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Cadmium(II) sorption and desorption in a fixed bed column using sunflower waste carbon calcium–alginate beads

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HIGHLIGHTS

- We studied removal of cadmium from wastewater by column mode by a new adsorbent.
- Sunflower plant biomass has been converted into calcium–alginate beads.
- The metal removal is dependent on bed height, flow rate and metal concentration.
- The column can be used for three cycles.

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ABSTRACT

The present study reports the use of sunflower waste carbon calcium–alginate beads (SWC-CAB) for cadmium removal from wastewater in continuous flow fixed bed columns. The experiments were conducted as a function of bed height, flow rate and initial Cd(II) concentration. The maximum biosorption capacity (23.6 mg/g) was attained at 30 cm bed height, 1.0 mL/min flow rate and 10 mg/L initial Cd(II) concentration. The Bohart – Adams model constants (N_0 and K) were 7.7 mg/L and 1×10^{-4} L/mg h with 0.999 R^2 value at 50% breakthrough time. The column regeneration efficiency after third cycle was 58.6% for cadmium.

1. Introduction

Cadmium is one of the six substances banned by European Union Restriction on Hazardous Substances (RoHSs) directive which bans carcinogens in computers. The International Agency for Research on Cancer (IARC) has classified cadmium as the most probable carcinogen to man (The International Agency for Research on Cancer, 1974). It is one of the toxic heavy metals that cause damage to kidney and bones (Volesky, 1990). It causes various types of acute and chronic disorders like pulmonary odema, erythrocyte destruction, skeletal deformity, salivation, weakness, pulmonary problems, renal damage, emphysema, *itai-itai* disease (Friberg et al., 1986). In humans, overdose of cadmium in kidney releases proteins into urine thus disrupting the protein metabolism (Waalkes, 2000). Therefore, cadmium being a threat to living organisms has to be eliminated from industrial wastewaters before discharging it into the environment.

Cadmium is released from various industries like electroplating, paints and pigment, silver-cadmium and cadmium–nickel batteries, phosphate fertilizer, mining and alloy industry (Riihimaki, 1972). Hence, it is important to remove cadmium from wastewaters before discharging it into aqueous bodies. Various technologies employed for treatment of wastewaters containing cadmium are chemical precipitation, ion exchange, solvent extraction, membrane technologies. But these technologies are uneconomical and are incapable of meeting strict water quality standards currently being imposed by public health authorities. Biosorption has emerged as a potential technology employing bacteria, fungi, algae, agricultural waste, etc. and has proved efficient and cost effective in wastewater treatment. Recently, researchers have focused on agricultural wastes which are cost effective, environment friendly and abundantly available. Sunflower (*Helianthus annuus*) is one such agricultural waste material which has been used in this study for removal of cadmium from wastewater. It was chemically

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