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ORIGINAL PAPER

Comparison of polymeric and ceramic membranes performance in the process of micellar enhanced ultrafiltration of cadmium(II) ions from aqueous solutions

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A comparison of polymeric and ceramic membranes in the ultrafiltration process was studied and presented. This study was conducted on the separation of cadmium(II) ions, with particular reference to parameters such as hydrodynamic permeability coefficient, membrane fouling, amount of surfactant in the permeate, efficiency, and effectiveness of the process. The effect of ionic (SDS) and non-ionic (Rofam 10) surfactants or their mixture was investigated. The hydrodynamic permeability coefficient of the ceramic membrane was found to be much lower in comparison to those of the polymeric ones (1.69×10^{-7} m^3 h^{-1} m^{-2} Pa^{-1}, 5.66×10^{-7} m^3 h^{-1} m^{-2} Pa^{-1}, and 9.26×10^{-7} m^3 h^{-1} m^{-2} Pa^{-1} for ceramic, CA, and PVDF, respectively). However, filtration of the surfactants solutions did not cause permanent blocking of pores and the surface of the ceramic membrane in contrast to the polymeric ones. No significant differences in surfactants permeation through the membranes tested were observed. Concentration of the surfactant in the permeate was lower than 1 CMC for the Rofam 10 solution and exceeded the CMC by about 40 % for the SDS solution. Better separation properties of polymer membranes for the separation of cadmium(II) ions from micellar systems were identified.

Keywords: ultrafiltration, ceramic and polymeric membrane, cadmium(II) ion

Introduction

Traditional methods of elimination or recovery of heavy metals, i.e. cadmium(II) ions, include precipitation, ion exchange, crystallization, evaporation, liquid–liquid extraction (Sadegh Safarzadeh et al., 2007; Staszak et al., 2011), etc. In most cases, the ultimate goal of the recovery process is not metal, but its removal from the effluent. However, the recovery of heavy metals allows their subsequent re-use and thus provides further economic and environmental benefits by contributing to the reduction of costs and saturating the demand for raw materials (Kurniawan et al., 2006).

A promising technique for the decontamination of wastewater containing these metals is the micellar enhanced ultrafiltration (Huang et al., 2009; Juang et al., 2003; Scamehorn et al., 1986) or polymer enhanced ultrafiltration (Cañizares et al., 2008; Palencia et al., 2009; Rivas et al., 2007). Membrane processes provide high permeate flux and high rates of elimination at low costs of energy and mild conditions. In addition, membrane separation can be carried out continuously and it can also be easily combined with other separation techniques. This method is used for the separation of low molecular mass solutes and macromolecules.

Basic idea of micellar enhanced ultrafiltration (MEUF) is that the surfactant solution, with the concentration higher than the critical micelle concentration (CMC), is added to the solution containing the separated compounds (e.g. metal ion, organic materials, or low molecular mass solute). When the

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