REDUCTION OF HALOACETONITRILES AND HALOKETONES IN NATURAL WATERS USING CERAMIC NANOFILTRATION MEMBRANES

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INTRODUCTION
Natural organic matter in aquatic environments can form carcinogenic organochlorine compounds when is chlorinated [1]. On the other hand, the lack of water in the southeast of Spain is the main reason for studying new alternatives of purification techniques and their optimisation. As a consequence, it will improve the use of natural waters.

The aim of this research is to determine how efficiently are two commercial NF ceramic membranes (450 Da and 1000 Da MWCO) for the reduction of specific chlorination by-products (DBPs) in samples from water reservoir in Alicante (Spain), and analyze effects of pressure, conductivity and pH.

MATERIALS AND METHODS
♦ EQUIPMENT: Experiments were carried out on a bench scale filtration unit (figure 1).
♦ MEMBRANES: Two NF ceramic tubular membranes were used for this study. One of them is a multi channel ceramic NF membrane of 1 kDa MWCO (NF 1000), Kerasep Nano-BW (Rhodia). The second membrane tested is a monochannel ceramic NF membrane of 450 Da MWCO (NF 450), Imopor-nano.
♦ FEED WATER: Water tested is from Amadorio reservoir.

Halogenation products (HAN) and halocarbons (HK) formed after chlorination were determined through the USEPA 551.1 [2] methods.

<table>
<thead>
<tr>
<th>MEMBRANE</th>
<th>MATERIAL</th>
<th>MWCO</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF 450 Mono Channel</td>
<td>TiO₂</td>
<td>450</td>
<td>0.0085</td>
</tr>
<tr>
<td>NF 1000 Multi Channel</td>
<td>ZrO₂/TiO₂</td>
<td>1000</td>
<td>0.0085</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION
♦ EFFECT OF PRESSURE
The permeate flux shows a gradual decrease to a steady state value that varied with pressure (figure 2)

DOC rejection percentages raise as the TMP increase. For NF 450, DOC removal is higher than when we use NF 1000 membranes.

Related to DBPs rejection, NF 450 membrane presents a similar tendency with DOC rejection, an increase of pressure produce an increase of HAN and HKs rejection. For NF1000 the values of HAN and HKs rejection diminish slightly. The values of HKs are higher than values of HAN for both membranes.

Figure 2. Flux reduction versus different pressure

♦ CONDUCTIVITY EFFECTS
In general, the experiments present a slight decrease in flux with an increase of ionic strength from 1000 μS/cm to 2000 μS/cm.

For both membranes NF450 and NF1000, when the conductivity increase DOC removal decrease. The analyses carried out to determine HAN and HKs potential formation reveal a slight decreases of these DBPs when increase the conductivity for NF450 membrane (figure 3).

Figure 3. HAN and HKs removal versus conductivity

♦ pH EFFECTS
Humic acids are negatively charged. At low pH, membranes are more positively adsorbed. Therefore, there is more attraction between the membrane surface and humic acids when the pH is low because the difference in charge is greater. This provokes an increase in flux reduction.

If we analyse the results of HAN and HKs rejection, for 450NF the results are similar without important tendencies. For NF1000 membrane there are not clear tendencies with the variation of pH.

<table>
<thead>
<tr>
<th>pH</th>
<th>HAN 450</th>
<th>HAN 1000</th>
<th>HKs 450</th>
<th>HKs 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>44.4</td>
<td>35.7</td>
<td>39.9</td>
<td>38.5</td>
</tr>
<tr>
<td>4</td>
<td>26.6</td>
<td>21.5</td>
<td>23.8</td>
<td>23.5</td>
</tr>
<tr>
<td>6</td>
<td>16.9</td>
<td>10.1</td>
<td>19.9</td>
<td>16.5</td>
</tr>
</tbody>
</table>

- NF450 membrane procures a greatest drop in flow-rate.
- The best removal of NOM is achieved using NF 450. The behaviour of fouling is similar for both membranes, althought it is slightly higher using NF 450.
- Both membranes (NF450 and NF 1000) exhibit a similar performance, in all cases the rejection is higher for HKs than for HANs.
- DOC removal and the fouling increases with increasing pressure for both membranes.
- At high conductivity, for both membranes NF450 and NF1000, when the conductivity increase DOC removal decrease. The analyses carried out to determine HAN and HKs potential formation reveal a slight decreases of these DBPs.
- At the beginning of experiments, when the pH decrease the flux reduction is increase.

♦ CONCLUSION
- NF450 membrane procures a greatest drop in flow-rate.
- The best removal of NOM is achieved using NF 450. The behaviour of fouling is similar for both membranes, although it is slightly higher using NF 450.
- Both membranes (NF450 and NF 1000) exhibit a similar performance, in all cases the rejection is higher for HKs than for HANs.
- DOC removal and the fouling increases with increasing pressure for both membranes.
- At high conductivity, for both membranes NF450 and NF 1000, when the conductivity increase DOC removal decrease. The analyses carried out to determine HAN and HKs potential formation reveal a slight decreases of these DBPs.
- At the beginning of experiments, when the pH decrease the flux reduction is increase and DOC rejection decrease, although there is not specific tendency in HAN and HK formation potential.

REFERENCES

ACKNOWLEDGEMENT
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