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Drinking Water Engineering and Science Discussions

Interactive comment on "An innovative treatment concept for future drinking water production: fluidized ion exchange-ultrafiltration-nanofiltration-granular activated carbon filtration" *by* S. Li et al.

S. Li et al.

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Referee #1

1. **Q**: FIEX-UF-NF-GAC could be an option to produce high quality drinking water at high recovery.

   A: Yes, FIEX-UF-NF-GAC could produce high quality drinking water at high recoveries.

2. **Q**: However, reducing calcium and magnesium and introducing sodium in drinking water is not the ideal method to produce drinking water. Calcium and magnesium

   in drinking water could provide important health benefits. High sodium in drinking water ($>$200mg/l) may give rise to unacceptable taste.

   A: In deed, calcium and magnesium in drinking water are necessary for health benefit. Reducing them in the FIEX step is to solve the fouling of UF and scaling of NF (which can substantially enhance the lifetime of UF and NF membranes and thereby the investment cost). As far as the health benefit concern, we can simply place a marble/GAC mixed bed filter after NF for the refilling of calcium and magnesium in drinking water. With weak acid cation resin, there should not be too much sodium introduced in drinking water after FIEX. In Table 1, effluent of FIEX show a very high sodium concentration, but that is probably because the sample was taken at the early stage of this study, the dosage of $NaHCO_3$ for pH adjustment in FIEX column is not optimized yet (too many $NaHCO_3$ in the column). When the dosage is optimized, the sodium concentration in FIEX effluent should be about 100 mg/l, based on the theoretical calculation (4mmol/l $NaHC_3$ dosed)

3. **Q**: The explanation of higher MTBE and TBA in NF permeate than NF feed is not reasonable.

   A: Yes, we agree with the referee. The explanation of higher MTBE and TBA in NF permeate than in NF feed is not reasonable. After checking the raw data (Figure 1 in this file), the higher MTBE and TBA in NF permeate is due to the discrepancy of measurements and only one measurement listed in table. In the Table 3 of the manuscript, only the data of the left column in the following figure is listed. And we cannot explain exactly why there is a difference between two measurements.

Referee #2

1. **Q**: In Fig.5, The initial big permeability recovery looks abnormal and does not

have any practical importance. Isn't it more sound to perform backwashing before filtration?

A: In Fig.5, the initial big permeability recovery for Schie water treated with FIEX is abnormal and not important. Of course we can leave it out and say performing backwashing before filtration. However, that is the original data, and we can explain why this happen. Therefore, if the readers can understand correctly, I think the modification is not necessary.

2. **Q**: In section 2.4, MTC is not different from inverse of [viscosity at T=20 times total resistance]. I believe that the temperature correction factor stems from the dependence of viscosity on temperature. I think it is better to stick to the conventional analysis method using total resistance. In addition, a definition of MTC is not shown in the paper.

   A: The definition of MTC is on line 25, page 6 of the manuscript for proofreading. "*The mass transfer coefficient (MTC), which defines the amount of produced permeate under unit time, area and pressure, was used to evaluate the scaling of NF*". I think it is better to use MTC, because it clearly shows how many water the membrane can produce (permeability of the membrane). Both permeability and resistance can indicate the situation of fouling, and permeability is quite often used in other publications.

3. **Q**: The paper shows a novel optimization method of hybrid filtration system in terms of membrane fouling. How do the authors claim that no cake layer is formed?

   A: The long-term experiments show that the UF/NF permeability can be maintained at a constant level. If the cake layer is formed, it should influence the membrane permeability and can be observed from the TMP and MTC graphs.

4. **Q**: The objective of the paper is to develop an efficient protocol for clean water

production. If nanofiltration is used, it requires a much higher pressure than that of UF. In terms of operation cost, does this process provide cost reduction?

A: This concept focuses on the drinking water requirement in future. The removal of micro pollutants present in surface water will be necessary. In that case, the NF is required although it is an expensive treatment step, since the traditional concept cannot reach a satisfying removal of micro pollutants. Because we have good pretreatments for NF in this concept, the cost on cleaning can be significantly reduced (which compensate part of the energy cost). Furthermore, NF reduces the NOM pre-loading of GAC, the GAC can be used for a much longer time as mentioned in the manuscript, which can reduce the cost from the scope of the whole concept. A rough cost estimation of this concept was made by KWR, the Netherlands, and the total cost is around 50 euro cents.

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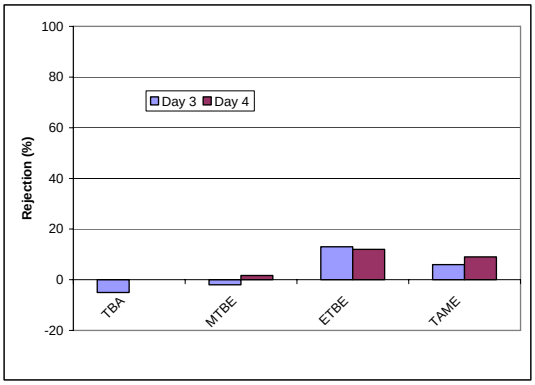

Fig. 1. Rejection of micro pollutants after 3-day filtration and 4-day filtration.