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Evaluation Method for Fouling Risk Using Quartz Crystal Microbalance

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Abstract : One of the most important tasks in operating desalination plants using a reverse osmosis (RO) method is preventing RO membrane fouling caused by foulants found in seawater. Optimal design of the pre-treatment process of RO process for plants enables the reduction of foulants. Therefore, a quantitative evaluation of the fouling risk in pre-treated water, which is fed to RO, is required for optimal design. Some measurement methods for water quality such as silt density index (SDI) and total organic carbon (TOC) have been conservatively applied for evaluations. However, these methods have not been effective in some situations for evaluating the fouling risk of RO feed water. Furthermore, stable management of plants will be possible by alerts and appropriate control of the pre-treatment process by using the method if it can be applied to the inline monitoring system for the fouling risk of RO feed water. The purpose of this study is to develop a method to evaluate the fouling risk of RO feed water. We applied a quartz crystal microbalance (QCM) to measure the amount of foulants found in seawater using a sensor whose surface is coated with polyamide thin film, which is the main material of a RO membrane. The increase of the weight of the sensor after a certain length of time in which the sample water passes indicates the fouling risk of the sample directly. We classified the values as “FP: Fouling Potential”. The characteristics of the method are to measure the very small amount of substances in seawater in a short time: < 2h, and from a small volume of the sample water: < 50mL. Using some RO cell filtration units, a higher correlation between the pressure increase given by RO fouling and the FP from the method than SDI and TOC was confirmed in the laboratory-scale test. Then, to establish the correlation in the actual bench-scale RO membrane module, and to confirm the feasibility of the monitoring system as a control tool for the pre-treatment process, we have started a long-term test at an experimental desalination site by the Red Sea in Jeddah, Kingdom of Saudi Arabia. Implementing inline equipment for the method made it possible to measure FP intermittently (4 times per day) and automatically. Moreover, for two 3-month long operations, the RO operation pressure among feed water samples of different qualities was compared. The pressure increase through a RO membrane module was observed at a high FP RO unit in which feed water was treated by a cartridge filter only. On the other hand, the pressure increase was not observed at a low FP RO unit in which feed water was treated by an ultra-filter during the operation. Therefore, the correlation in an actual scale RO membrane was established in two runs of two types of feed water. The result suggested that the FP method enables the evaluation of the fouling risk of RO feed water.

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