



Comparing the efficacy of a novel waste-based adsorbent with PAC for the simultaneous removal of chromium (VI) and cyanide from electroplating wastewater

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A B S T R A C T

The potential of powdered pistachio hull (PHP) for the co-adsorption of Cr(VI) and cyanide from electroplating wastewater was compared to that of powdered activated carbon (PAC). The results of dynamic adsorption experiments indicated that the complete and simultaneous removal of Cr(VI) and cyanide from wastewater was achieved with 2 g/L of PHP after 60 min of contact. Alternatively, with PAC, 69.2 and 77.8% of Cr(VI) and cyanide, respectively, were removed under the same conditions. Adsorption of Cr(VI) and cyanide by PHP and PAC followed pseudo-second order kinetics, and the equilibrium adsorption data best fit the Langmuir isotherm. The maximum capacity of PHP for the co-adsorption of Cr(VI) and cyanide was 117.6 and 151.5 mg/g, respectively, and the maximum capacity of PAC for the adsorption of Cr(VI) and cyanide was 47.6 and 39.4 mg/g, respectively. It was found that which intraparticle diffusion controlled the adsorption of Cr(VI) and cyanide onto PHP and PAC under the selected conditions. Overall, PHP efficiently adsorbed Cr(VI) and cyanide from industrial effluents; thus, PHP is an affordable and cost-effective system for the treatment of wastewater.

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1. Introduction

The electroplating industry generates wastewater with high concentrations of cyanide ions and various heavy metals (Monser and Adhoum, 2002; Srisuwan and Thongchai, 2002); thus, the control of pollutants from the effluent of the electroplating industry is important for preserving human and environment health. Hexavalent chromium (Cr(VI)) and cyanide are among the most toxic compounds in electroplating baths and wastewater. Namely, exposure to Cr(VI) and/or cyanide causes adverse health effects in humans and other organisms (Dash et al., 2009; Rao and Rehman, 2010); therefore, these contaminants must be separated from electroplating industrial effluents before being discharged into the environment.

Several techniques have been investigated for the removal of Cr(VI) and cyanide as separate contaminants in aqueous and industrial wastewater. The most common method for the removal of Cr(VI) is the acidic reduction of Cr(VI) to

Cr(III) and subsequently as chromium hydroxide (Módenes et al., 2010). Alternatively, alkaline chlorination/oxidation and chemical precipitation are conducted to remove cyanide from wastewater (Marder et al., 2004). Conventional methods of Cr(VI) and cyanide removal have several drawbacks including the generation of hazardous sludge, which is difficult to handle and discard, using chemicals to regulate the pH, to reduce Cr(VI) and oxidize cyanide, as well as to produce metal; thus, multiple reactors are needed to process the sludge. However, when Cr(IV) and cyanide are present in wastewater, the removal of Cr(VI) and cyanide with conventional techniques is more complex because the reduction of Cr(VI) to Cr(III) is conducted under acidic conditions (pH ~ 3), and the chlorination of cyanides requires alkaline media (pH ~ 10).

Due to the aforementioned limitations, conventional techniques are not attractive for the treatment of industrial effluents containing Cr(VI) and cyanide. Therefore, a novel and efficient treatment method for the simultaneous removal

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