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Graphene oxide coated sand (GO-sand) as adsorbent for efficient removal of multiple heavy metal ions from aqueous medium: Batch and Column Studies

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In recent years, with the diversified development of industry and unreasonable human activities, heavy metals such as lead (Pb) and chromium (Cr) have been introduced into the environment through various anthropogenic activities such as fuel combustion, disposal of sewage sludge and effluents, emissions from mining and automobiles etc. These heavy metals are not biodegradable, they are easily transferred and enriched among crops, fish and other substances, and eventually reach the human body through the food chain. Geochemical evaluation revealed that these heavy metals were the most worrying elements, due to their unstable geochemical properties. The "Sustainable Development Goals" (SDGs) of the United Nations, SDG 3 and SDG 6 cannot be met without monitoring and addressing groundwater pollution through these heavy metals. USEPA and WHO have established a 0.00015 to 0.01 mg/L maximum contamination level (MCL) for Pb and 0.1 to 0.05 mg/L for Cr. Adsorption technology is most widely used technology for these heavy metals removal. In this regard, we explored Graphene oxide coated sand (GO-sand) as low cost adsorbent for removal of Pb, Cr in both batch and column studies. Characterization of GO-sand was done by FT-IR, XRD, FE-SEM, and EDX to confirm proper coating of graphene oxide on sand. The synthetic wastewater with 5 mg/L concentration of Pb and Cr was prepared in lab. The as-prepared adsorbent showed maximum adsorption around ~ 96.4 % and 95.4 % for Pb and Cr, respectively in 45 min at an optimized dose and pH with pseudo second order kinetics model and Langmuir adsorption isotherm. Such high Pb, Cr removal was due to the interaction of positively charged species of Pb and Cr (Pb^{2+}, $Cr(OH)^{+}$, $Cr_3(OH)_4^{5+}$) with negatively surface charged adsorbent (pH_{zpc} = 2.5). Lead and chromium adsorption mechanism was confirmed from FE-SEM, XPS analysis. The quantification of was done by ICP-MS. The sorbents exhibit appreciable adsorption capacities per gram of active phase (254.07 mg/g for Pb^{2+} ions and 234.39 mg/g for Cr^{3+} ions), on the basis of experimental results GO-sand can be a viable cost effective treatment for heavy metals removal and be used in water treatment plants as GO-sand filter.