Evaluation of electro-oxidation, electrocoagulation, Fenton, electro-Fenton and photoelectro-Fenton methods for treatment of tannery effluents

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Tannery effluents, which are difficult to biodegrade, have been detected in surface water, and in influents and effluents of wastewater treatments plants where removal rates as high as 75 and 92% have been achieved depending on the methods used [1].

Complete removal of these pollutants from the aquatic environment is necessary to prevent their possible hazardous health effects on living beings and the environment. In this work, we present a detailed study on the degradation of tannery effluents by means several systems such as Fenton (F), electrocoagulation (EC) [2], electro-oxidation (EO) [3], electro-Fenton (EF) [4], and photoelectro-Fenton (PEF) methods [5]. Some of these electrochemical advanced oxidation processes (EAOPs) are based on the generation of the hydroxyl radical ($^{\bullet}OH$).

In the Fenton's reaction, the pollutants are removed by radical $^{\bullet}OH$ formed from added Fe^{2+} and H_2O_2. In the electro-oxidation method, the radical $^{\bullet}OH$ is formed from water discharge at the surface of the anode. With EF, the organic matter is then removed by Fenton's reaction between catalyst Fe^{2+} and electrogenerated H_2O_2 that is continuously supplied from the two-electron reduction of O_2 on a boron diamond doped (BDD) cathode. In PEF, the solution is directly irradiated with a 6 W UVA light to photolyze complexes of Fe(III) with contaminants, thus increasing their degradation rate.

Under these conditions, the organic matter is oxidized by the hydroxyl radical in the bulk. Experiments were carried out with 250 ml of tannery effluent containing up to 1800 mg L^{-1} of total organic carbon (TOC) at pH 3 and 25 ºC.

Contaminants were degraded in an electrolytic cell composed of a pair of electrodes, with areas of 7.6 cm^2, connected to a power source. The Fe or BDD anode and Fe or BDD cathode, passed a current density (j) < 66 or 111 mA cm^{-2}.

The influence of methods on total organic carbon removal was studied, with higher degradation found for the photoelectro-Fenton treatment after 180 min. The oxidation power of chemical and electrochemical methods increases in the order: Fenton < electro-oxidation < electro-Fenton < electrocoagulation < photoelectro-Fenton.

PEF had the greatest oxidation power due to photodegradation of Fe(III)-complexes under UV light. It should be mentioned that all pollutant decayed obeying pseudo first-order kinetics for the electrochemical methods.

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