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Modelling and simulation of short and long term membrane filtration experiments

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ABSTRACT

Membrane bioreactors (MBRs) are a recent innovation in wastewater treatment that combines membrane filtration with biological processes [G. Tchobanoglous, F.L. Burton and H.D. Stensel, Wastewater Engineering, Treatment and Reuse, McGraw-Hill Professional, 2003].The focus of this study is on membrane filtration. It concentrates on developing a mathematical model to describe filtration and fouling on micro and ultrafiltration membranes using work based on an earlier published model by Liang et al. (S. Liang, L. Song, G. Tao, K.A. Kekre and H. Seah, A modelling study of fouling development in membrane bioreactors for wastewater treatment, Water Environ. Res., 78(8) (2006) 857–863). Initial modelling experiments with Liang's model showed its deficiencies at predicting transmembrane pressures (TMPs) over a wide range of fluxes. A very basic structure of this model and its behavioural character limit its applicability to only a limited number of operational regimes. In an endeavour to develop a more universal yet simple model, the Liang model has been extended and modified to include: backwash mechanism; cake and soluble microbial product (SMP) deposit compressibility effects; various cake removal models (air scouring and crossflow velocity); and, flux dependent SMP deposition rates. The model was calibrated on experimental data from flux stepping experiments performed on a pilot scale membrane filtration unit with horizontal hollow fibres of 0.1 μm pore size and on a long-term filtration data from a MBR pilot plant equipped with vertical hollow fibres of similar pore size. The model proved to be in good agreement with the measurements in both calibration studies.

Keywords: Cake; Filtration; Fouling; MBR; Membrane; Modelling; Simulation; SMP; Wastewater

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