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Application of Nanoparticles on Surface of Commercial Carbon-Based Adsorbent for Removal of Contaminants from Water

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Abstract : Adsorption/sorption is believed to be one of the optimal processes for the removal of heavy metals from water due to its low operational and capital cost as well as its high removal efficiency. Different materials have been reported in literature as adsorbent for heavy metal removal in waste water such as natural sorbents, organic polymers (synthetic) and mineral materials (inorganic). The selection of adsorbents and development of new functional materials that can achieve good removal of heavy metals from water is an important practice and depends on many factors, such as the availability of the material, cost of material, and material safety and etc. In this study we reported the synthesis of doped Activated carbon and Carbon nanotube (CNT) with different loading of metal oxide nanoparticles such as Fe2O3, Fe3O4, Al2O3, TiO2, SiO2 and Ag nanoparticles and their application in removal of heavy metals, hydrocarbon, and organics from waste water. Commercial AC and CNT with different loadings of mentioned nanoparticle were prepared and effect of pH, adsorbent dosage, sorption kinetic, and concentration effects are studied and optimum condition for removal of heavy metals from water is reported. The prepared composite sorbent is characterized using field emission scanning electron microscopy (FE-SEM), high transmission electron microscopy (HR-TEM), thermogravimetric analysis (TGA), X-ray diffractometer (XRD), the Brunauer, Emmett and Teller (BET) nitrogen adsorption technique, and Zeta potential. The composite materials showed higher removal efficiency and superior adsorption capacity compared to commercially available carbon based adsorbent. The specific surface area of AC increased by 50% reaching up to 2000 m2/g while the CNT specific surface area of CNT increased by more than 8 times reaching value of 890 m2/g. The increased surface area is one of the key parameters along with surface charge of the material determining the removal efficiency and removal efficiency. Moreover, the surface charge density of the impregnated CNT and AC have enhanced significantly where can benefit the adsorption process. The nanoparticles also enhance the catalytic activity of material and reduce the agglomeration and aggregation of material which provides more active site for adsorbing the contaminant from water. Some of the results for treating wastewater includes 100% removal of BTEX, arsenic, strontium, barium, phenolic compounds, and oil from water. The results obtained are promising for the use of AC and CNT loaded with metal oxide nanoparticle in treatment and pretreatment of waste water and produced water before desalination process. Adsorption can be very efficient with low energy consumption and economic feasibility.

Keywords : carbon nanotube, activated carbon, adsorption, heavy metal, water treatment
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