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Fluorescent nano particle application for a membrane surface integrity test: Sensitivity, stability, and reliability of the particles

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ABSTRACT

In this research, silica-based fluorescent particles were synthesized and used as a surrogate detector to evaluate the integrity of a compromised flat sheet membrane. Three different sizes of particles were synthesized and dyed with a fluorescent dye to make a fluorescence image under a UV light. Experiments were designed to test the sensitivity of the detection limit, stability of particles, and reliability of the proposed method. UV spectrometer and image analysis were used to evaluate the detection limits and measure the concentration and mass of the particles in the feed and permeate. For the stability of the particles, dye-leakage tests were conducted to estimate the amount of fluorescent decay when fluorescent particles were dissolved in an aqueous solvent. The effect of the particles on the membrane fouling was also investigated by conducting a batch filtration test of undamaged membranes. To examine the reliability of the proposed method, a series of filtration tests were performed with the damaged membranes by applying the fluorescent particles as a surrogate. As a result, the image analysis could detect the maximum mass of particles of 5 mg. The particles showed the stable fluorescence intensity within 24 h after being dissolved into 100% ethanol solution. In considering the pore size in the membrane, the particles with a size of about three times larger than the membrane pores were the most compatible surrogate for the integrity test to prevent the undesirable affect of having the membrane fouling. Finally, the size of breach on the membrane surface could be predicted, possibly from the image analysis of the permeate containing the fluorescent particles outflow from a damaged part of the membrane surface.

Keywords: Fluorescent particle; Membrane; Integrity test; Fouling; Sensitivity

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