ABSTRACT

This Doctoral Thesis studies the ultrafiltration process by utilizing ceramic membranes for the treatment of wastewaters from textile industry, as a stage prior to nanofiltration process, aiming at its reuse. In particular, the study has focused on membrane fouling under different operating conditions: transmembrane pressure (PTM), cross-flow velocity (VT), feed composition, pH, temperature and molecular weight cut off of the membranes. To that end, synthetic effluents of different complexity simulating real effluents have been used. In this way, it becomes easier to study the fouling mechanisms involved and the interactions existing between solutes and with the membranes.

In this study, it has been verified that certain operating conditions (high PTM, MWCO, organic matter and salt concentration, as well as low VT) enhance membrane fouling and decrease the rejection of solutes. Similarly, other parameters such as temperature or pH significantly affect membrane performance. However, it has been observed that not only do operating conditions influence the effectivity of the process, but also electrostatic interactions solute-solute and membrane-solute play an important role regarding membrane fouling and selectivity. In the UF stage, COD is notably reduced, color is fairly removed and salt rejection is negligible. The obtained permeate must be subjected to a subsequent NF or RO treatment, depending on the quality required, before its reuse in the textile process.

The study has been supplemented with the assessment of a nanofiltration stage for the direct treatment of several synthetic effluents by means of two ceramic membranes with different MWCO and material. It has been observed that membrane performance is influenced by both the pore size and the material. At this stage, a colorless permeate stream, free of organic matter and rich in salt is obtained with the lower MWCO membrane. This permeate is suitable for its reuse in the textile process.

In addition, a cleaning protocol for the recovery of the initial membrane permeability after fouling has been developed and validated by means of flux measurements and microscopy analyses. Furthermore, the operating conditions of a mechanical cleaning procedure involving the use of ultrasound have been optimized through a statistical study.