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Adsorption of hexavalent chromium on *Arundo donax Linn* activated carbon amine-crosslinked copolymer

Yuanyuan Sun, Qinyan Yue *, Baoyu Gao, Yuan Gao, Qian Li, Yan Wang

Shandong Provincial Key Laboratory of Water Pollution Control and Resource Reuse, School of Environmental Science and Engineering, Shandong University, Jinan 250100, China

HIGHLIGHTS

- *Arundo donax Linn* activated carbon (AC) was prepared with $H_4P_2O_7$ activation.
- AC—EDT was prepared by grafting amine-group onto AC.
- AC—EDT had better chromium adsorption performance than AC.
- The XPS analysis was used to confirm the adsorption/transformation mechanism.

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ABSTRACT

A composite sorbent (AC—EDT) was prepared by grafting amine-group onto activated carbon (AC). Both raw AC and AC—EDT were characterized by scanning electron microscopy (SEM), Fourier transformed infrared (FTIR) and X-ray photoelectron spectroscopy (XPS). Batch experiments with variable pH, time, and concentrations of Cr(VI) were conducted to evaluate the sorption performance of Cr(VI) by both adsorbents from aqueous solutions. The total chromium in the aqueous solution was also recorded to study the mechanism of adsorption/transformation of Cr(VI). The ratio of the amount of Cr(VI) to Cr(III) on the sorbent was confirmed by the XPS analysis results. Langmuir, Freundlich and Temkin adsorption isotherms were used to fit the experimental equilibrium data and values of the parameters of the isotherms were reported. When compared with the untreated activated carbon, the modified activated carbon provided more faster kinetics and the sorbent exhibits greater adsorption capacity for chromium(VI) by comparing the maximum adsorption capacity calculated by Langmuir model. Overall, AC—EDT can effectively remove Cr(VI) from aqueous solutions under a wide range of experimental conditions.

1. Introduction

Chromium and its compounds produced in leather tanning, plating, cement, dye, and photography industries [1] are becoming severe environmental and public health problem. It exists in trivalent Cr(III) and hexavalent Cr(VI) from, both of which are oxidation states in aqueous systems [2]. The Cr(VI) form of chromium has gain more attention because of its greater toxicity [3,4]. The presence and accumulation of Cr(VI) in industrial effluents have a carcinogenic and mutagenic effect on human living [5]. In China, the maximum levels permitted for total chromium are 0.5 mg/L and for hexavalent chromium are 0.2 mg/L to meet wastewater emission standard. The widely used methods to remove Cr(VI) from wastewater include adsorption [3], membrane filtration [6], chemical precipitation [7], reduction, ion exchange [8] and biosorption treatment [9]. As an economical and efficient method for pollutants in aqueous solution, adsorption technique has been widely applied.

Because of its large specific surface area and surface active adsorption sites, activated carbon is a conventional adsorbent and has been applied for Cr(VI) adsorption [10,11]. The interaction of Cr(VI) with activated carbon involves three steps: sorption of Cr(VI) onto carbon surface, transformation of Cr(VI) to Cr(III), and reduced Cr(III) potential release back into the solution or adsorption onto the carbon surface [12]. However, the adsorption of Cr(VI) on activated carbon was less effective and nonselective. Apart from specific surface area, the surface chemistry of activated carbon has a significant influence on its capacity to adsorb inorganic pollutants, especially metallic cations. Thus, many researches have appropriately modified activated carbon by physical or chemical treatments to increase their adsorption capacity for metal ions.

Coating or grafting an ion exchanger onto various sorbents was commonly used to improve the physical and chemical properties of a sorbent. The advantages of activated carbon such as large specific

* Corresponding author. Tel.: +86 531 88365258; fax: +86 531 88364513.
E-mail address: qyyue58@yahoo.com.cn (Q. Yue).

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