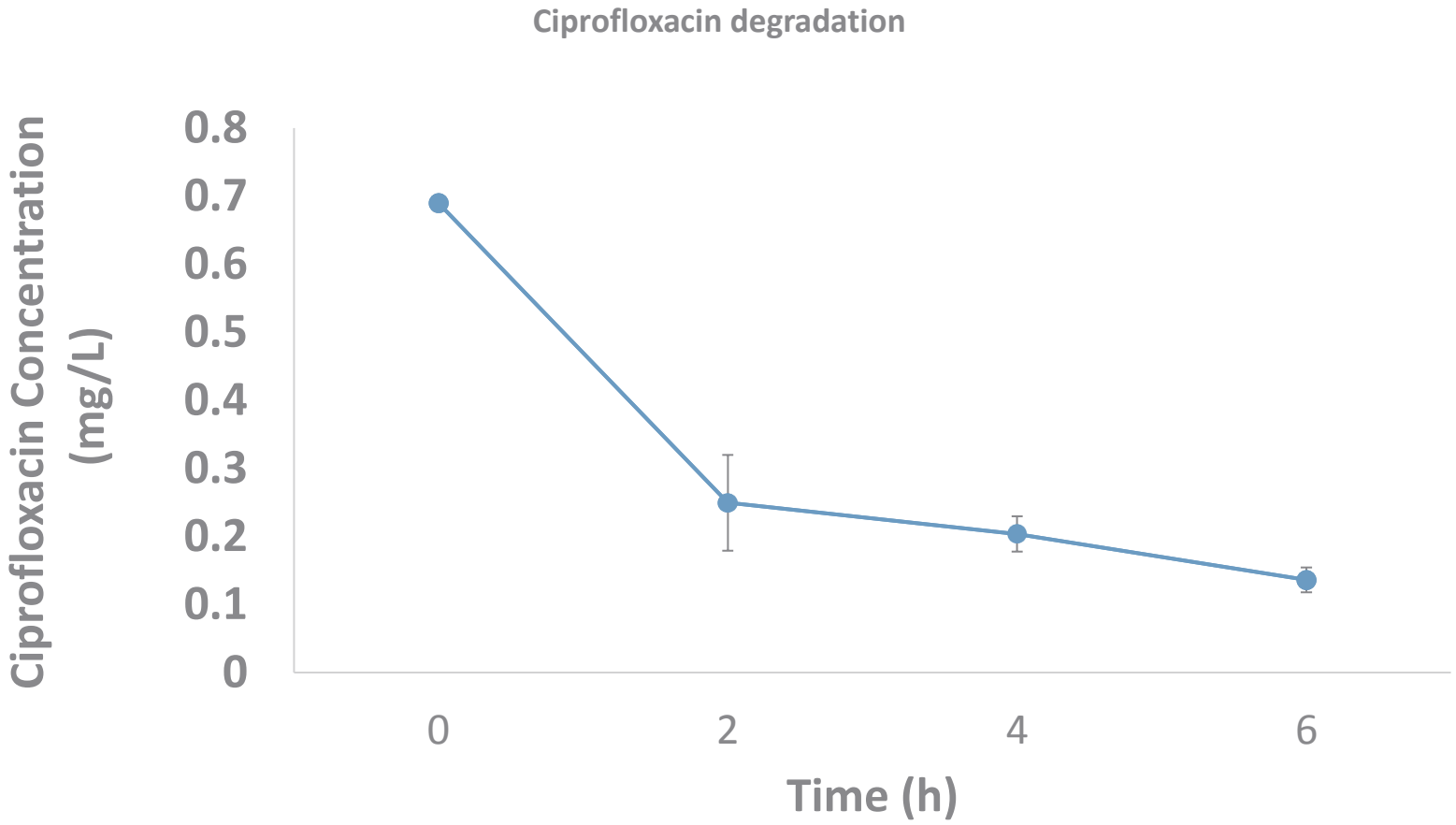


Batch nitrogen removal rates

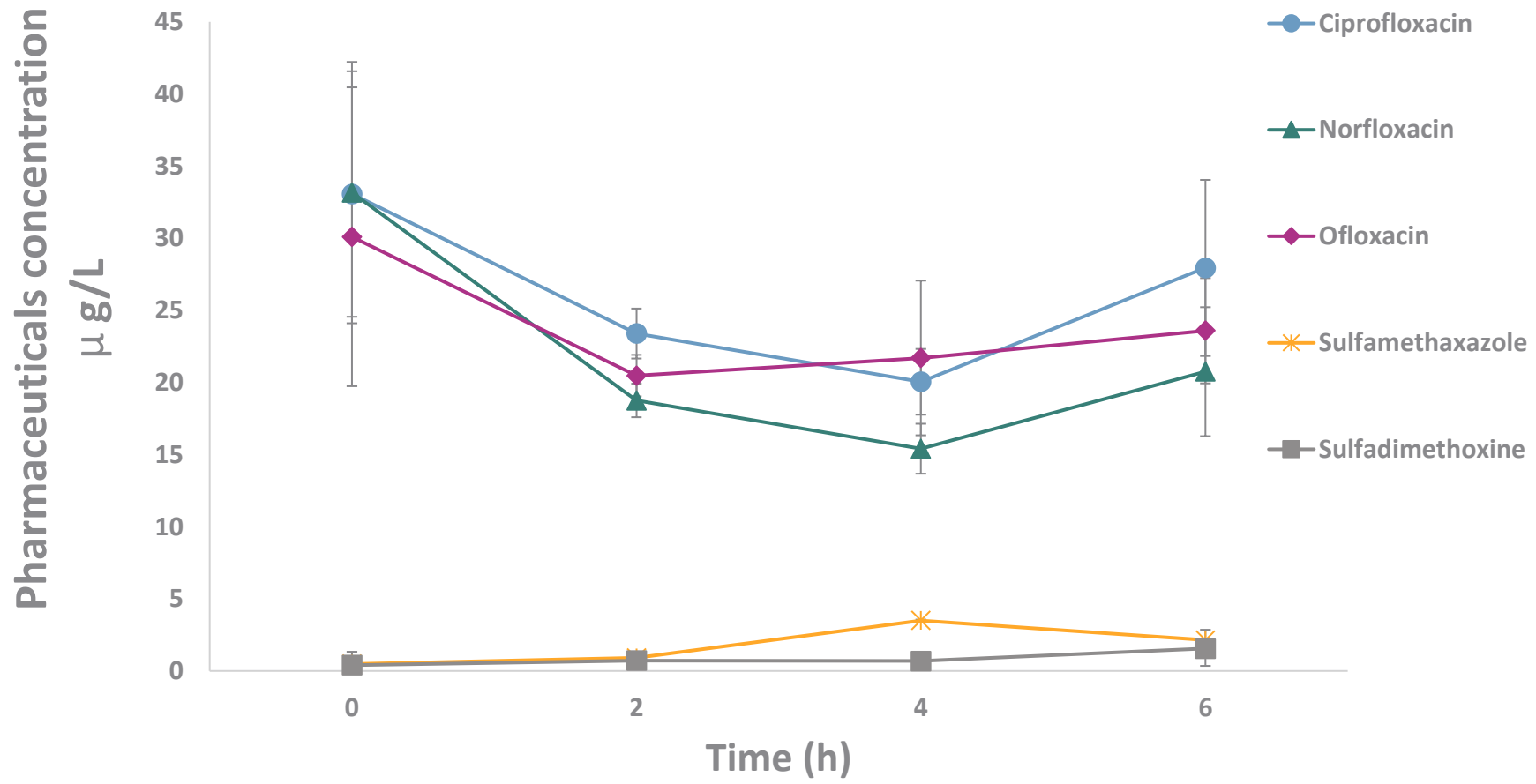


Batch PHACs removal rates

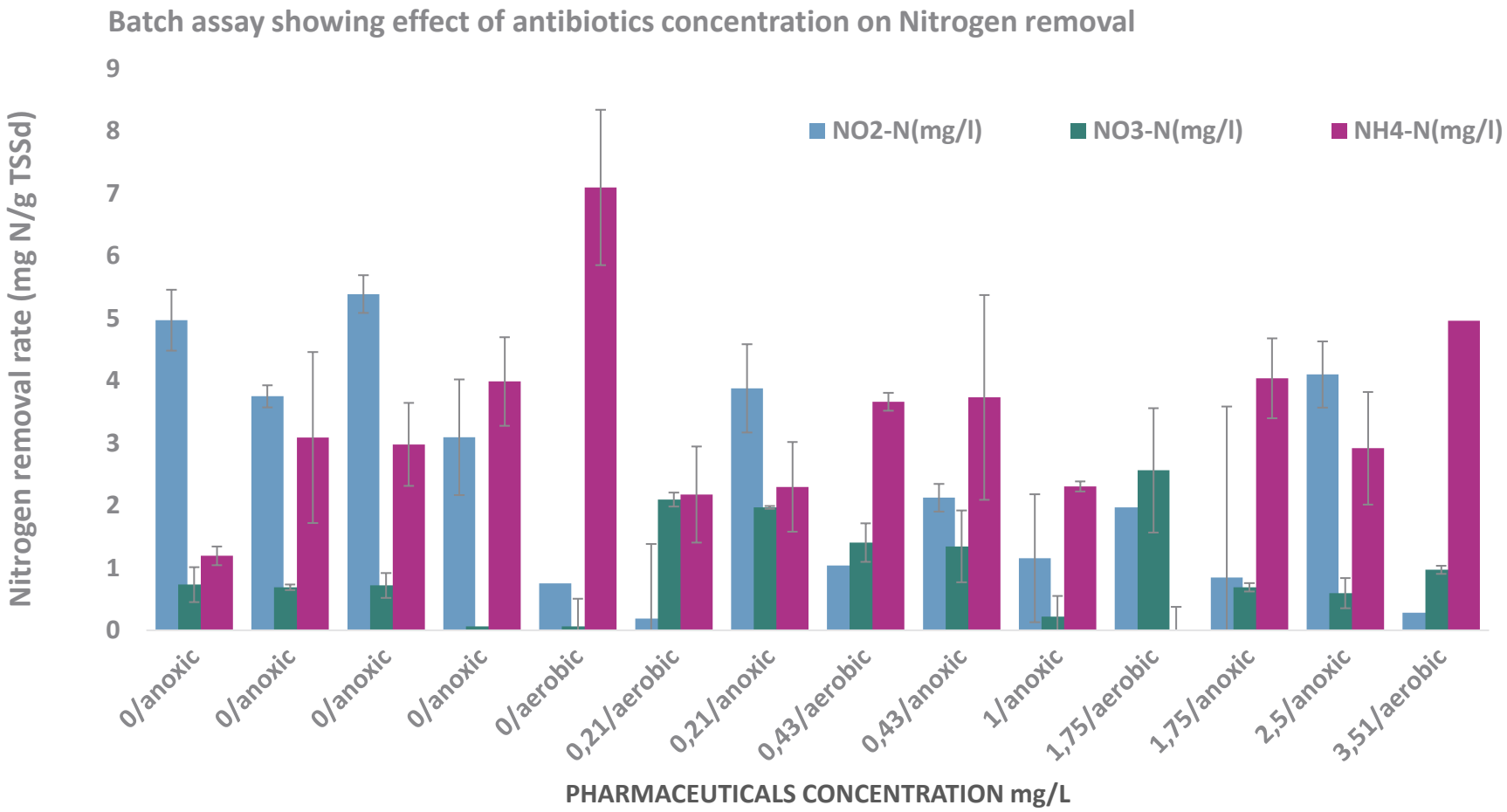
B



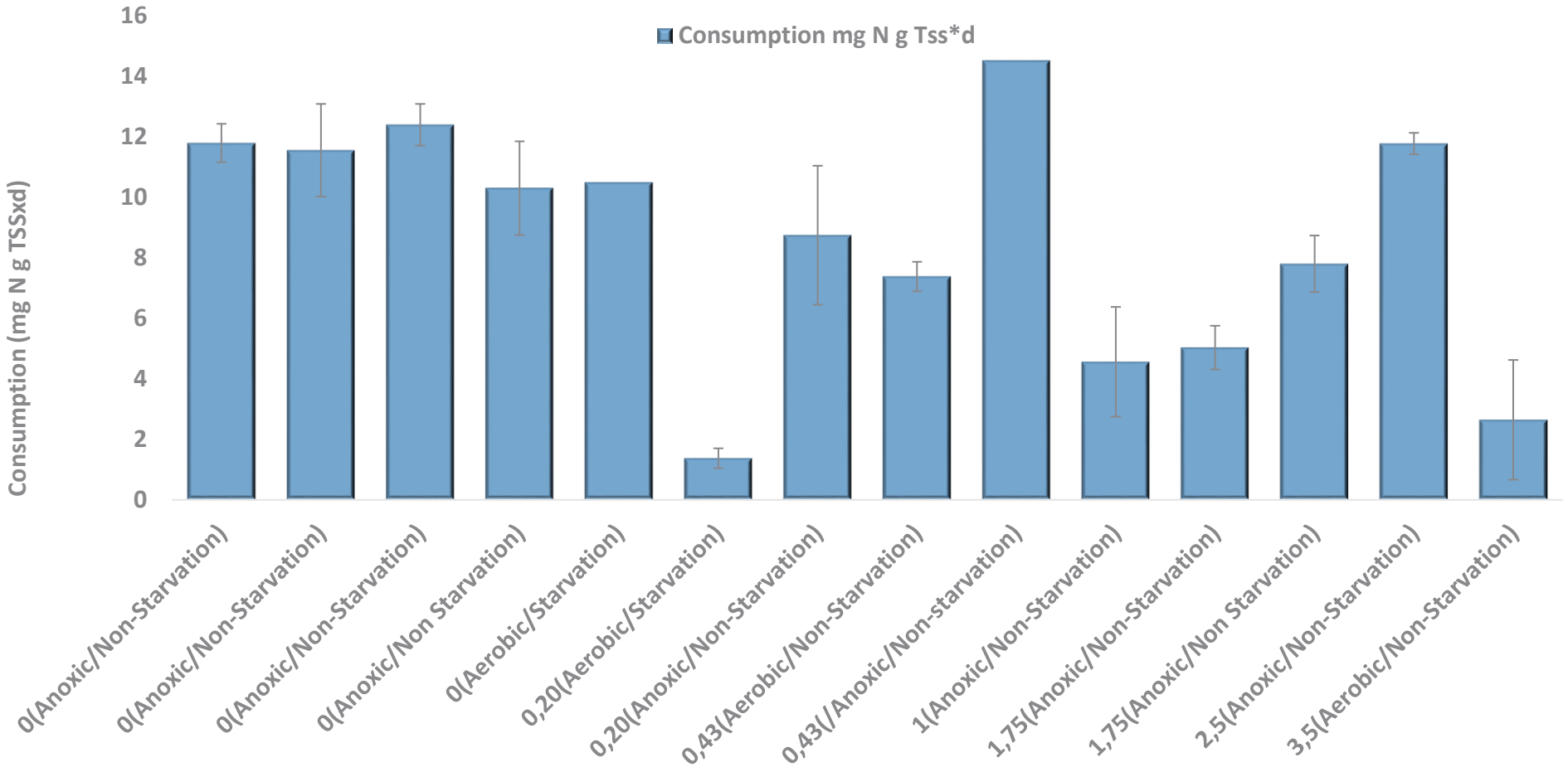
Batch PHACs removal rates



Batch nitrogen removal rates

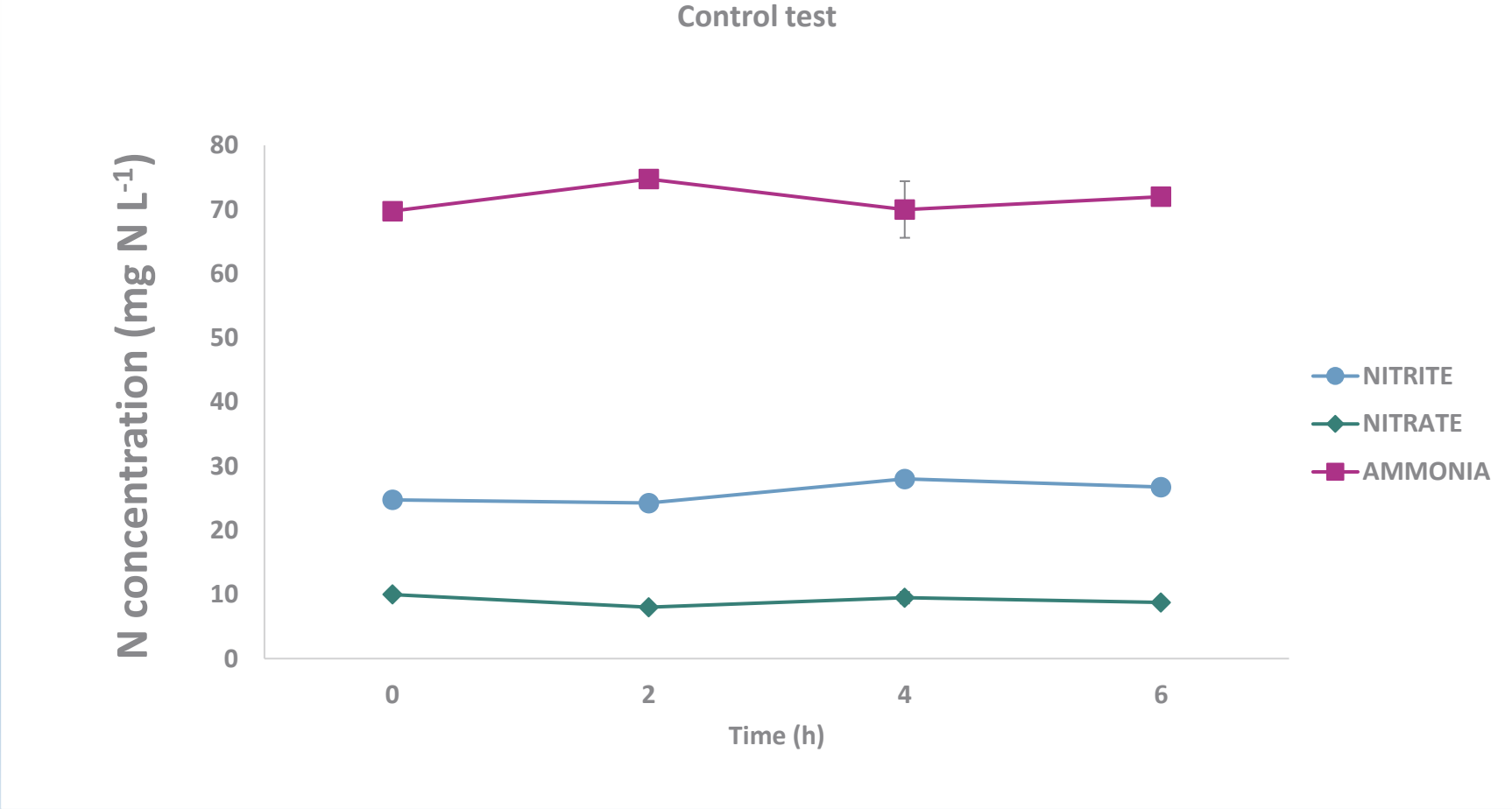


Batch nitrogen removal rates

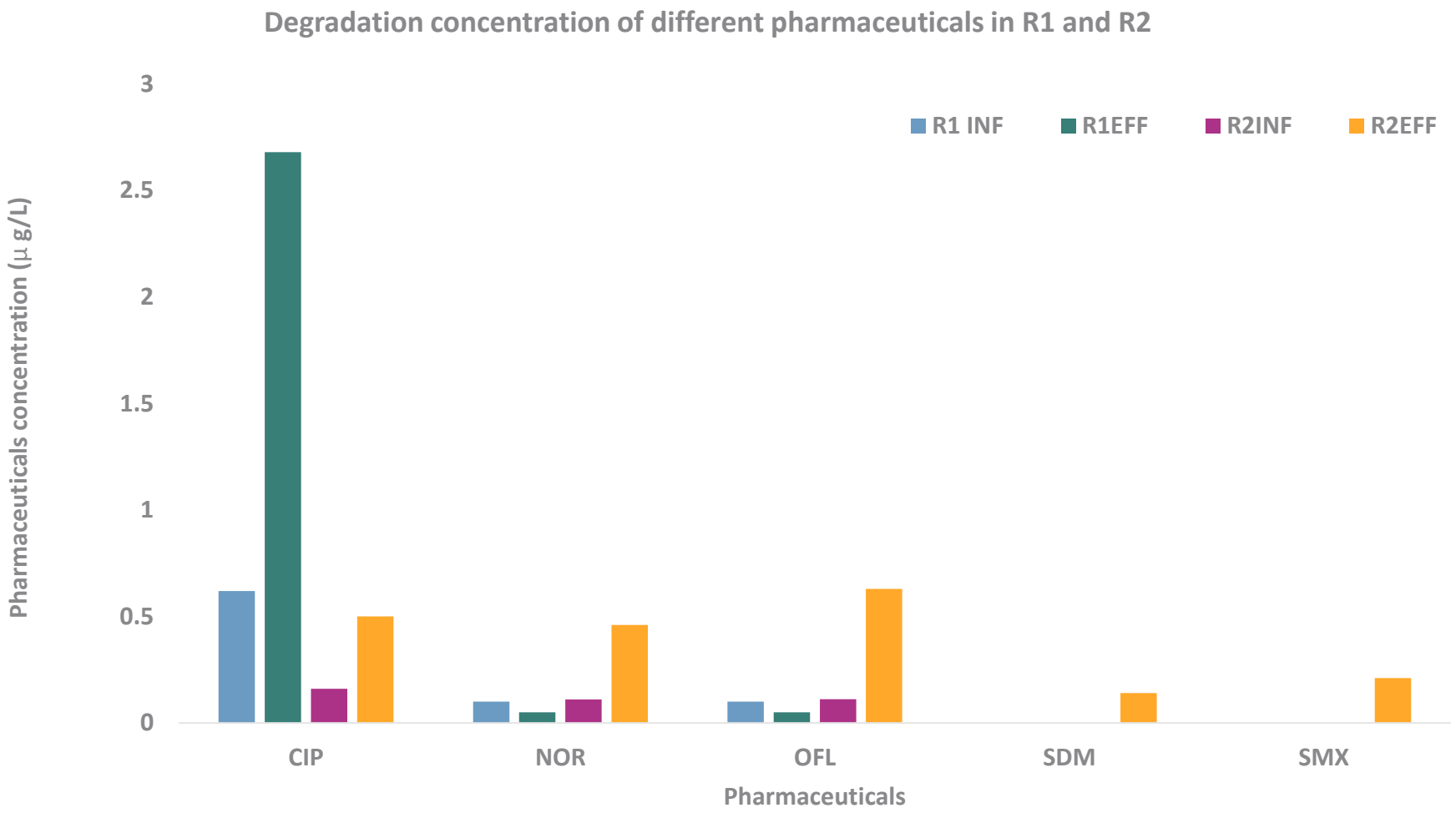


PHARMACEUTICALS CONCENTRATION mg/L

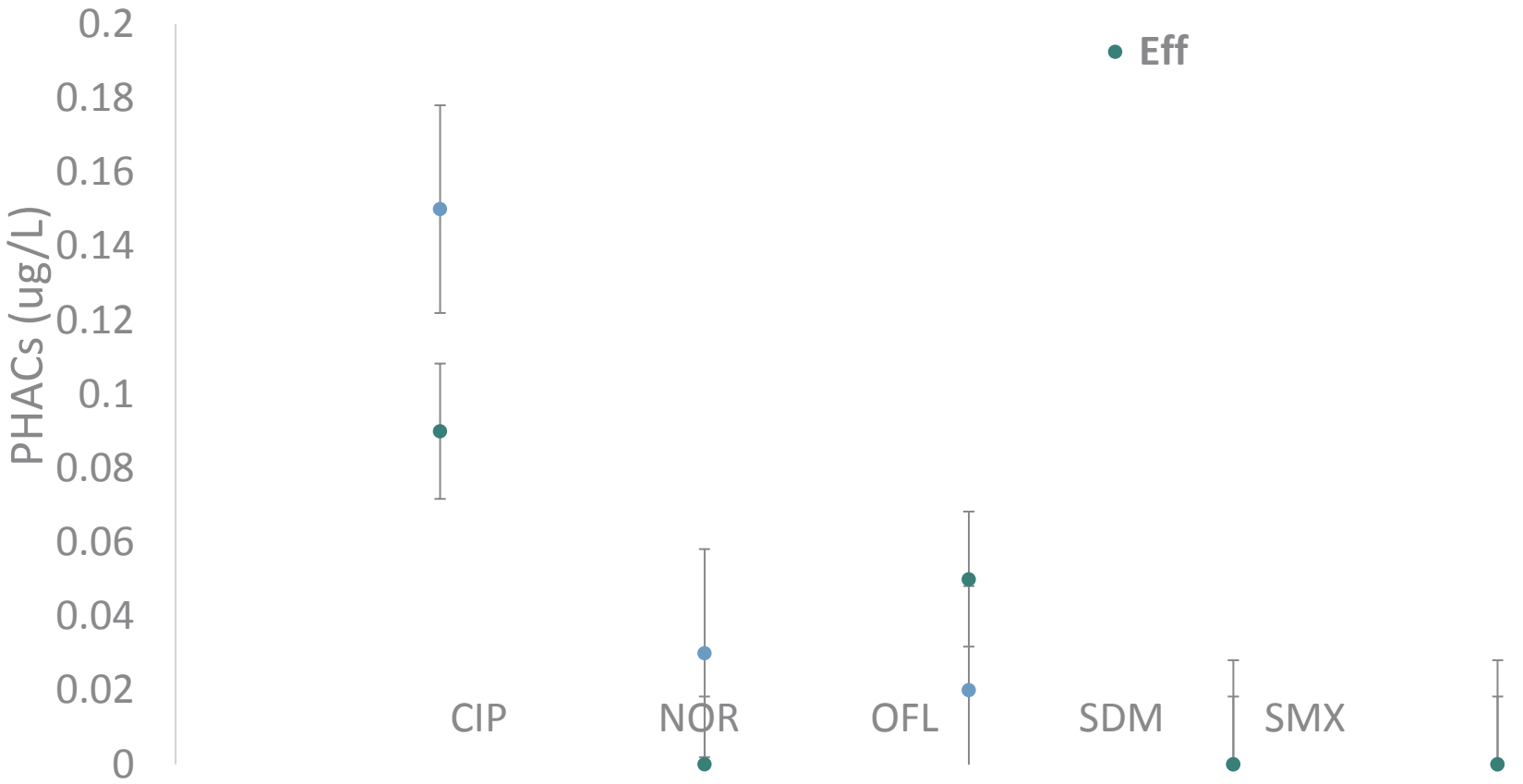
Batch nitrogen removal rates



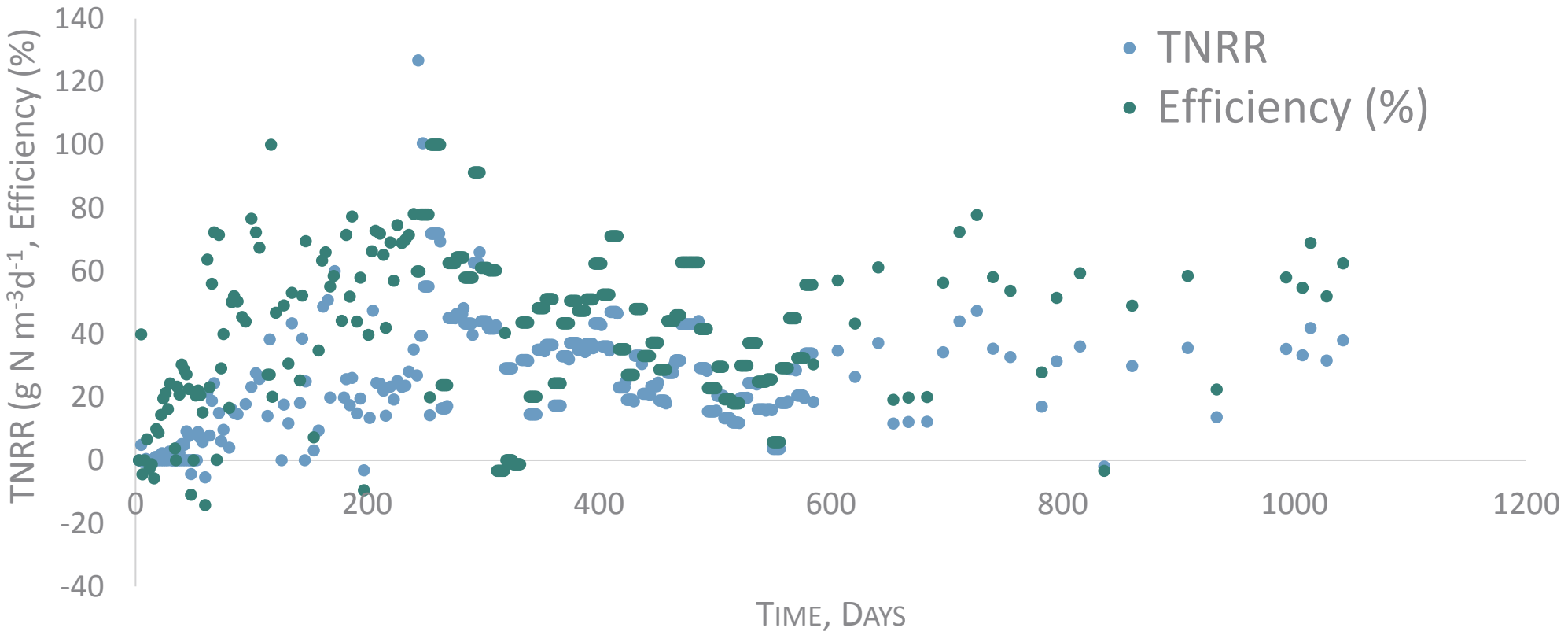
PHACs removal in MBBR operation



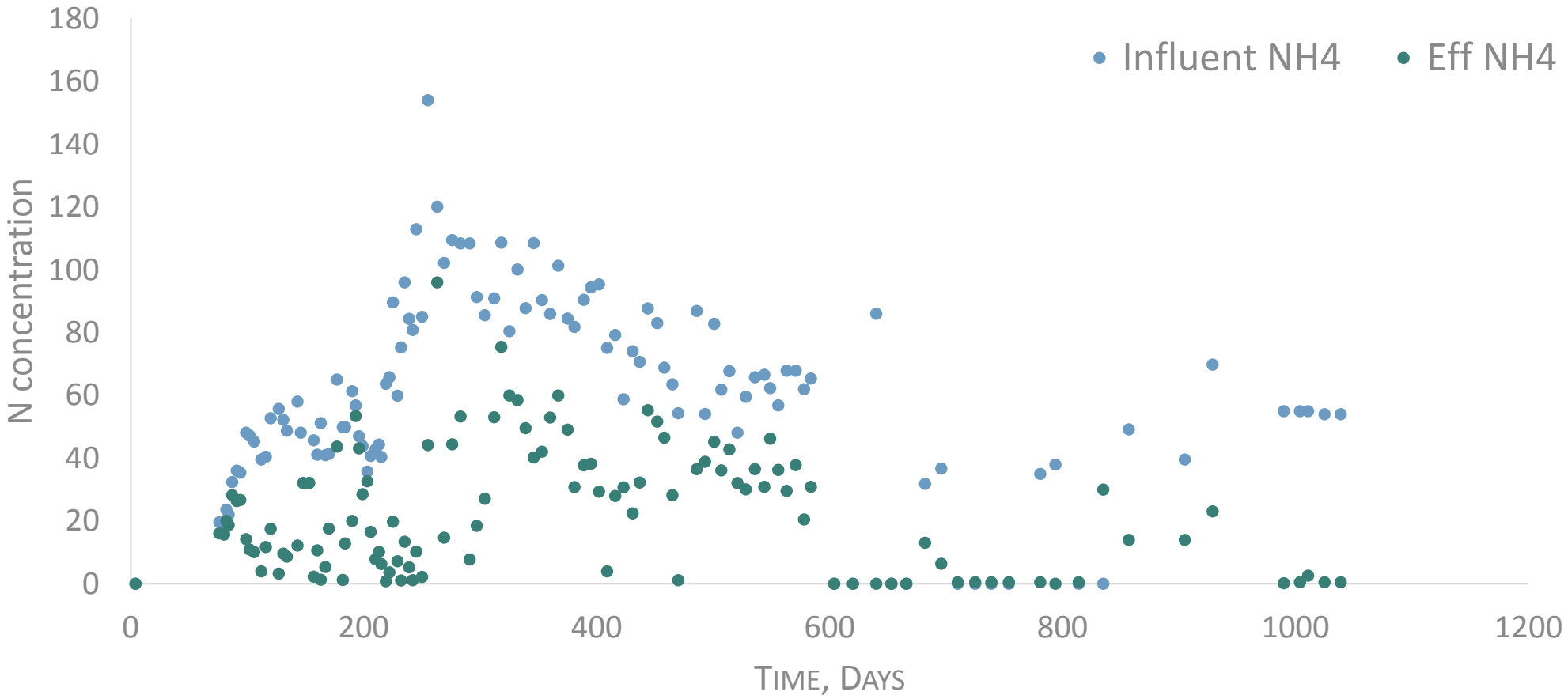
SBR PHACs removal rates



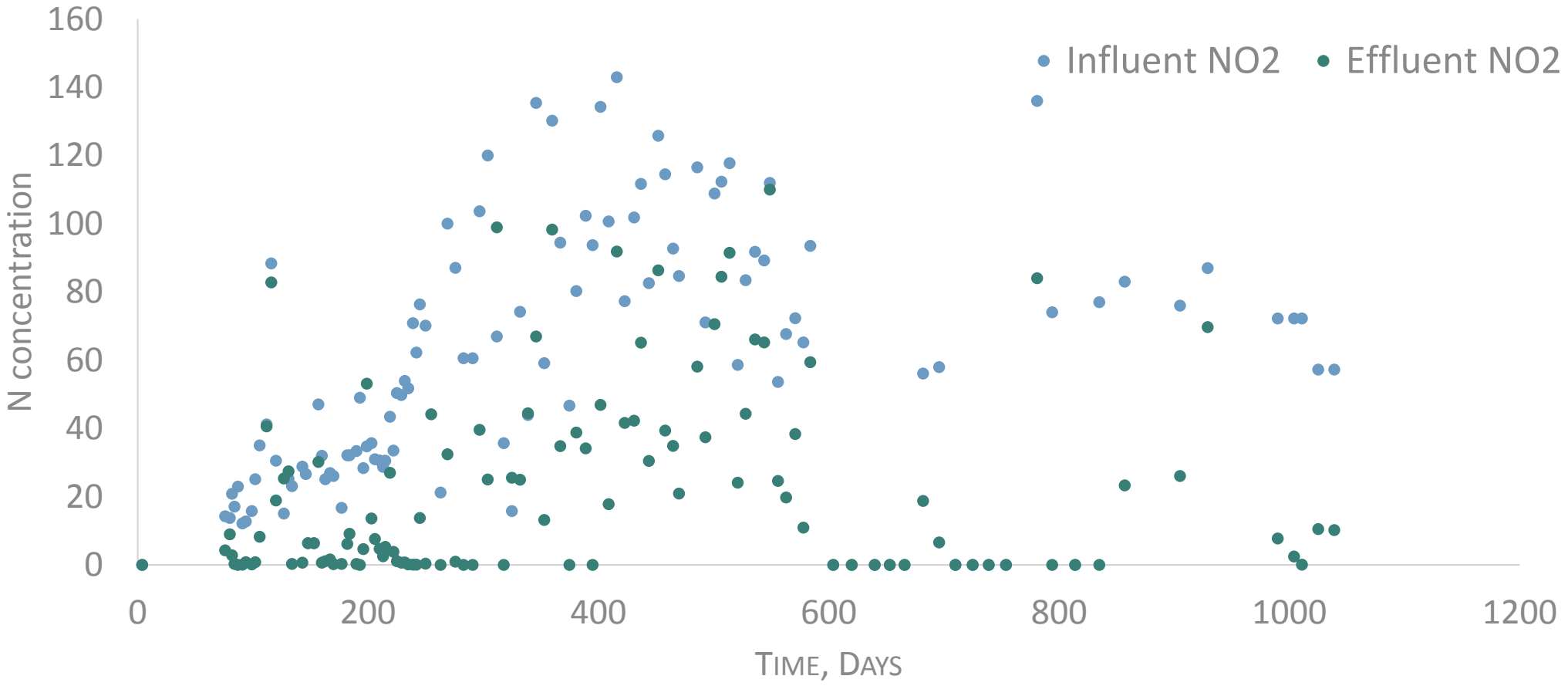
SBR Total nitrogen removal rates



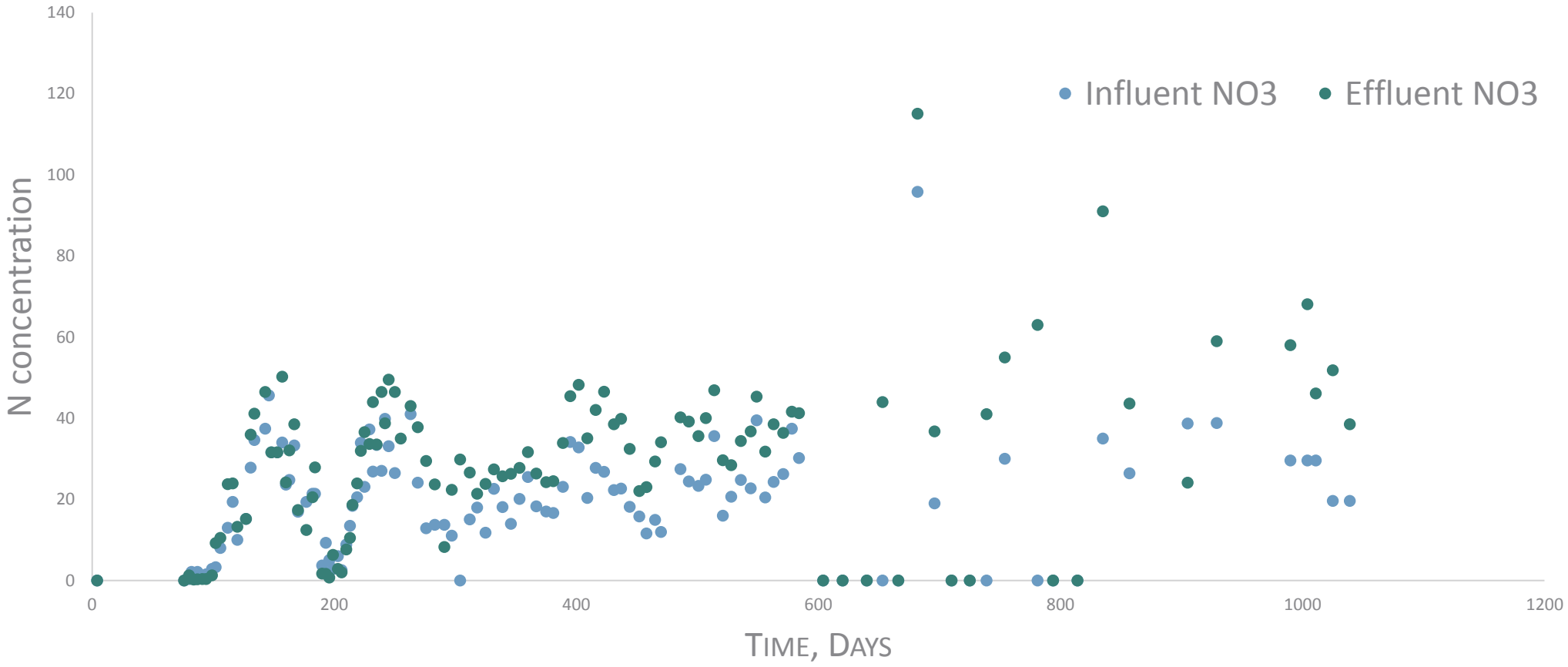
NH_4 concentration



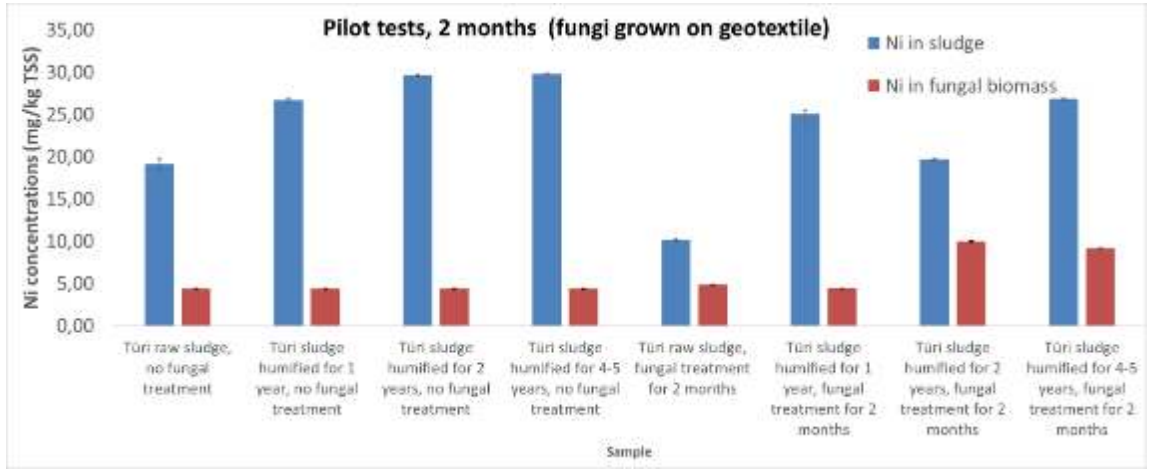
NO_2 concentration

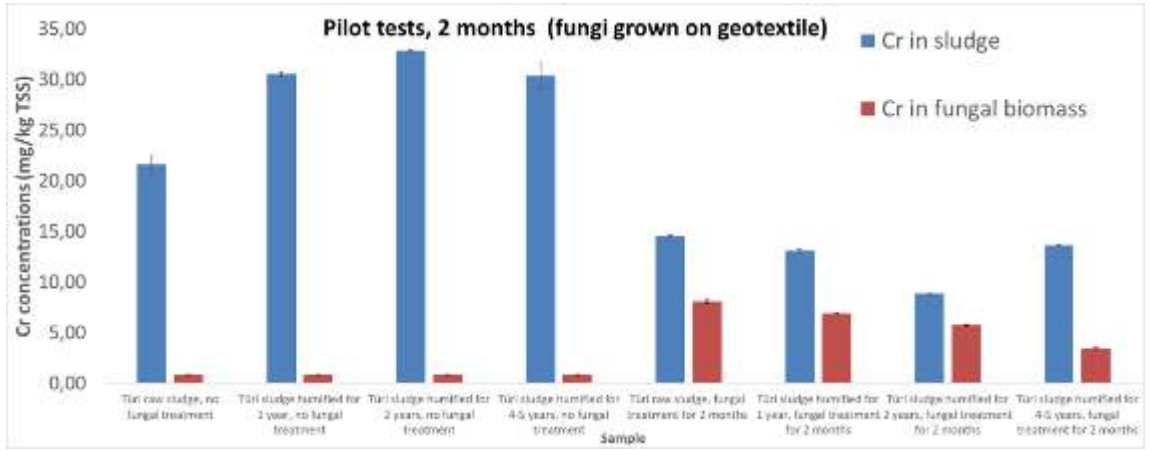


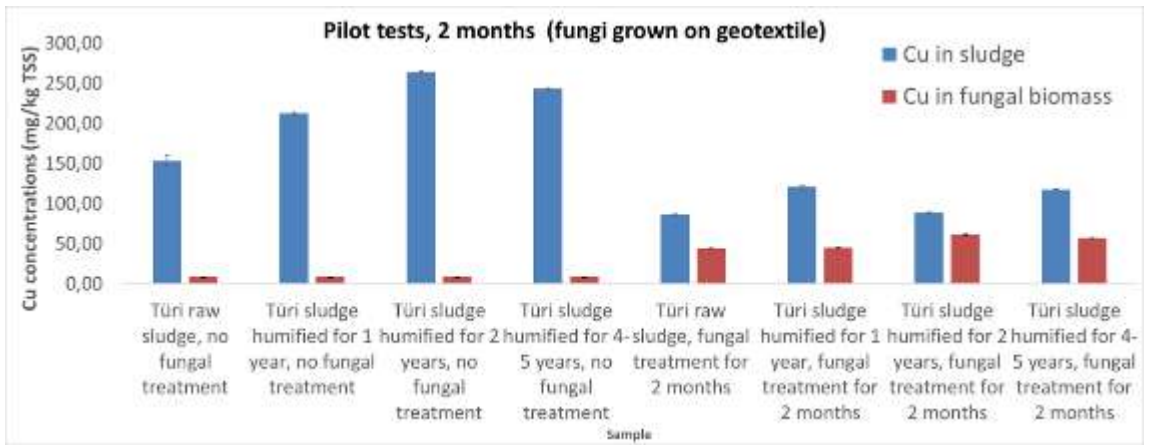
NO_3 concentration

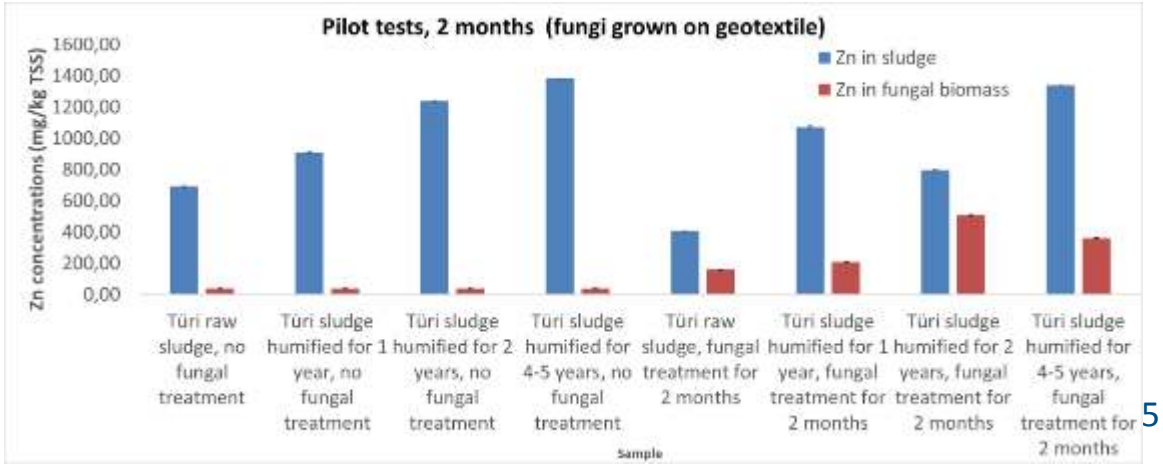


Pilot tests (5 kg tests)
Türi sludge composts fungal treatment

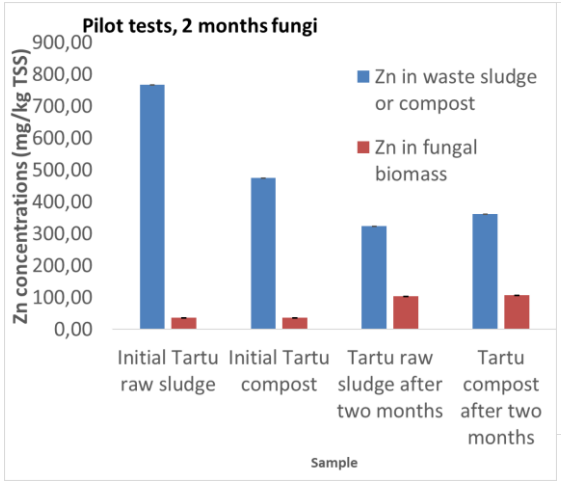


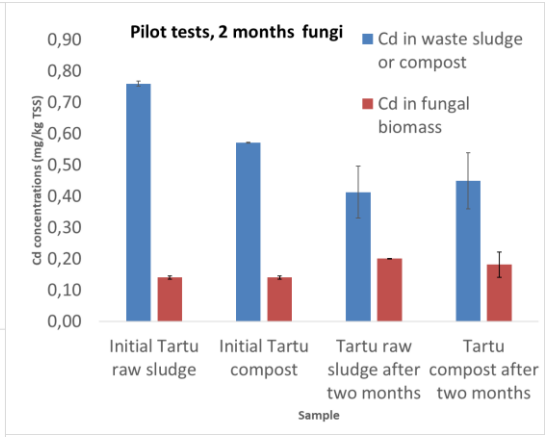


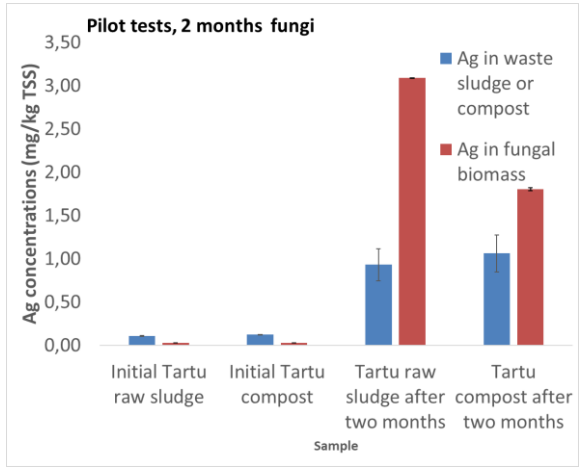


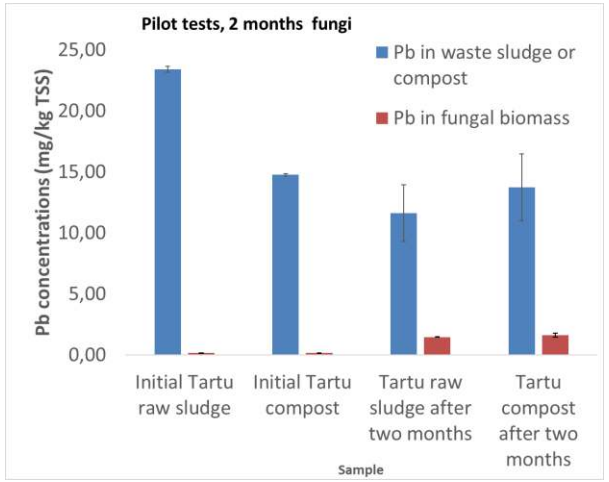


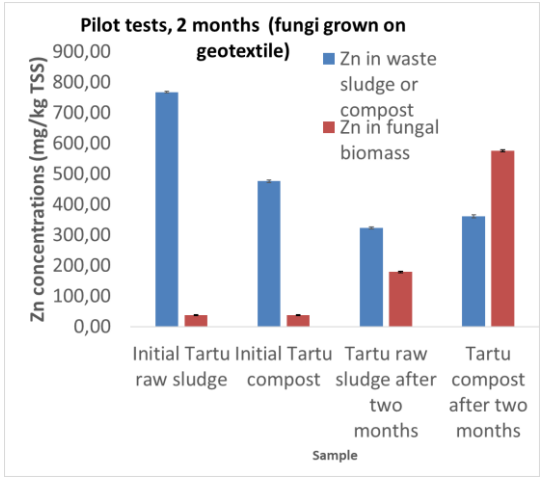
Pilot tests (5 kg tests)
Tartu raw sludge and Tartu compost, metal in fungi and fungi grown on geotextile at 0 months (Initial Tartu raw sludge/compost) and 2 months fungal treatment

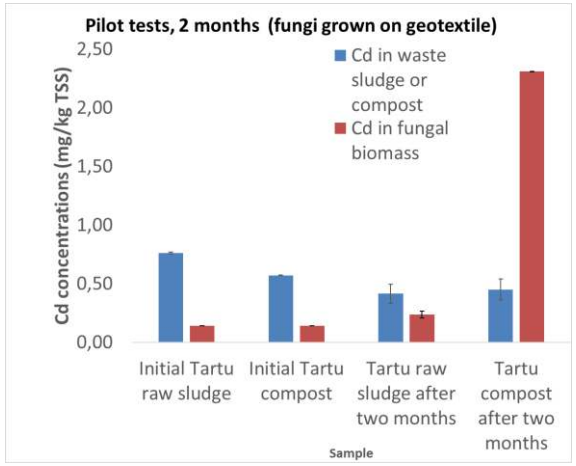


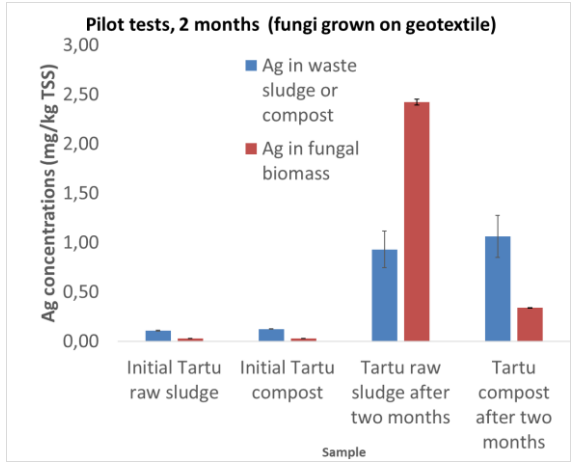


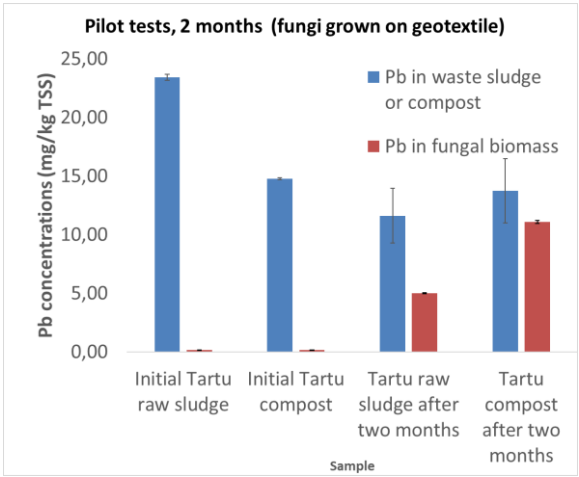












Acknowledgments

Thank You for being here!

Co-funded by European Union within Interreg Baltic Sea Region programme under the project:
AdvIQwater - Improving quality of BSR waters by advanced treatment processes