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Electrochemical Oxidation of Simulated and Real Cr(III) Tannery Wastes on PbO_2 Electrodes †

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Abstract: Tannery bath effluents contain significant amounts of unused Cr compounds (30-40% of the original concentration) [1], where Cr(III) naturally oxidizes to the more toxic Cr(VI), whose bioaccumulation is harmful to live organisms [2]. The reduction of Cr(VI) wastes to Cr(III) has been thoroughly investigated [3], contrary to the respective oxidation, where Cr(III) oxidation is mostly carried out by the Fenton process [4, 5]. Electrochemical waste oxidation on PbO_2 electrodes has been used for nitrates [6], phenols [7], and Cr(III) [8] as an alternative to the Fenton process. In this work, we studied the electrochemical oxidation of Cr(III) in a batch reactor using PbO_2/Pb (prepared by potentiostatic anodization, E=1.95 V vs. SCE), PbO_2/Graphite, and PbO_2/Ti (galvanostatic PbO_2 anodic electrodeposition, j=2.5 mA cm^{-2}) electrodes. The catalysts were characterized and compared by cyclic voltammetry, verifying that PbO_2 catalyzes Cr(III) oxidation over the competing Oxygen Evolution Reaction. The bulk oxidation of real Cr(III) waste took place in a batch reactor under different conditions (i=0.5, 1 A, pH 0, 1.27, 3). The PbO_2/Graphite and PbO_2/Ti electrodes yielded minimal oxidation of Cr(III), with the adhesion of the PbO_2 being better on the Ti substrate, while the PbO_2/Pb electrocatalysts demonstrated the most satisfying conversions of 19% (applied current 0.5A, pH=1.27, 8 hours of consecutive electrolysis). Electrochemical Cr(III) oxidation on PbO_2 electrodes can result in effective tannery waste treatment for Cr(VI) production to be reused in other industrial processes, with the PbO_2/Pb electrocatalysts yielding the most satisfactory conversion. Furthermore, for higher pH values, the conversion took place more efficiently.

Keywords: electrochemical waste treatment; trivalent chromium oxidation; electrochemical oxidation; lead dioxide; bulk electrolysis.

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Conflicts of Interest

The authors declare no conflict of interest.

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