Fouling of forward osmosis membrane by protein (BSA): effects of pH, calcium, ionic strength, initial permeate flux, membrane orientation and foulant composition

Pin Zhao\textsuperscript{a}, Baoyu Gao\textsuperscript{a}, Qinyan Yue\textsuperscript{a,*}, Ho Kyong Shon\textsuperscript{b}, Qian Li\textsuperscript{a}

\textsuperscript{a}Shandong Provincial Key Laboratory of Water Pollution Control and Resource Reuse, School of Environmental Science and Engineering, Shandong University, Jinan 250100, China, Tel. +86 15806625680; email: wszplak@163.com (P. Zhao), Tel. +86 531 88365258; Fax: +86 531 88364513; emails: baoyugao_sdu@aliyun (B. Gao), qyyue58@aliyun.com (Q. Yue), qianli@sdu.edu.cn (Q. Li)

\textsuperscript{b}School of Civil and Environmental Engineering, University of Technology, P.O. Box 129, Broadway 2007, Sydney (UTS), NSW, Australia, email: Hokyong.Shon-1@uts.edu.au

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\textbf{ABSTRACT}

In this study, bovine serum albumin (BSA) was selected to represent proteins of secondary wastewater effluent. The role of various physical and chemical interactions, such as calcium concentration, ionic strength, solution pH, feed foulant composition, initial permeate flux, and membrane orientation, in BSA fouling of forward osmosis (FO) membranes was investigated. Fouling experiments showed that membrane fouling by BSA was enhanced with increasing calcium concentration and ionic strength. The former was mainly due to the complexes formed by the interaction of $\text{Ca}^{2+}$ and carboxylic functional groups of BSA, and the latter resulted from the decreasing electrostatic repulsion among BSA molecules and between BSA molecules and membrane. Moreover, FO membrane fouling became much more significant at solution pH 4.7 (the BSA isoelectric point), where BSA molecules were neutrally charged and had no electrostatic repulsion among themselves. It was also demonstrated that the presence of alginate (a model polysaccharide) as co-foulant aggravated the BSA fouling of FO membrane, which could be attributed to the remarkable contribution of the alginate$\text{BSA}$\textsuperscript{2+} complexes within the fouling layer to the total membrane resistance. The fouled membranes were examined by scanning electron microscopy to further sustain the conclusion. In addition, the size distribution of foulant molecules in various FS was measured and used as a reference to judge and control the behavior of BSA fouling. The present paper is contributed to better understanding of FO membrane fouling caused by protein (BSA) and has instructive significance for the future development.

\textbf{Keywords:} Forward osmosis; Membrane fouling; Protein fouling; Bovine serum albumin; BSA; Size distribution