SEPARATION OF THE CHROMIUM(III) PRESENT IN A TANNING WASTEWATER BY MEANS OF PRECIPITATION, REVERSE OSMOSIS AND ADSORPTION

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***Abstract*— The separation of the chromium(III) dissolved in a tanning wastewater was studied by means of precipitation with calcium carbonate, reverse osmosis with polyamide membrane and adsorption on activated carbon. All tests were carried out at laboratory scale with a wastewater obtained from a unique typical tannage process. In a first stage, the original effluent was treated by sieving and ultrafiltration to perform a partial removal of fats and denaturalized proteins. The separation of chromium(III) by precipitation, reverse osmosis and adsorption was performed with the tanning wastewater so treated. The precipitation efficiency was determined by taking into account the chromium(III) content of the supernatant with the reaction time and with the alkali amount added. The polyamide membrane behavior used was established by the permeate flux and by the rejection of each species. The adsorption valuation involved the determination of the adsorbed amounts of chromium(III), sodium, chloride and sulfate. Under optimum conditions established for each process, the following results were obtained: a supernatant with less than 3.0 mg L^{-1} of chromium(III) by precipitation, a permeate with less than 2.0 mg L^{-1} of chromium(III) by reverse osmosis and an equilibrium solution with less than 6.0 mg L^{-1} of chromium(III) by adsorption. To conclude, the main physicochemical characteristics of the three processes used to remove chromium(III) dissolved in the industrial effluent were analyzed.**

***Keywords*— chromium(III); tanning wastewater; precipitation; reverse osmosis; adsorption.**

I. INTRODUCTION

The separation of chromium(III) dissolved in a tanning wastewater and the subsequent discharge of the effluent treated are complementary activities in the leather industry that demand a very important attention of the productive sector (Heidemann, 1993; Alexander *et al.*, 1992; Rutland, 1991; Prasad, 1991; Bienkiewicz, 1983). The environmental impact produced by the chromium discharge from tanneries has been subject of extensive scientific and technical dispute, without the existence of a unique criterion at the present time for fixing regulatory limits. Thus, diverse countries of the world have established total chromium maximum values that vary between 0.05-10 mg L^{-1} for discharges into water bodies (direct discharge) and 1-50 mg L^{-1} for discharge into sewage systems (indirect discharge) (Bosnic *et al.*, 2000).

Besides the place in which the discharge of liquid effluents containing chromium is made, it results useful to consider the metal oxidation state. Although chromium(III) oxidation to chromium(VI) occurs under environmental specific conditions (Milaĉiĉ and Stupar, 1995; Eary and Rai, 1987; Bartlett and James, 1979), special attention is devoted to this transformation because chromium(VI) causes adverse effects for the human health (Committee on Biologic Effects of Atmospheric Pollutants, 1974). Even when the tanning wastewater has chromium only in trivalent form since the tannage process does not generate chromium(VI), some countries fixed regulatory limits for the two species. This criterion appears from the assumption that the oxidation would be produced during storage and subsequent treatment of the liquid effluent to reduce its total chromium content. In Buenos Aires Province, Argentine district with an important activity of tanneries, maximum values established are the same for both types of discharge but they differ with the oxidation state: 0.2 mg L^{-1} for chromium(VI) and 2.0 mg L^{-1} for total chromium.

The most important processes to remove the chromium(III) from the tanning wastewater are: precipitation, reverse osmosis and adsorption. The chromium(III) precipitation is frequently carried out in tanneries. Substances used habitually to promote the precipitation are: calcium hydroxide, sodium hydroxide, magnesium oxide or calcium magnesium carbonate. The liquid effluent is heated at 60-90 °C and after the addition of the alkaline substance (denominated in generic form "alkali") it is maintained with stirring at pH 7.0-9.0. With this methodology, a supernatant free of chromium(III) (with abundant calcium/sodium or magnesium chloride) and a precipitate of chromium(III) hydroxide (containing diverse impurities) are obtained.

The added alkali determines the formation of reaction products that affect the later chromium(III) reuse. When the precipitation is carried out with calcium hydroxide (or carbonate), the sulfate present in the tanning wastewater is combined with the alkaline cation to form calcium sulfate. The anion of the organic acid (formic,