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Combining adsorption on activated carbon with electrocoagulation process for copper removal from used water

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ABSTRACT

In this work, electrocoagulation (EC) combined to adsorption onto granular activated carbon (GAC) was studied for the removal of copper ions. EC process was firstly optimized. The effect of the main parameters such as: pH (4–8), electrolysis time t_{EC} (5–60 min), current density j (0.277–1.388 $mAcm^{-2}$), conductivity, inter-electrode distanced$_{ie}$(0.5–2 cm), area volume ratio S/V (3.6–14.4 m^{-1}), initial concentration (10–70 mgL^{-1}), stirring speed (0.0–600 rpm) and the mode of connection (bipolaire-monopolaire) on copper removal were explored. Under optimum conditions (pH = 5.0, J = 1.388 mA cm^{-2}, t_{EC} = 30 min, d_{ie} = 1 cm, S/V = 7.2 m^{-1}, stirring speed = 300 rpm and monopolaire connection) 97% copper removal was achieved with an energy consumption of W = 0.065 KW hm^{-3}. Combining adsorption on GAC with EC notably reduces the electrolysis required time inducing a strong decrease of energy consumption. The removal of copper from industrial waste water showed the advantage of combining adsorption on GAC with EC in order to reduce the processing time and thus the process energy cost.

Keywords: Electrochemistry; Electrocoagulation; Copper removal; Adsorption onto granular activated carbon

1. Introduction

Heavy metals are the most toxic mineral pollutants which are mutagenic, carcinogenic … [1,2]. Copper is one of vital element for human. However, if it consumed in surplus amounts, copper can be toxic, and even deadly to organisms [3,4]. For the United States Environmental Protection Agency (USEPA) the highest contaminant concentration for Cu (II) in industrial effluent was fixed at 1.3 mg L^{-1} [5]. For these purposes, the removal of excess copper from water and wastewater is imperative for saving public health and the environment. Various methods have been used to remove copper ions from water and wastewater including chemical coagulation, biological treatment, adsorption, ultrafiltration, ion exchange and electrocoagulation … [6].

Recent researches reported that EC and adsorption are the most favorable methods for metals ions removal due to convenience, easy operation, compact treatment,simplicity of design and environmental compatibility [7]. Furthermore, the search for cheap treatment methods has led to the development of combined processes.

EC is an electrochemical process consisting of forming metallic hydroxide flocks within the wastewater by electrodissolution of sacrificial anodes. The generation of metallic cations takes place at the anode (usually made of iron or aluminum) due to the electrochemical oxidation, whereas at the cathode the production of H_2 typically occurs [8]. When metal ions are neutralized with ions of opposite electric charge provided by an EC system, they become unstable and precipitate in a settled form [9]. These insoluble metal hydroxides react with the suspended and/or colloid solid-sand precipitate.

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