Adsorption of copper(II) and zinc(II) ions from aqueous solution by activated carbon derived from halophytes (*Suaeda maritime*)

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**Abstract**

Sample of a halophytes activated carbon (ACHs), *Suaeda maritime*, has been carbonized after impregnating with H₃PO₄. Batch adsorption technique was employed for the metal ions biosorption onto ACH2 in a single component system. The activated carbon prepared was characterized by SEM, XRD, FTIR analysis and also ash content, bulk density, moisture content, BET surface area and porosity analysis, were carried out. The influence of pH, contact time, initial metal ions concentration and temperature on metal sorption capacity have been examined. The maximum sorption capacities calculated by applying the Langmuir isotherm were 29.41 mg/g for Cu, and 14.64 mg/g for Zn, respectively. Thermodynamics and kinetic adsorption of two metal ions were examined in batch experiments. It was verified that the Freundlich, Langmuir and Temkin isotherms describe the adsorption of Cu(II) and Zn(II) ions reasonably well. Adsorption of Cu(II) and Zn(II) ions onto ACH2 was better fitted to Freundlich isotherm model. According to the obtained thermodynamic data, the adsorption of Cu(II) and Zn(II) ions onto ACH2 were spontaneous and an endothermic processes with large adsorption enthalpy. The kinetic study showed that the whole adsorption process fit the pseudo-second-order kinetics model well. The kinetic data confirmed that particle diffusion is not the only rate-limiting step in the adsorption process.

**Keywords:** Halophytes; Sorption; Batch adsorption; Activated carbon; Thermodynamics

1. Introduction

Heavy metals such as copper and zinc are among the most toxic and easily encountered metals released into the environment through various industrial activities, consumer products, and waste disposal [1]. As such, they are stable elements and can't be degraded biologically by the body. They can be passed into the food chain to humans via wastewater from industrial and domestic activities. Heavy metals are taken into the body via inhalation, ingestion, and skin absorption. Heavy metal pollution may be occurred due to irrigation with contaminated water, the addition of fertilizers and metal-based pesticides, industrial emissions and transportation. Food and agriculture organization (FAO) recommended the maximum acceptable concentration of copper and zinc in irrigation water as 0.2 and 2.0 mg L⁻¹, respectively [2,3].

Several technologies were available to remediate heavy metals pollution. However, many of these technologies were costly or not achieve a long-term nor an aesthetic solution [4,5]. Till now, treatment of industrial effluents containing heavy metals as copper and zinc is mainly based on precipitation, coagulation, ion exchange, membrane filtration and electroplating. These processes are usually expensive and sometimes ineffective, especially when the concentration of heavy metals is low [6]. Adsorption had been investigated as an efficient technique for the removal of heavy metals from wastewater. Among these methods, carbon adsorption was the most widely used absorbent materials because of its simplicity and economic feasibility. It has also been shown that adsorption is one of the most effective removal...