Evaluation on membrane fouling by hydrophobic and hydrophilic substances through permeation coefficient and concentration polarization factor in SWRO processes

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It is difficult to evaluate fouling of high-pressure membranes such as seawater reverse osmosis (SWRO) membranes, although the fouling of low-pressure membranes such as microfiltration (MF) and ultrafiltration (UF) membranes can be evaluated by monitoring the decrease in flux or the increase in trans-membrane pressure (TMP). In particular, it is more difficult to evaluate membrane fouling of SWRO membranes actually in plant because SWRO membranes are connected in series of six to eight elements in one vessel and fouling and concentration polarization occur at the same time. This study aimed to distinguish concentration polarization from membrane fouling by calculating the permeation coefficient and concentration polarization factor with the progression of membrane fouling. As fouling was progressed by organic matters, the permeation coefficient and concentration polarization factor decreased. Fouling layers by organic matters reduce the concentration polarization factor because fouling layers reduce the permeation coefficient by increasing the filtration resistance and cause cake reduced concentration polarization (CRCP) by interrupting the convection of salt. Furthermore, membranes with forward osmotic backwashing (FOB) are effective in controlling membrane fouling because FOB alleviate the decreasing rate of the permeation coefficient and concentration polarization factor compared to membranes without FOB. Therefore, it was possible to evaluate the degree of membrane fouling in SWRO membranes by analyzing changes in the permeation coefficient and concentration polarization factor with the progression of membrane fouling and to evaluate cleaning efficiency by comparing them before and after FOB. This made it possible to use permeation coefficient and concentration polarization factor as an indicator to determine the timing of cleaning-in-place (CIP) or physical cleaning such as FOB.

Keywords: Permeation coefficient; Concentration polarization factor; Fouling; Reverse osmosis; Forward osmotic backwashing

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