DESIGN OF ADSORPTION SYSTEM BASED ON THE UTILIZATION OF LOW-COST ADSORBENT FOR THE REMOVAL OF TOXIC HEAVY METALS FROM INDUSTRIAL EFFLUENT

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Heavy metals are a group of pollutants that have drawn extensive attention in recent years due to high-level toxicity, even at low concentrations. The main concern arises due to their non-decomposable nature, and they start accumulating in the organisms. So, even at their lowest concentrations, their presence in water poses a threat to humans and ecosystems. Of all the technologies reported, biochars have proved to be highly efficient and low-cost adsorbents to treat heavy metals. Different feedstocks are utilized to produce biochars; however, wood biochars are reported to be efficient in terms of its characteristics, produce a better yield of biochar, easily producible, cost-efficient and so, are in trend. This study takes into account two different types of wood feedstocks and analyses them at two different pyrolysis temperatures based on their yield. The biochars are then subjected to different characterization techniques in order to understand the properties and their applicability in different fields of study. In this study, biochars are utilised to remediate toxic heavy metal species from industrial wastewater. In this context, out of the most toxic and hazardous group of heavy metals, three toxic heavy metal species, As(III), Cr(VI) and Pb(II) has been considered for this study. Four biochars, N300, N500, OF300, OF500 and a composite (N-OF) were considered for this study. The biochars were analysed for their efficiencies using batch studies and the parameters analysed using kinetics, thermodynamics and intraparticle diffusion studies. The results showed comparable outcomes for the biochar composite (N-OF) which was then considered for the continuous column studies that mimicked the performance in field conditions. The column study was further considered to analysed the effect of adsorbent bed shaped and two adsorbent beds (vertical and horizontally vertical) were designed and tested with industrial wastewater to evaluate their performances using real-time wastewater. The column study showed that the efficiency of the biochars reduced when the system was subjected to continuous flow mode and an efficiency of 54.3% for As(III), 44.72% for Cr(VI) and 60.13% for Pb(II) was recorded against batch efficiencies of 94.71% for As(III), 96.4% for Cr(VI) and 83.62 for Pb(II). The kinetics showed that the adsorption followed pseudo second-order that indicated the process of chemisorption of the ions into the adsorbents. The intraparticle diffusion analysis also hinted at film diffusion being predominant over particle diffusion. Also, the vertical bed column proved more efficient than horizontally vertical bed column when tested with industrial wastewater. After utilisation of the biochars, the spent biochars were also studied for their disposal by incorporating them in applications and hence, reduce the activity of contamination that could have otherwise arisen due to open disposal. The research can be imparted to areas of material science and engineering where the adsorbent material can be studied further and modifications can be made in certain ways to target different types of pollutants in different sources. The design using a low-cost adsorbent gives a chance to impart it to the rural technologies where it can be implemented to create filters that can be affordable by all sections of the people.