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Copper Purging from Industrial Effluent by Adsorption using Fe_3O_4/MnO_2 Nanocomposites

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Using chemical affinity, zero potentials, XRD, FTIR and TEM, this study examines the structure of Fe_3O_4/MnO_2 composites and explores the mechanism of interface adsorption. The investigation extends to examining adsorption, desorption and recycling experiments. Cu (II) was extracted from industrial wastewater using repurposed magnetic sorbents. The study shows that the Fe_3O_4/MnO_2 composites comprise two layers, one made of amorphous MnO_2 and the other with Fe_3O_4 in the center. Because they replaced H in Mn-O-H to produce the structure of Mn-O-Me; heavy metals were removed from the solution using ion exchange. Cu was impressively removed by the sorbent with a 99.76% efficiency, demonstrating high removal efficiency of Fe_3O_4/MnO_2 composites. The examination of equilibrium data led to the conclusion that the Langmuir model was the most appropriate for elucidating adsorption on the surface of Fe_3O_4/MnO_2 composites. Kinetic studies revealed a strong alignment between heavy metal ion adsorption and the pseudo-second-order model of heavy metal ions on the surface of Fe_3O_4/MnO_2 composites. This study proved that using an external magnetic field to extract water from Fe_3O_4/MnO_2 sorbent for recycling was a practical and effective way to remove heavy metal ions.

KEYWORDS

Cu (II) ions, Fe_3O_4/MnO_2 sorbent, Industrial wastewater, Langmuir model

1. INTRODUCTION

A global problem, trace metal contamination of soil and sediments is caused by various industrial activities, including ore processing, printing, metallurgy, batteries, electroplating, mining and the chemical industry [1,2]. Heavy metal ions, such as lead (Pb), copper (Cu), cadmium (Cd) and zinc (Zn) are frequently identified as prevalent contaminants in industrial wastewater that harm human health and other living organisms [3,4]. As a result, research has focused on removing metal ion contaminants to environment friendly and affordable levels. In recent years, there has been a considerable focus on various techniques for eliminating heavy metals from wastewater. Several methods have been proposed to remove heavy metal ions from polluted water, including chemical precipitation, electrochemical treatment, ion exchange and adsorption [5,6]. Adsorption has stood out among polluted water treatment techniques due to its high removal efficiency, reliability and affordability and lack of toxic by-products [7]. Numerous techniques have recently been looked at for production of more efficient and less-priced mineral adsorbents. Minerals have drawn increased attention for heavy metal clean-up applications due to their outstanding metal sorption properties [8,9]. In particular, mineral with a wide surface area and a nanostructure offered a high capacity and the capability to improve pollutant affinity with the surface [10,11]. To construct composite sorbents to absorb heavy metals, MnO_2 has been used [12]. Unfortunately, because these minerals tended to form small particles in an aqueous solution and result in secondary contamination, they still had separation problems from the wastewater. Thus, there was a lot of interest in creating new nano sorbents with easy separation capabilities and recycling applications. Due to their high magnetic susceptibility, iron oxides, like magnetite (Fe_3O_4) and maghemite (-Fe_2O_3) have been widely used in design. In addition to effectively removing heavy metal ions, MnO_2 modification of Fe_3O_4 resulted in magnetic recovery. It was discovered that surface complexation was responsible for the adsorption. The adsorption process and its sensitivity to surface structure were not well understood. It is yet unclear how the parameter affects the efficacy of the adsorbents after being recycled and the adsorp-

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