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Catarino, Mendonça, Picado *et al.*

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Membrane-based treatment for tanning wastewaters

Justina Catarino
INETI- Instituto Nacional de Engenharia, Tecnologia e Inovação, Estrada do Paço do Lumiar, 22, 1649 038 Lisboa, Portugal

Elsa Mendonça
INETI- Instituto Nacional de Engenharia, Tecnologia e Inovação, Estrada do Paço do Lumiar, 22, 1649 038 Lisboa, Portugal

Ana Picado
INETI- Instituto Nacional de Engenharia, Tecnologia e Inovação, Estrada do Paço do Lumiar, 22, 1649 038 Lisboa, Portugal

Ana Lança
INETI- Instituto Nacional de Engenharia, Tecnologia e Inovação, Estrada do Paço do Lumiar, 22, 1649 038 Lisboa, Portugal

Luis Silva
INETI- Instituto Nacional de Engenharia, Tecnologia e Inovação, Estrada do Paço do Lumiar, 22, 1649 038 Lisboa, Portugal

Maria Norberta de Pinho
IST- Instituto Superior Técnico, Av Rovisco Pais, 1049 001 Lisboa, Portugal

Tanning wastewater was subjected to different unit operations to select the best treatment sequences. Textile membrane filtration (TMF), microfiltration (MF), and ultrafiltration (UF) were complemented by screening, flocculation or flotation operations. The general chemical characterization determined that the wastewater had a high organic load. The ecotoxicological study classified the wastewater as highly ecotoxic. The sequence of screening–TMF–UF was found to be the optimal treatment for wastewaters of the first and second soaking stages, while the sequence of screening–TMF–flotation–UF proved to be adequate for the liming wastewater concerning productivity and water quality. Larger pore sizes MF membrane or higher molecular weight cut off (MWCO) UF membranes with higher permeability to pure water showed lower permeation fluxes for tanning wastewater. After membrane treatments, a decrease in the ecotoxicity was measured. The use of membrane treatment technology showed to be promising in removing organic pollutants and allowing the reuse of water and chemicals in the process.

Introduction

The tanning industry that converts animal skins into leather is highly demanding in terms of water and chemical usage and produces wastewaters that need a complex decontamination process before being discharged (Sengul and Gurel 1993; Ates *et al.* 1997). Alternatively, the adoption of a cleaner production strategy for this industry, aiming at the recovery of process water and chemicals, is of major environmental and economical importance (Kryger 1995; Viero *et al.* 2002).

The tanning process can be divided into three main phases: beamhouse (for the cleaning of the raw hide, rehydration, and preparation), tanning (irreversible collagen structure modification by the action of tanning agents), and finishing (final operations such as bleaching, stuffing and fat-liquoring and colouring) (Nemerow 1978). In general, beamhouse phase (Fig. 1) includes soaking (desalting, cleaning, and rehydration), liming (treatment with sulphide and lime milk for unhairing), washing (rinse with water and sodium bisulphide), deliming (lime removal with water, organic acids, and ammonium salts), "purge" (enzymatic treatment), and bating (hides preparation for tanning with salt and acids).

Membrane processes, namely pressure driven, are the best available technologies for water recovery. Among these, microfiltration (MF) and ultrafiltration (UF) have been described for organic matter removal in wastewater (Aloy and Vulliermet 1998). It is important to address the issue of chemical and ecotoxicological assessment of the different treatment processes efficiency.

Considering that the colloidal character of the organic matter causes fouling and has adverse effects on membrane operation, the main objective of the present work is the integration of MF and UF with previous screening, Textile membrane filtration (TMF), flocculation, and flotation to minimize fouling, yielding maximal flux productivity and a permeate water complying with process water quality requirements (Soffer *et al.* 2000; Minhalma and Pinho 2001; Abdessemed and Nezzal 2003).

The optimization of an integrated sequence of pretreatments–TMF–MF–UF was investigated for the treatment of wastewaters from the three first stages of the tanning process (Fig. 1) for on-site recycling of water and chemicals. Due to the high organic load, the use of tangential microfiltration and ultrafiltration has to be complemented with other operations to minimize the membrane fouling. Although MF membranes appear to be the better solution due to higher pure water fluxes, when processing effluents with colloidal organic matter flux declines as a result of fouling. It was mentioned that this problem could be attenuated by using smaller pore size membranes (Brites Alves and Norberta de Pinho 2000; Minhalma and Pinho 2001).