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Real Time Fouling Monitoring with Electrical Impedance Spectroscopy

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Abstract
Electrical Impedance Spectroscopy (EIS) was explored as an *in situ* tool for the detection of fouling of reverse osmosis membranes, during filtration of industrial (molasses) wastewater and model feeds containing silica and BSA foulants. The electrical capacitance measured at low frequencies (<100Hz) was found to be the most sensitive electrical parameter for detecting fouling, during the early stage of flux decline. The effective gain (the percentage of change in capacitance divided by the percentage change in the flux) was ~3 for molasses waste water, 1.4 for silica and 2.5 for BSA. The formation of the reversible fouling layer occured in conjunction with concentration polarization during this period and EIS was more sensitive than flux decline in monitoring this process. Hence EIS has potential in industrial application for fouling detection. Further the impedance spectra after cleaning were consistent with the flux recovery.

The impedance spectra obtained following macromolecular (BSA & molasses wastewater) fouling was found to be significantly different from those obtained with colloidal (Silica) fouling. The decrease in capacitance observed for BSA and molasses wastewater, suggests the formation of a gel like layer on the membrane surface, whilst the increase in capacitance of the silica suggests a loose cake which enhances concentration polarisation. Hence EIS may also be capable of indicating the type of fouling which is occurring at the membrane surface.

Highlights

- First demonstration of Electrical Impedance Spectroscopy for monitoring Industrial Organic fouling of Reverse Osmosis Membranes
- Industrial organic foulant gives similar signals to model organic foulant
- Organic fouling found to give different EIS signal to inorganic fouling
- Colloidal Silica fouling found to give similar EIS signal to inorganic scale

Key Words: Membrane Fouling, Electrical Impedance Spectroscopy, In Situ Fouling Measurement, Real Time Fouling Measurement.