Autopsy of ultrafiltration membranes for drinking-water production with in-line coagulation and ozonation pre-treatments

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ABSTRACT

Membrane autopsies were performed after a pilot-scale study with ultrafiltration (UF) membranes for drinking-water production from humic-rich influents where FeCl₃ coagulation–flocculation (CF) and ozonation (OZ) were used as pre-treatments. Membrane fragments and extracted residues were analysed to identify the foulants and evaluate the condition of the respective modules used. The amount of deposits on the membrane surface proved higher for CF-UF system, although microbial activity was more remarkable in OZ-UF, as significantly more SMP was detected. Bacterial growth was confirmed by the spongy and fully developed biofilm found for both systems with scanning electron microscopy (SEM). XRF showed Fe content to be predominant for the CF-UF membrane, while elements such as Al, Si or Ca were also found, though these were not as abundant as in the OZ-UF system. Cross-section analyses with SEM/energy dispersive spectrometer (EDS) revealed the presence of Fe combined with P inside the membrane pores for CF-UF fragments. By contrast, OZ-UF fragments revealed the presence of aluminosilicates with no visible effect on membrane pores. Finally, ATR-FTIR profiles showed that neither the chlorine used in the chemical cleaning nor the pre-treatments had damaged the chemical structure of the membranes. However, the main absorption bands were masked for OZ-UF in comparison to CF-UF system, indicating that fouling was more severe after the application of ozone.

Keywords: Drinking water; Ultrafiltration membrane autopsy; Biofilm; Foulants; Coagulation–flocculation; Ozonation

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