Optimizing seawater operating protocols for pressurized ultrafiltration based on advanced cleaning research

Guillem Gilabert Oriol\textsuperscript{a,∗}, Nasir Moosaa, Ricard Garcia-Valls\textsuperscript{b}, Markus Buscha, Veronica Garcia-Molina\textsuperscript{a}

\textsuperscript{a}Dow Water & Process Solutions, Autovia Tarragona-Salou s/n, 43006 Tarragona, Spain
Tel. +34 619953901; Fax: +34 977559488; email: ggilabetoriol@dow.com
\textsuperscript{b}Department of Chemical Engineering ETSEQ, University Rovira i Virgili (URV), Avda. Paisos Catalans 26, 43007 Tarragona, Catalonia, Spain

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\textbf{ABSTRACT}

This paper is part of a global research project conducted by Dow Water & Process Solutions to optimize the efficiency of ultrafiltration processes. After an initial identification of the backwash as the key opportunity to increase the efficiency of the process, a study based on its optimization is developed. Main emphasis is given to the sequence and subsequent number of steps involved in the backwash. The ultimate goal is thus to increase the availability and recovery of the process while still attaining a high cleaning effect during the backwash. This optimization is done through the realization of various experiments using DOW\textsuperscript{TM} Ultrafiltration SFP-2660 outside-in polyvinylidene difluoride (PVDF) membranes following an exhaustively planned factorial design of experiments. The factors being assessed are the steps normally performed during a backwash. These are the air scour (AS/D), the draining (D), the backwash top (BWT) with or without air scour, the backwash bottom (BWB) and the forward flush (FF). The responses analyzed are the calculated efficiency of the process and the experimentally obtained transmembrane pressure, which represents the fouling rate of the membrane. The results are analyzed through a formal statistical study of the analysis of the variance and are validated through 25 days of stable operation. The results show that the backwash can be simplified from an original sequence of five steps to only two steps, which are the backwash top with air scour and the forward flush without impairing the effectiveness of the cleanings. This leads to an increase in efficiency higher than 5%, which represents a decrease of 50% in the filtration inefficiency. This is achieved thanks to the reduction of the time invested for the cleanings and the decrease in the amount of water consumed.

\textbf{Keywords:} Ultrafiltration; Cleaning; Backwash; Seawater; Desalination; Efficiency; Fouling