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Autopsy of RO desalination membrane
Part 2. Chemical characterisation of the foulant

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ABSTRACT

The objective of this study was to determine the nature of the fouling material that was physically (scrapping) recovered from the harvested fouled RO membrane elements (FILMTEC, SW30HR LE-400 8'') located in front position of a pressure vessel from the first pass of a RO desalination unit (the same membranes as described in the abstract of the same title part 1 from G. Schaule et al.) As an initial step, permeability measurements were performed on 140 cm² membrane sheet using a bench-scale high pressure filtration unit-Sepa CF II Osmonics. Filtration tests were conducted on the fouled membrane as received and after physical cleaning (wet sponge) with synthetic seawater at TMP = 60 bar and 20°C with cross flow velocity of 0.2 $m.s^{-1}$. Results showed that the foulant layer, clearly visible at the membrane surface (brown deposit) was responsible for a significant loss of the membrane permeability (15–20%). Indirect characterization was conducted on the foulant material recovered from the membrane sheets by scrapping and lyophilized. A large number of analyses were performed i.e. elemental analysis, ICP, FT-IR (KBr pellet), solid state 13C-NMR, pyrolysis and thermochemolysis GC/MS, phospholipids (GC/MS), proteins (polyacrylamide gel electrophoresis) and sugars (Alditol acetate method followed by GC/MS). Elemental analyses indicated that the foulant material was mainly organic in nature with 26–30% of inorganics (slightly higher proportion in the feed part). FT-IR (KBr pellets) showed, as observed by ATR FT-IR analysis conducted on the membrane surface, that the deposit was enriched in sugar and protein type structures. Solid state 13C-NMR showed an aliphatic carbon structure (aromatic carbon undetectable) with the presence of sugar (anomeric C + alcohols) and amide + carbonyl functional groups. Pyrolysis GC/MS confirmed the existence of a mixture of biopolymers with the abundance of aminosugar and sugar type structures (amide + acetic acid peaks) and the presence of proteins. Thermochemolysis GC/MS exhibited a strong bacterial origin with specific markers (C16 dominant fatty acid, presence of C15 iso and anteiso) but also evidence of the presence of aromatic type structures. These aromatic structures are generally considered to be of terrestrial origin (terrestrial input near the water uptake). Complementary experiments are conducted to confirm this hypothesis. Phospholipids were detected by GC/MS after liquid/liquid extraction showing the same distribution. Glucose, mannose and arabinose were the major sugars present. The results of these analyses suggest a strong bacterial origin of the foulant layer observed on the desalination RO membrane. The observed fingerprint was similar to the one detected on NF membranes operated in a drinking water treatment plant fed with a river water. No significant differences were observed on foulants recovered before and after cleaning suggesting a minor impact of the cleaning procedure on the organic composition of the deposit. Strong interactions between the inorganic spieces and this complex organic matrix were noticed.

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