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Simultaneous removal of hexavalent chromium and COD from industrial wastewater by bipolar electrocoagulation

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ABSTRACT

The purpose of this study is to remove hexavalent chromium and COD from wastewater by electrocoagulation. The experiments were carried out in an electrochemical reactor using iron sacri ficial electrode. Operating parameters such as current density (100, 150, 200 A/m²), pH of the effluent, number of electrodes and their materials were studied. The optimal operating conditions were determined and applied to the process. The results show that this process of removal can reduce chromium (VI) into chromium (III) with an output of 100% and 95.95% of COD in a relatively short reaction time and at low cost.

1. Introduction

Toxic metal species are some of the most common pollutants that are found in industrial wastewaters. They pollute the environment and have negative effects on human health. Because of their toxicity, the prevention of environmental pollution has been studied actively [24].

One such toxic metal, chromium, is abundantly available in nature; the most common forms of chromium are trivalent chromium [Cr (III)] and hexavalent chromium [Cr (VI)], which are commonly used in various industrial processes.

The hexavalent chromium is considered harmful even in small dose; whereas, Cr in oxidation state 3+ is considered essential for good health in moderate dose. Hexavalent chromium (VI) is extremely labile in the biological system and it can easily pass through cell membranes, often via sulphate transport system [22,6] which makes is very harmful to human.

In aqueous phases, the hexavalent chromium exists as monomeric ions H_2CrO_4, $HCr_2O_4^-$ (bichromate), and CrO_4^{2-} (chromate), or as a dimeric ion $Cr_2O_7^{2-}$ (bichromate). The monomeric species give a yellow color to the water when the [Cr (VI)] is greater than 1 mg/L [8,15].

Conventional chromium removal methods include adsorption [18,28,27], chemicals precipitation [25,13,14], biological degradation [29], and ions exchanges [7,23]; these techniques are limited to selective separation and they are associated with high investment and operation costs [31], the reason for why they are more and more less used.

Recently, an electrochemical technique called electrocoagulation has a significant role in chromium removal due to its operational simplicity. This process does not require additional chemical products due to the oxidation and reduction of reactions which take place [32–34].

The results of the present study and other related studies that have been conducted in the field show that electrocoagulation process is used to remove the majority of toxic metals (Fig. 1). Some investigators have observed that aluminum electrodes were almost effective for Cr (VI) removal [1,16,26].

Electrocoagulation was used to separate some toxic metal ions such as iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), lead (Pb) and

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