Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.21625

97 (2017) 72–78
November

Applicability of short-term accelerated biofouling studies to predict long-term biofouling in reverse osmosis membrane systems

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Received 25 April 2017; Accepted 9 November 2017

ABSTRACT

Biofouling studies addressing biofouling control are mostly executed in short-term studies. It is unclear whether data collected from these experiments are representative for long-term biofouling as occurring in full-scale membrane systems. This study investigated whether short-term biofouling studies accelerated by biodegradable nutrient dosage to feed water were predictive for long-term biofouling development without nutrient dosage. Since the presence of a feed spacer has an strong effect on the degree of biofouling, this study employed six geometrically different feed spacers. Membrane fouling simulators (MFSs) were operated with the same (i) membrane, (ii) feed flow and (iii) feed water, but with feed spacers varying in geometry. For the short-term experiment, biofilm formation was enhanced by nutrient dosage to the MFS feed water, whereas no nutrient dosage was applied in the long-term experiment. Pressure drop development was monitored to characterize the extent of biofouling, while the accumulated viable biomass content at the end of the experimental run was quantified by adenosine triphosphate (ATP) measurements. Impact of feed spacer geometry on biofouling was compared for the short-term and long-term biofouling study. The results of the study revealed that the feed spacers exhibited the same biofouling behavior for (i) the short-term (9-d) study with nutrient dosage and (ii) the long-term (96-d) study without nutrient dosage. For the six different feed spacers, the accumulated viable biomass content (pg ATP.cm^{-2}) was roughly the same, but the biofouling impact in terms of pressure drop increase in time was significantly different. The biofouling impact ranking of the six feed spacers was the same for the short-term and long-term biofouling studies. Therefore, it can be concluded that short-term accelerated biofouling studies in MFSs are a representative and suitable approach for the prediction of biofouling in membrane filtration systems after long-term operation.

Keywords: Biofouling; Reverse osmosis; Membrane fouling simulator; Feed spacers; Modified spacer geometry

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Presented at the 11th International Conference on Membranes in Drinking and Industrial Water Production (MDIW), 6–8 February 2017, Leeuwarden, The Netherlands.