Novel feed spacer designs and membrane cleaning using carbon dioxide nucleation for (bio)fouling control

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Abstract

In this work, we propose to control the persistent (bio)fouling phenomenon in membrane processes via two novel techniques i) enhancing unsteadiness in the feed channel by tuning spacer geometry, and ii) dislodging deposited (bio)foulants using nucleated carbon dioxide bubbles.

Different feed spacer designs, namely hole-type, pillar/column, air-foil, and twisted filaments (micro-helices) w/wo holes, are proposed by modifying either the filament geometry or the filament intersections at elemental level followed by in-house prototyping using 3-D printing technology. In all cases, calculations using Direct Numerical Simulation (DNS) aided by membrane surface visualization via Optical Coherence Tomography (OCT) imaging were performed to validate the experimental data.

The proposed novel cleaning technique consists of using a solution supersaturated with CO_2. The process is initiated by nucleation of CO_2 bubbles which lift the deposited foulants from the membrane surface and pores. Under extreme fouling conditions, pulsating nucleation improved significantly the cleaning performance compared to current practices.