

# Effect of surface loading fluctuationson ammonium removal during rapid sand filtration

**Tatari, Karolina; Smets, Barth F.; Nielsen, P. B.; Lind, S.; Albrechtsen, Hans-Jørgen**

*Publication date:*
2012

*Document Version*
Publisher's PDF, also known as Version of record

DTU Environment
Department of Environmental Engineering

Technical University of Denmark

# Effect of surface loading fluctuations on ammonium removal during rapid sand filtration

**Karolina Tatari[a]*, Barth F. Smets[a], Peter B. Nielsen[b], Søren Lind[c], Hans-Jørgen Albrechtsen[a]**

[a] Department of Environmental Engineering, Bygning 113, DTU, 2800, Lyngby, Denmark, [b] Krüger A/S Gladsaxevej 363 Søborg, 2860 Denmark, [c] Københavns Energi, Ørestads Boulevard 35, 2300 Copenhagen S., Denmark
*kaot@env.dtu.dk

Insert picture of you here 10 x 8 cm Or Remove

## Introduction

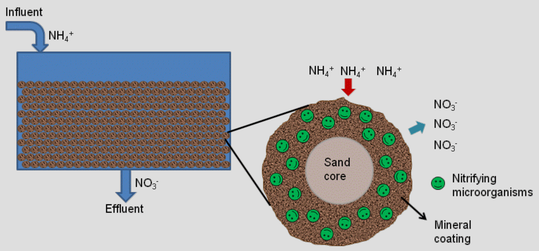
- Rapid sand filtration is used in drinking water treatment to remove particles and inorganic compounds such as $NH_4^+$, $Fe^{+2}$ & $Mn^{+2}$
- $NH_4^+$ is removed biologically by microorganisms attached on the sand
- About 25% of waterworks in Denmark exceed the effluent $NH_4^+$ guideline of 0.05 mg/L.
- Loading can often change due to switching between abstraction wells with different water quality
- Loading that exceeds a filter's removal capacity may cause transient ammonium breakthrough

**Research question:**

In which operating region have $NH_4^+$ loading changes no effect a filter's performance?

## Objectives

- Investigate the relationship between $NH_4^+$ loading and effluent $NH_4^+$ concentration in a filter
- Identify the loading region where loading changes do not affect effluent concentration




**Surface loading :**

Ammonium load per unit of external surface area

**Figure 1:** Sketch of nitrification in a rapid sand filter. Ammonium is degraded by a nitrifying biofilm attched on the sand grain surface

## Conclusions

- $NH_4^+$ loading variations below the critical loading had no effect on effluent $NH_4^+$ concentration
- Once the critical loading was exceeded, effluent $NH_4^+$ concentration was strongly affected by loading increases
- For the investigated filter, the critical load was 5 times larger than the operating load. Performance of this filter is expected to be robust against load variations

## Method

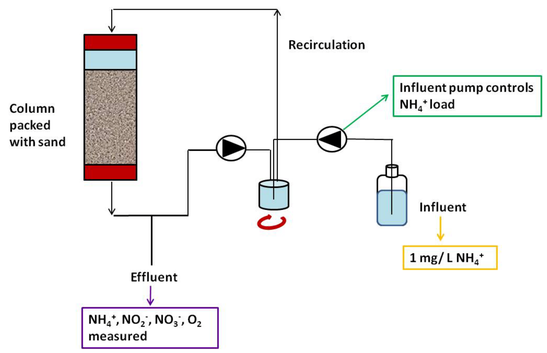



**Figure 4:** Schematic drawing of experimental set-up. Column dimensions: 5 cm x 2.6 cm ø. Loading was controlled by adjusting influent flow rate, influent concentration was 1 mg/L.

**Table 1:** Different experimental loads applied. Steady state loading = surface loading of the full scale filter. Duration of experiments was short to avoid growth of nitrifying biomass

| Loading (mg $NH_4^+$-N/ $m^2$ sand surface area / h ) | Duration of experiment (h) |
|---|---|
| 0.4 | steady state |
| 1 | 5 |
| 2 | 4 |
| 4 | 3 |

## Results

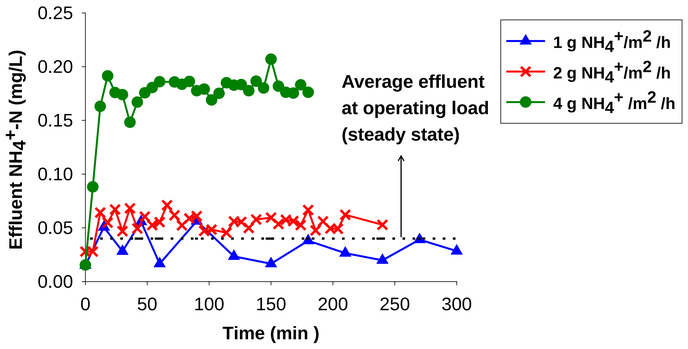



**Figure 2:** $NH_4^+$ effluent concentration profile during loading increase experiments. During each loading change ammonium effluent concentration stabilizes to a new value (temporary steady state)

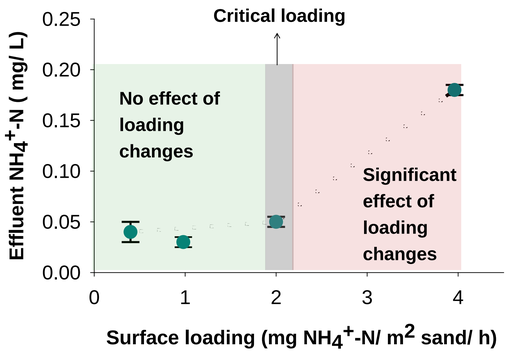



**Figure 3:** Relationship between $NH_4^+$ effluent concentration (temporary steady state concentration) and surface loading

- Loadings up to 2 mg $NH_4^+$- N/ $m^2$ / h have no effect on ammonium effluent concentration

  (t-test, α = 0.05)
- Loadings higher than 2 $NH_4^+$- N/ $m^2$ / h result in higher effluent $NH_4^+$ concentration
- **Critical loading = 2 mg $NH_4^+$- N/ $m^2$ / h**

**This work was supported by the Danish Council for Strategic Research, the project DW Biofilters – Sustainable drinking water treatment, biological filters**

DWBIOFILTERS
Sustainable Drinking Water Treatment – Biological filters