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Upgrading of submerged membrane bioreactor operation with regard to soluble microbial products and mathematical modeling for optimisation of critical flux

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ABSTRACT

Recent studies have shown that the colloidal and soluble fraction of the sludge (sludge water) correlates well with Membranes Bioreactor (MBR) fouling. Soluble microbial products (SMP) are the main constituent of MBR sludge water. However, it is not clear how to predict the foulant concentrations, how foulants are deposited onto the membrane, and how to predict the impact of deposited foulants on membrane permeability. The goal of this paper was therefore to characterize the foulants in MBRs and to develop a mathematical model to predict both membrane fouling and effluent quality. The focus of this study is the interaction between the MBR biology, membrane fouling and the optimum critical flux for the treatment of a municipal wastewater was determined. A lab-scale MBR reactor was constructed for biological nutrient removal, equipped with a tubular membrane in side-stream configuration. Laboratory-scale tests were performed at two sludge retention time conditions: 15 and 40 d, respectively, while maintaining a hydraulic retention time of 7 h. The sludge obtained from this membrane was used in specifically designed batch experiments to produce biomass associated products (BAP) and utilization associated products (UAP) separately, which allowed their characterisation using a new tool, liquid chromatography—organic carbon detection (LC-OCD). Both BAP and UAP exhibited a very wide molecular weight (MW) distribution. The biopolymer fraction of SMP exhibited a very high 230 MW and a good correlation with MBR fouling. The UAP produced during the biomass growth phase exhibited a lower MW than the BAP, suggesting UAP has a lower fouling potential than BAP. Finally. Based on experimental values from submerged membrane bioreactor and on values predicted by a simulation model generated using the back propagation neural network (BPNN) theory and the MBR-ASM2d model was used to predict the impact of operational parameters on SMP concentration. The results showed that the critical flux measured by the stepwise flux method was almost related to UAP/SMP ratio the optimum critical flux for the treatment of a municipal wastewater were determined. Therefore, it is suggested that the UAP/SMP ratio be used as a new filterability index for SMBR processes in wastewater treatment.

Keywords: Wastewater Treatment; Submerged membrane bioreactor; Soluble microbial products (SMP); Critical flux; Activated sludge model; Back propagation neural network (BPNN)

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