Synthesis of novel nanocomposite of activated Kaolinite with various proportions of modified carbon nanotube for improved adsorption of heavy metals at very low concentration from water

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Abstract:

Environmental Pollution has increased tremendously since last few years as a result of urbanization leading to environmental, geological and global changes. There are numerous emerging pollutants which are toxic in nature. Since they may have critical environmental repercussions they have to be deactivated or mitigated by various technical means. Therefore, there is a need to develop new and novel smart material for sustainable environmental pollution control. Various types of clay and carbon materials are well known for their application in environmental protection using their properties of adsorption. However, they have been used separately. Keeping this thought, new material using clay and multiwalled carbon nanotubes (MWCNT) has been developed with the potential application in water treatment.The detailed procedure and properties of this new material have been investigated and reported (Yadav et al., 2018). This material has been characterised by using XRD, FTIR and BET surface area.

The effect of CNT loading levels and adsorption behavior of heavy metals like Pb (II) and Ni (II) onto synthesized nanocomposite has been explored. The sorption percentage increased from 52% and 45% to 76.70% and 72.9% of Pb (II) and Ni (II) respectively after decrease amount of mass percent of CNT from 15% to 3% in clay-CNT nanocomposite. Various factors, including pH, Equilibrium time, temperature, initial metal concentration and amount of adsorbent correlated effectively with lead adsorption. The removal efficiency of nanocomposite for Pb (II) and Ni (II) is about 88.65 and 96% at pH 6.0, and at same reaction condition the adsorption capacity is 9.2 and 9.8 mg L^{-1} respectively. The kinetic study shows that Pb (II) and Ni (II) adsorption onto synthesized nanocomposite equilibrate within 120 and 60 min respectively. The enthalpy change of Pb (II) and Ni (II) adsorption the values being in the range of -17.72 to -77.92 KJ mol^{-1} with entropy change in the range of -53.22 to -252.74 J mole $^{-1}$ K^{-1} for solution containing concentration of 5, 10, 15 and 20 mg L^{-1} respectively, indicating an exothermic and spontaneous adsorption process.

Clay-CNT nanocomposite showed satisfactory performance for sorption of lead and nickel from water. The most favorable condition for adsorption were pH, contact time, temperature, initial lead concentration and amount of adsorbent as 6.0, 120 and 60 min, 308K, 20 mg L^{-1} and 1.4 g L^{-1} respectively.

Keywords: Adsorption; Waste water; Toxicity; Kaolin; MWCNT; Heavy metal