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

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# DTU Environment Department of Environmental Engineering

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

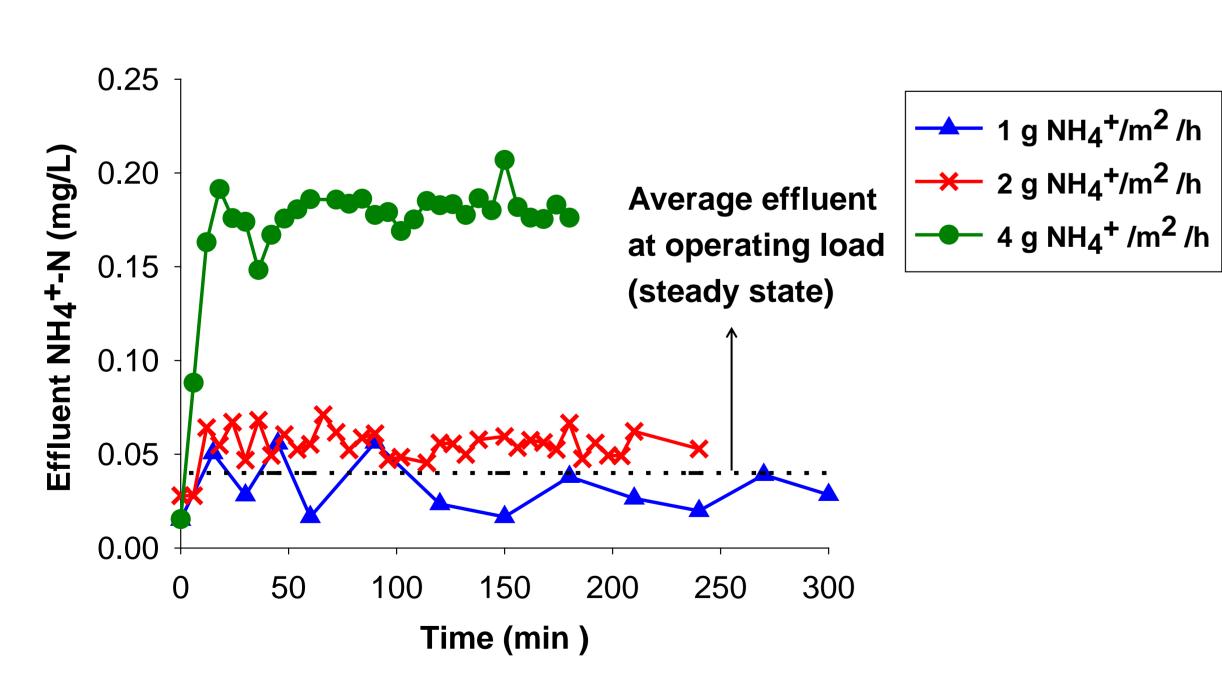
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# Introduction

- Rapid sand filtration is used in drinking water treatment to remove particles and inorganic compounds such as  $NH_4^+$ ,  $Fe^{+2}$  &  $Mn^{+2}$
- NH<sub>4</sub>+ is removed biologically by microorganisms attached on the sand
- About 25% of waterworks in Denmark exceed the effluent NH<sub>4</sub>+ 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:**

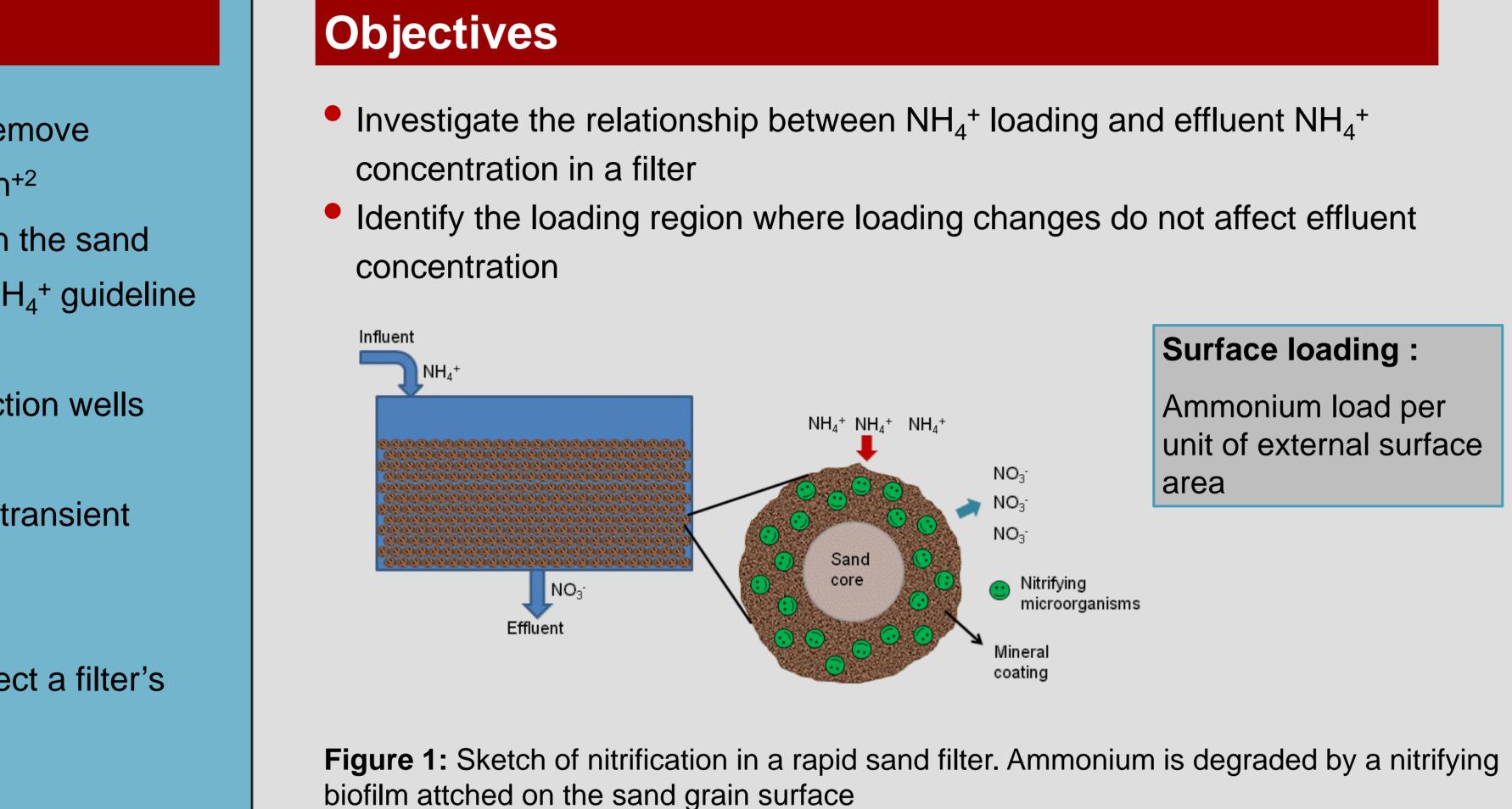
In which operating region have  $NH_4^+$  loading changes no effect a filter's performance?

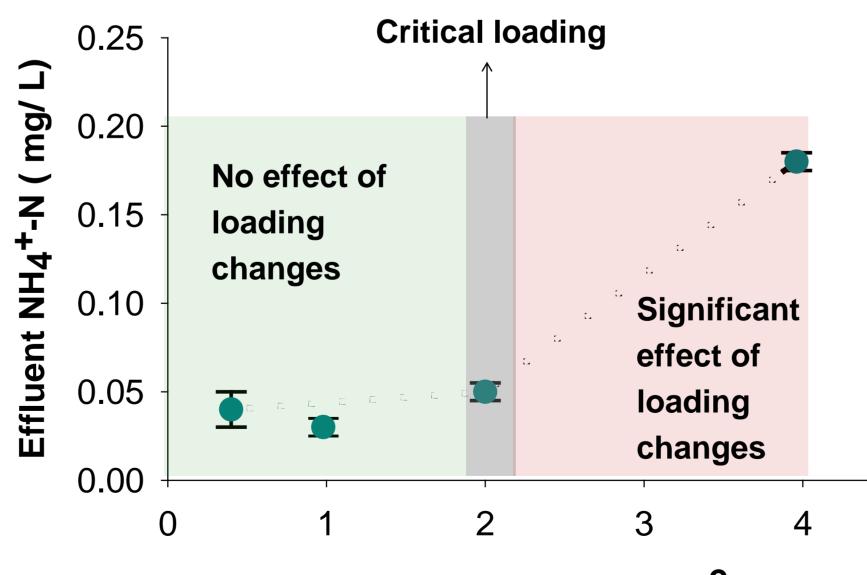


**Figure 2:** NH<sub>4</sub><sup>+</sup> effluent concentration profile during loading increase experiments. During each loading change ammonium effluent concentration stabilizes to a new value (temporary steady state)

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## Results





Surface loading (mg NH<sub>4</sub>+-N/ m<sup>2</sup> sand/ h)

**Figure 3:** Relationship between NH<sub>4</sub><sup>+</sup> effluent concentration (temporary steady state concentration) and surface loading



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#### Surface loading :

Ammonium load per unit of external surface area

 Nitrifying microorganisms

coatina

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

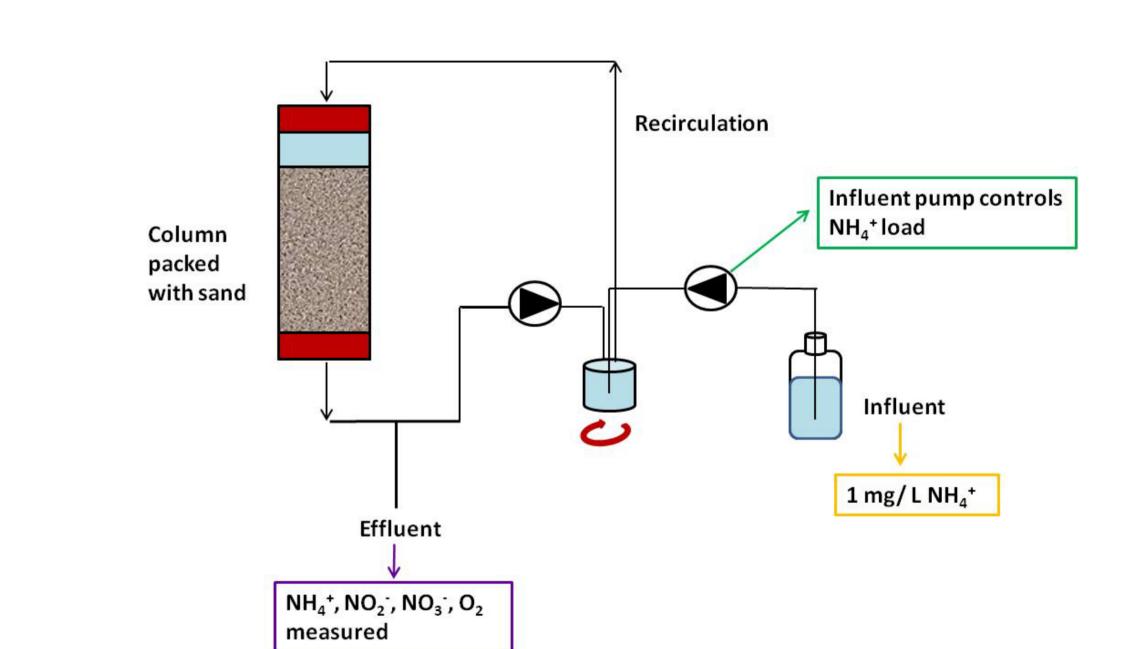
(t-test,  $\alpha = 0.05$ )

- Loadings higher than 2  $NH_4^+$ - N/ m<sup>2</sup> / h result in higher effluent NH₄<sup>+</sup> concentration
- Critical loading = 2 mg  $NH_{4}^{+}-N/m^{2}/h$

## Conclusions

Method

- NH₄<sup>+</sup> 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



**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 <sub>4</sub> +-N/ m <sup>2</sup> sand surface area / h )	Duration of experiment (h)
0.4	steady state
1	5
2	4
4	3

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•  $NH_4^+$  loading variations below the critical loading had no effect on effluent