PERSPECTIVE

Sulfur doped binary layered metal oxides integrated on activated carbon derived from pomegranate peel for heavy metal ion removal

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ABSTRACT

In this study, a unique biomass adsorbent based on activated carbon was combined with sulfur based binary metal oxides layered nanoparticles, including Sulphur (S_2), Manganese (Mn), and Tin (Sn) oxide. Utilizing FTIR, FESEM, EDX, and BET, the freshly synthesised SML-AC was examined to ascertain its functional groups, surface shape, and elemental makeup. In order to properly perform the BET, the particular surface areas for raw AC (356 m^2 g1) and modified AC-SML (195 m^2 g1) were used. The proposed nanocomposite was employed as an effective adsorbent to remove Lead (Pb^{2+}), Cadmium (Cd^{2+}), Chromium (Cr^{3+}), and Vanadium (V^{5+}) from oil rich locations to prepare water samples for ICP-OES analysis.

Keywords: Biomass; Food waste; Removal; Heavy metal ions; Nanocomposite; Layered metal–sulphur

INTRODUCTION

In items made by the oil industry, heavy metal ions are usually found. Heavy metal ions include those for Vanadium (V^{3+}), Lead (Pb^{2+}), Chromium (Cr^{3+}), and Cadmium (Cd^{2+}). Many different processes, such as oil processing (extraction, shipping, and storage), mining, and other activities, present significant opportunities for these metal ions to enter groundwater, surface water, and drinking water; as a result, the risk posed to the environment as well as to human health is increased. Trace levels of heavy metals are needed for metabolic processes in order to prevent illnesses and syndromes in humans. Because of this, it's crucial to check for and remove heavy metal ions from environmental water supplies. The permitted concentrations of Cd^{2+}, Cr^{3+}, Pb^{2+}, and V^{5+} in drinking water have been set at 5 g/L, 50 g/L, 10 g/L, and 100 mg/L, respectively. Several techniques have been used to remove heavy metal ions from water samples, including bioremediation, electrocoagulation, reverse osmosis, oxidation, filtration, nanofibrous membrane, biochar, and adsorption. Each of these techniques has a variety of advantages and disadvantages. Hazardous waste is produced by chemical precipitation, secondary pollution is produced by photo catalysis and reverse osmosis, and modern technology is needed for ion exchange and filtering, to name a few. Additionally non-regenerative is oxidation. Both membrane technology and electrocoagulation are complex procedures that produce undesirable sludge. Despite being a solution that is known to be secure, bioremediation is expensive and cannot be used in harsh environments. Adsorption based technologies for water treatment, particularly for the removal of heavy metal ions, continue to pique the interest of researchers due to its many benefits. These benefits include not introducing secondary contaminants into the environment, being affordable, regenerable, requiring less sophisticated equipment, and having a high adsorption capacity. Various micro/nanoscale materials, such as biomass, montmorillonite, carbon based materials, polymers, metal organic frameworks, and metal oxides, have been used to make adsorbents for removing heavy metal ions.

DESCRIPTION

The majority of suggested materials have shortcomings such high cost, instability, insufficient sorption capacity, ineffective removal efficacy, poor selectivity, and the production of secondary pollutants. A highly porous adsorbent called Activated Carbon (AC) is employed in the adsorption process to reduce air and water pollutants. This is due to the cationic and anionic natures, high surface area, cost effectiveness, quick biodegradability, structural dependability, and thermal stability of activated carbon. Commercial activated carbon made from coal is frequently used to remove dissolved solids and ionic pollutants from industrial effluent and potable water, including heavy metal ions and artificial colours. However, its utility is constrained by its high cost, challenges with regeneration, and disposal issues. One way to reduce costs is to create activated carbon (biochar) from inexpensive agricultural products or materials like pomegranate peels and other food waste. The use of biochar AC as an adsorbent in the process of altering or reactivating the surface has a lot of potential. The effectiveness and stability of the adsorption process can be increased by adding metal oxide nanoparticles to AC. Negatively charged metal layered solids can effectively exchange the cations that are present between the layers. They are stiff and unaffected by changes in temperature. Due to the synergistic interaction between the several phases, they also have better properties than compounds with a single layer. The ions that are intercalated between the layers, despite the poor link between them, contribute to keep them stable. These multilayer heterostructures are particularly interesting research subjects since they serve a variety of purposes. Different cations can produce a wide range of unique properties and structures when they are intercalated. Due to qualities including biocompatibility, pH-dependent solvability, and the unique intercalating property, they are less dangerous and less likely to leach. Sulfide based metal layered ion exchangers exhibit outstanding metal ion adsorption and selectivity properties, and their removal kinetics are quite rapid.

CONCLUSION

An effective nano sized adsorbent for extracting heavy metal ions from aqueous solutions was created in this study employing a metal sulfur layered oxide adsorbed on activated carbon produced from pomegranate peel. The heavy metal ions Cd^{2+}, Cr^{3+}, Pb^{2+}, and V^{5+} were removed from the water sample using the nanocomposite, which was created and employed at pH 4.

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