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Prediction of ultrafiltration membrane fouling using statistical models in pilot and full-scale operations

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ABSTRACT

Prediction of ultrafiltration membrane fouling using statistical models has been investigated. Statistical models employed in this study include artificial neural network (ANN), genetic programming (GP) and M5P tree model. Data obtained from pilot-scale (A plant) and full-scale (B plant) membrane plants were used for training and testing models. Fouling prediction by the classic Hermia model was also carried out for comparison with the statistical models. The Hermia model is used for simple estimating membrane fouling by data fitting but can provide information on the cause of membrane fouling according to the fitting trend. On the other hand, the statistical models can be used to predict the actual degree of membrane fouling rather than simple data fitting; however, these models do not provide information on the causes of membrane fouling. Therefore, complementary studies are possible by using these two types of models together. The ratio of the number of training and test data was varied to be 8:2, 6:4, 4:6, and 2:8 for prediction error control. As a result of applying the Hermia model, the ratio of training data to test data can be predicted up to around 8:2. Reliable predictions have been obtained up to the ratio of 4:6 in the ANN model, 6:4 in the GP model and 4:6 in the M5P tree model. Except for the summer period where the corrected trans-membrane pressure (TMP) at 25°C was unstable (in the full-scale plant B), the reliable prediction was obtained up to the ratio of 2:8 for the ANN model, 4:6 for the GP model and 6:4 for the M5P model. It has been demonstrated that the statistical models can make acceptable fouling predictions despite a small number of training data in both the pilot-scale and full-scale plant. In addition, the time for membrane cleaning can be scheduled in advance as the models also predict the proper cleaning time in combination with fouling prediction.

Keywords: Membrane fouling; Hermia model; Artificial neural network; Genetic programing; M5P tree model

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