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Hotel Sewage Sludge Derived Biochar as an Adsorbent for Aqueous Cadmium Removal

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Abstract

The hotel industry is considered to be one of the main sources of sewage sludge. Sewage sludge (by-products) of wastewater treatment is considered as water, inorganic and organic materials removed from wastewater. These by-products coming from various sources through physical, chemical, and/or biological treatments. Cadmium is a non-essential heavy metal available in water sources accumulated through both natural phenomena and anthropogenic activities. Direct and indirect accumulation of Cadmium in tissues through food and drinking water causing various diseases and disorders. Thus, developed biochar from hotel sewage sludge Sri Lanka and its applicability to remove aqueous Cadmium ions was studied. In this study, the biochar was synthesised pyrolsing the sewage sludge in a muffle furnace at 450^{o} C. To maintain an oxygen-free atmosphere during the process, nitrogen was supplied to the system at a 200 mL/min flow rate. The temperature increase rate was set at 17^{o} C/min. The pH, EC, total solid (TS), total fixed solid (TFS), and total volatile solids (TVS) were determined in sewage sludge. Then the synthesised biochar was characterised by X-ray diffraction (XRD), particle size analyser, and scanning electron microscopy (SEM). Furthermore, the Cadmium removal efficiency of synthesised biochar was tested with different concentrations of Cadmium solutions, pH levels, adsorbent dosages, and contact times. Atomic adsorption spectroscopy was used to analyse the Cadmium concentrations in water samples. The results were, pH (5.46), EC (1270 µs/cm), TS (55 mg/mL), TFS (14 mg/mL) and TVS (41 mg/mL). The maximum Cadmium removal percentage of 100% was obtained with 8 pH, 50 mL of 25 mg/L Cadmium solution, and 0.150 g of the synthesised biochar. Adsorption data were fitted with the Langmuir adsorption isotherm model and adsorption kinetics were fitted with a pseudo-second-order model with R^2, 0.9924. The study presents a viable option for removing Cadmium ions in water to desirable levels as a means for controlling Cadmium related health issues while sustainably controlling the sewage sludge.

Keywords: Adsorption, Biochar, Heavy metal, Sewage sludge