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MODELING AND SIMULATION OF AN ULTRAFILTRATION PROCESS FOR THE REMOVAL OF SUSPENDED SOLIDS AND COLLOIDS FROM WASTEWATER

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Abstract

Mathematical modeling of the ultrafiltration (UF) process is motivated by the complexity of retention phenomena that occur during the UF in conjunction with the complexity of wastewater matrices submitted to ultrafiltration, as well as by the need to predict the process behavior in extreme conditions, such as high pollution loads for UF-membrane cleaning cycles optimization or for automated control of the process. Thus, series of laboratory-scale ultrafiltration experiments were performed with synthetic wastewaters containing suspended solids and colloids onto two tubular polymeric membranes: one made of polysulfone (MWCO 20 kDa), the other made of modified polyethersulfone (MWCO 6 kDa). The experimental results have shown good removal efficiencies for suspended solids and colloids for both the membranes (over 95% for the polysulfone membrane and 100% for the other), as well as completely different hydrodynamic behaviors. The polysulfone membrane had produced high initial permeate fluxes but was readily fouled by the suspended solids and colloids, while the polyethersulfone membrane had significantly lower fluxes, but has shown a very good resistance to fouling. The mathematical model used for the verification of the experimental results was based on the resistance-in-series model and considered, beside the intrinsic membrane resistance, the filtration resistance due to superficial accumulation of the suspended solids and colloids. The model uses an exponential term for cake filtration resistance growth and the experimental data verification was possible by calculating a statistical coefficient through non-linear regression. The mathematical modeling was performed in two ways: for every experiment, as well as by using multiple data sets. The results show that in both cases this model describes very well the UF process for the removal of suspended solids and colloids from wastewaters, although the two membranes present different characteristics and filtration behaviors. The correlation coefficients R were over 0.87, while the determination coefficients R^2 had values of over 0.77. The good modeling results have enabled the use of the model for the simulation of permeate fluxes in extreme conditions which usually are not replicable at laboratory scale. The simulations were performed for very long UF times as well as for very high UF pressures.

Key words: colloids, modeling, resistances-in-series, simulation, suspended solids, ultrafiltration

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