

Osmotic effects of biofouling in reverse osmosis (RO) processes: Physical and physiological measurements and mechanisms

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ABSTRACT

Microbial biofilm formation on reverse osmosis (RO) membranes is known to reduce permeate flux and, in most cases, to reduce salt rejection. These effects are consequences of increased overall hydraulic resistance for water permeation through the membrane and a hindered back-diffusion of salts through the biofilm. In return, salt concentration near the membrane is elevated, a phenomenon known as “biofilm enhanced osmotic pressure” (BEOP), resulting in enhanced salt passage. While the effect of elevated hydraulic resistance is clear, the effect of salt passage increase is counterintuitive. In most cases tested, the typical increase of salt passage due to biofouling using commercial high-flux RO membranes cannot be attributed just to RO transport (permeate flux and salt rejection relation), and the typical values of salt passage elevation are too high under biofouling conditions and can only be explained by enhanced concentration polarization effects. Delineating biofouling mechanisms of RO membranes and analyzing the interrelated effects of the biofouling layer on the system performance as well as further changes in the biofouling layer physiology are important for monitoring the extent of biofouling in desalination processes. The BEOP phenomena is enlightened by synthetic biofouling controlled experiments as well as by more realistic studies using tertiary wastewater.

Keywords: Reverse osmosis; Biofouling; Fouling; BEOP; CEOP; Extracellular polymeric substances; EPS; Biofilm
