ABSTRACT

Specific treatment schemes for three tannery effluent streams namely, pickling, degreasing and fat-liquoring are developed using a hybrid separation process involving gravity settling, coagulation and combinations of membrane based separation processes (e.g. nanofiltration followed by reverse osmosis for the fatliquoring effluent). The developed processes have resulted in substantial decrease in the COD (chemical oxidation demand) values of the final permeate - well within the permissible limit. Once the treatment scheme is established, experiments are carried out in cross flow mode in three flow regimes (laminar, turbulent and laminar regime with turbulent promoters) to observe the effects of various process parameters. Steady state models for flux and separation are formulated by combining osmotic pressure, film theory and solution-diffusion models. Physically consistent values of important transport parameters (namely, effective osmotic coefficient, solute diffusivity and solute permeability) are estimated using a numerical optimization technique. The numerical solutions of the model equations coupled with the experimental data add valuable insights to the process involving leather plant effluent - a complex mixture of several compounds.

Two flux enhancement techniques (besides the use of turbulence promoters), namely air-sparging and plasma treatment are successfully used to overcome the decline in process flux as well as detoriation in permeate quality due to concentration polarization. The use of air-sparging to reduce deposition on the membrane during ultrafiltration and nanofiltration has been studied first with a model solute (pectin) and finally with the degreasing effluent. Argon–oxygen ($Ar–O_2$) plasma treatment of polyethersulfone (PES) membranes is carried out to enhance the hydrophilicity of the membranes leading to less deposition of solute particles and subsequent flux enhancement. The enhanced hydrophilicity and flux enhancement of the plasma treated membranes are quantified by contact angle measurements and experiments with a model solute. The deposition thicknesses on the membrane surfaces are optically quantified and are correlated to permeate flux enhancements.

Key words: Membrane separation processes, Tannery effluent, Flux enhancement, Air-sparging, Plasma treatment, etc.