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Abstract

Increasing permeate flux whilst maintaining energy demands at reasonable levels is of great interest for membrane bioreactors (MBRs) widespread application. One of the main issues for this is to develop effective fouling control strategies under dynamic conditions. This study proposes a filtration length-based feedback control system for optimal filtration performance. A pilot-scale tertiary MBR was used for the control system validation. The control permitted the adjustment of the permeate flux and the final allowable transmembrane pressure at real-time, in order to obtain the desirable filtration length within a filtration cycle. A flux-step procedure was used to develop the model-based control law. The control system was tested by short-term tests under different initial permeate fluxes (30-60 L/h m^2), transmembrane pressure increment factors (15-25 Pa) and sludge characteristics (1.8-3.5 mg/L of biopolymeric clusters), revealing a short transient response and a negligible steady-state error. The potential of this control system was reinforced during long-term operation at unsteady organic load conditions. At pre-fixed filtration time of 5 min, continuous operation at supra-critical fluxes (47.1-56.8 L/h m^2) was maintained at low specific aeration demands (SAD_{pnet}=6.1-8.2 $Nm^3{}_{air}/m^3{}_{permeate}$). The control strategy designed in this study achieved better reversible fouling control than the conventional one (fixed permeate fluxes) which in turn led to a considerable lower residual fouling rate.

Key-words: Dynamic filtration control; Set-point filtration length; Supra-critical flux; Fouling mitigation; Dead-end filtration