Effect of water type and pretreatment on fouling and performance of an Al_2O_3 microfiltration membrane

Introduction

For water treatment pretreatment is often combined with low pressure membranes. Studies show that 30-40% of the low pressure membranes operate without pretreatment, and that especially coagulation and powdered activated carbon are common forms of pretreatment. Coagulation is generally perceived as the most successful pretreatment for fouling control, but requires a proper dosing of the used chemicals (both coagulant and chemicals used for pH corrections) as it may otherwise exacerbate fouling. Other potential methods of pretreatment include anion exchange (AIEX), which can be used to remove large parts of the NOM, particles and anions.

Importance

AIEX is increasingly being used to reduce the colour of drinking water by the removal of dissolved organic matter. Research has shown that AIEX as pretreatment can either increase or decrease fouling of various types of polymeric membranes, depending on AIEX resin type, additional pretreatment and membrane pore size. However, the effect of AIEX pretreatment on fouling of ceramic membranes is unknown.

Approach

In this study, we investigate the fouling and performance of an Al_2O_3 ceramic membrane with a pore size of 0.2 µm by direct filtration. Three different water types were filtered directly for 5 hours with a backwash occurring every 20 minutes. The most severely fouling water type was tested again after pretreatment with either AIEX or coagulation. One of the used water types is originally from a groundwater source (Nuland) and has a low amount of NOM and a low turbidity. A second type, surface water from Noord Bergum lake, has a high amount of NOM and a high turbidity. The third type, surface water from the Lek canal, has a low NOM content, but a high turbidity. The composition of the different water types was measured, as well as the non-purgeable organic compound (NPOC) content of the backwash water, permeate and the CIP-waste obtained from the filtration experiments. This allows us to make a mass balance of the NPOC and to determine the separation characteristics of the membrane and the combined processes.

Result

Filtration experiments with three different water types with an Al_2O_3 membrane show that:

- Removal of NPOC, turbidity and UV extinction by MF was lowest for the water type with a very low turbidity (0.14 FNU), being 11±2, -25±45 and 12±1% respectively.
- Removal of NPOC, turbidity and UV extinction for MF of the water types with more representative turbidity (0.14 FNU) and varying

NPOC level (3 or 15 mg/L) were 24±5, 98.6±0.5 and 22±3%, respectively.
- The TMP increase due to irreversible fouling is mostly determined by the presence of particles, whereas the amount of NPOC does not appear to be relevant.
- The TMP increase due to reversible fouling is correlated to the amount of NPOC present.

Filtration experiments with pretreated water show that:

- Pretreatment of Noord Bergum lake surface water with AIEX removes most of the NPOC, turbidity and UV extinction (81, 96 en 94%, respectively).
- The combined process of AIEX pretreatment followed by MF removes: 90±0% of NPOC, 97.9±1% of turbidity and 95.6±0.7% of UV extinction.
- For the AIEX pretreated water the TMP increase due to reversible fouling is decreased, but the TMP increase due to irreversible fouling is increased compared to filtration without pretreatment. This is even though the load of NPOC, and the load of (as 96% was removed) on the membrane decreased significantly.
- The combined process of coagulation and MF decreases NPOC by 41±1%, turbidity by 96±0.2%, and UV extinction by 45±2%.
- For the experiment with coagulation pretreatment the TMP increase due to reversible fouling is decreased, but the TMP increase due to irreversible fouling is increased compared to filtration without pretreatment – although less than in the case of AIEX pretreatment.
- NPOC mass balance based on NPC measurements of the feed water, permeate, backwash water and cleaning solution show that in the case of AIEX and coagulation as pretreatment for MF only 67±4% is found, whereas 88±2% is found in case of direct MF. Thus, a substantial part of the NPOC is still attached to the membrane, even after cleaning as is also shown by the calculation of the minimum and maximum irreversible fouling loads.

Concluding; using AIEX pretreatment before MF greatly enhances fouling and should therefore be avoided. The combined effect of particles and (parts of) NOM on fouling should be investigated.

More information

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