Effect of forward flush on fouling mitigation in ceramic nanofiltration membranes

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Effect of forward flush on fouling mitigation in ceramic nanofiltration membranes

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Research Goals

The purpose of this research was to investigate chemical-free approaches for cleaning ceramic NF membranes to prolong the chemical cleaning intervals, while maintaining a high flux.

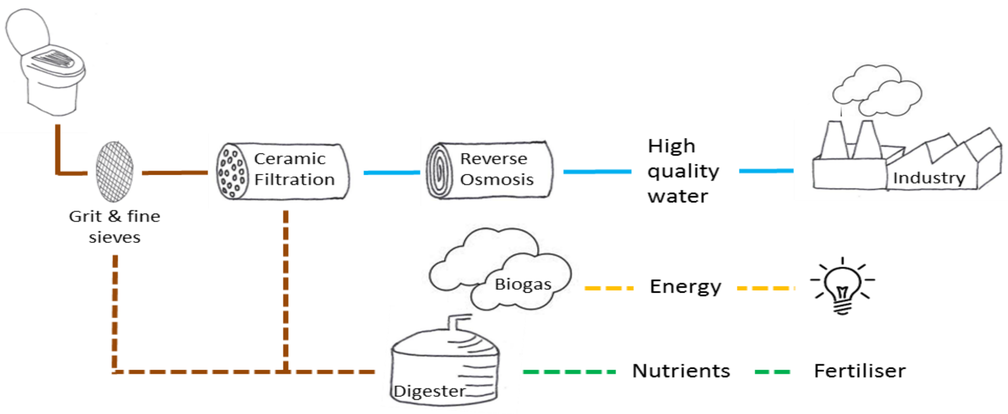
Highlights

- Ceramic NF can run up to 5 days fed with pre-sieved domestic sewage without cleaning required*.
- Interval forward flush can maintain the flux higher, thus higher water production.
- The effect of the forward flush is not related to the crossflow velocity.

Introduction

Ceramic membranes have become increasingly popular in water treatment over the last decade, thanks to their robustness. These membranes have a long service life and can tolerate high temperature, pressure and concentration of chemicals. Ceramic nanofiltration (NF) is a promising development for treatment of waste streams with high organic load; long runtimes can be achieved without required cleaning. Previous research has shown that pre-sieved sewage can be filtrated with a duration of 5 days without cleaning (Figure 2). Afterwards, chemical cleaning using hypochlorite and acid could completely restore the membranes permeability.

The most commonly applied cleaning method for ceramic membranes is hypochlorite treatment, since it is very effective in the removal of the (ir)reversible organic fouling. In this project, the following sewer mining concept is investigated.



** Kramer, F. C. et al. Direct water reclamation from sewage using ceramic tight ultra- and nanofiltration. Sep. Purif. Technol. 1–21 (2015)*

Material & Methods

- Ceramic NF membranes: 450 Da, filtration layer of TiO_2.
- Fouling experiments: flux of 20-60 $L \cdot m^{-2} \cdot h^{-1}$, constant pressure of 5 bar, and cross-flow velocity of 1.1 m/s.
- Feed water: sodium alginate as a surrogate compound for sewage.
- Forward flush experiments: one cycle was 20 min filtration followed by 10 min forward flush, crossflow velocities: 0.4, 1.1, 2.2 and 4.3 m/s.

Results & Discussion

- Fouling experiments cause a permeability drop down to 2 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$ within 2 hours using a surrogate compound for wastewater. The graph stabilises at 2 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$ (Figure 3).
- The most severe fouling occurs in the beginning. The steepness of the graph in the beginning of the experiment indicates that most severe fouling occurs in the first 30 min of the experiment.
- Forward flush was executed at different flow rates on 20 min intervals. Figure 3 shows that the effect of the forward flush is similar for all crossflow velocities. This result is different from polymeric UF were forward flush is common applied and the flow rate is related to the effectiveness of the forward flush.
- Fouling reduces with each forward flush cycle until a steady state is reached. The impact of the forward flush (the hydraulic removal) increases with each cycle (Figure 4).

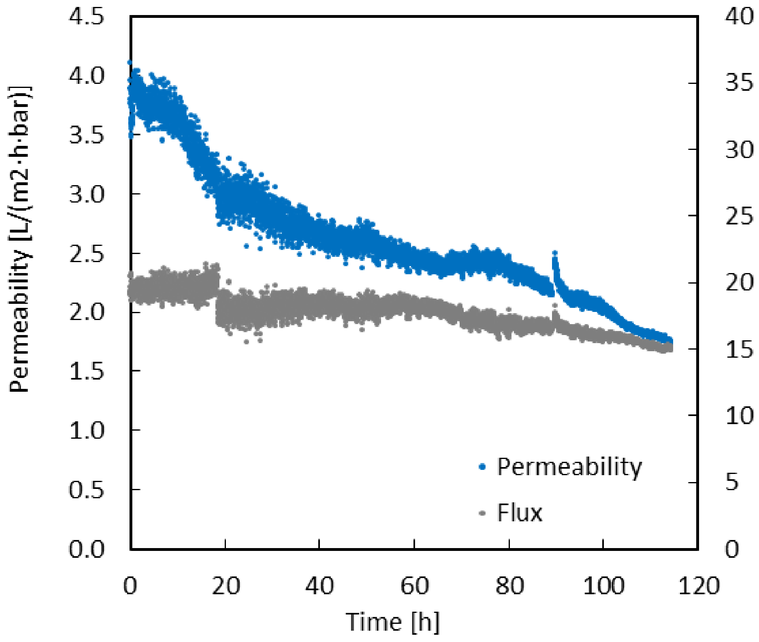


Figure 2: Permeability and flux in time of ceramic NF using pre-sieved domestic wastewater. Duration of 5 days without cleaning the membranes.*

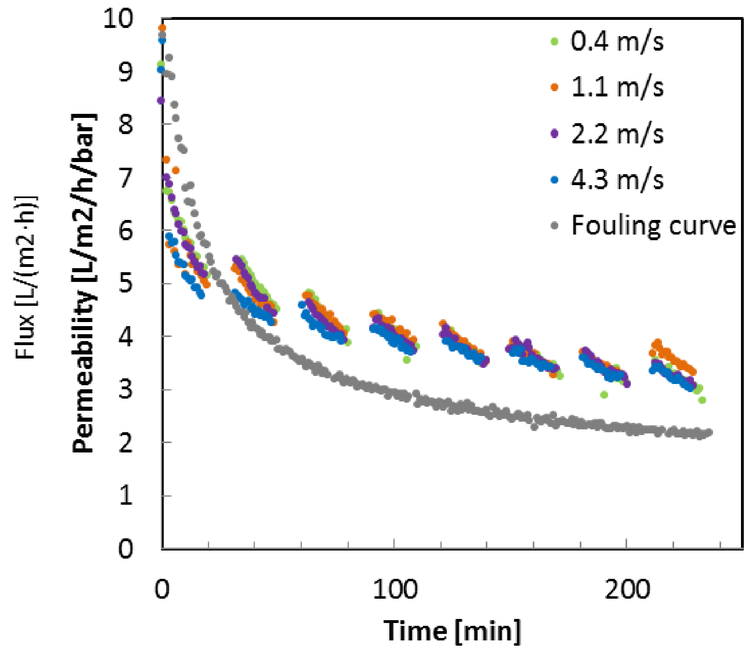


Figure 3: Permeability in time of ceramic NF with and without interval forward flush (20 min). Different crossflow velocities for forward flush are shown.

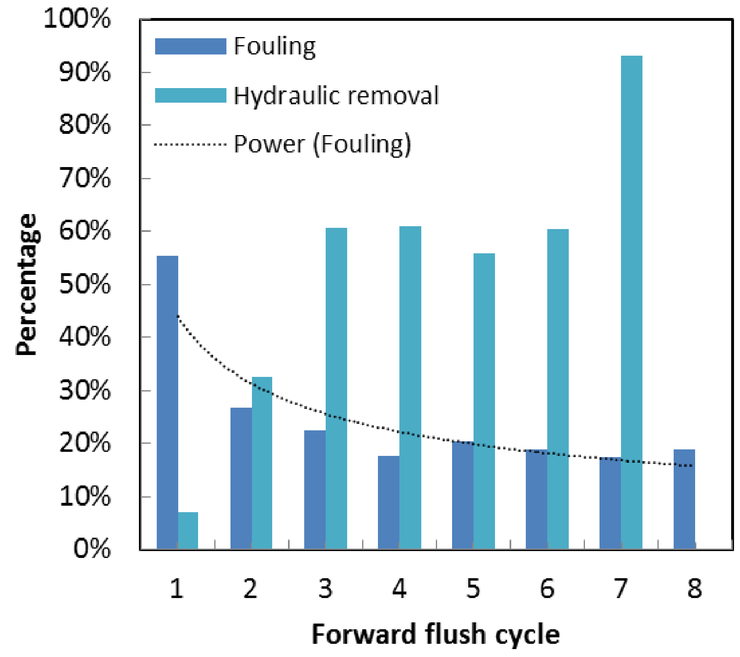


Figure 4: Fouling and hydraulic removal per forward flush cycle. Forward flush cycles of 20 minutes were executed.

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