NMR STUDIES OF BIOFILMS ON REVERSE OSMOSIS MEMBRANES

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Reverse osmosis (RO) is one of multiple pressure-driven membrane separation processes used primarily for the production of high purity water for various industries, including food processing. Biofilm growth on the membrane surface, commonly referred to as biofouling, causes problems within the membrane units as it increases the operational pressure and energy demands and degrades product quality. Biofilm formation and chemical removal on RO membranes were studied using nuclear magnetic resonance (NMR) imaging techniques. Both industrial modules and model flow cells were examined using NMR spatial and velocity images during operation. The different physical environments of the water internal and external to the biofilm allowed good NMR contrast for spatial imaging. Likewise, the flowing free water during operation was captured using NMR velocity imaging to show clearly the restricted flow channels and reduced membrane surface area resulting from biofouling. Changes in the biofilm distribution and flow channels were also observed during multiple chemical cleaning studies. Images of the industrial module studied are shown in Figure 1. In both fouling and cleaning experiments, NMR proved an effective and non-invasive method for characterising biofilm distribution and flow patterns within RO membrane systems. Lattice-Boltzmann simulations of the biofilm growth on RO membranes were performed and showed excellent agreement with experimental results.

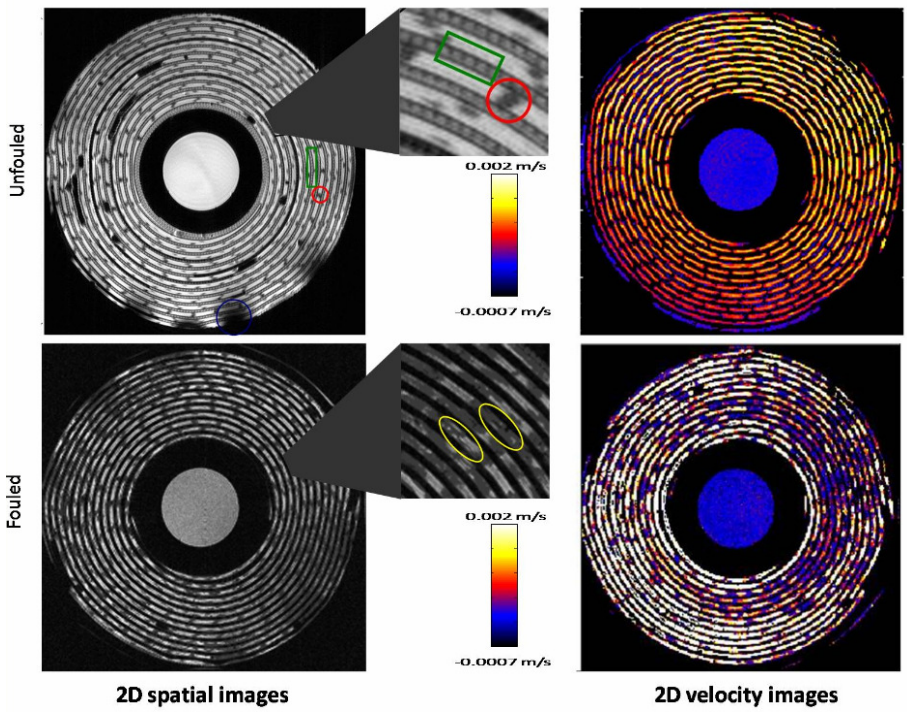

Figure 1. NMR images of a fouled and unfouled industrial RO membrane.

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