Synthesis of Surface-Modified Graphene-Based Sand for Fluoride Removal from the Drinking Water

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Graphene and graphene-based material such as graphene oxide (GO) are materials of great interest for potential applications in nanoelectronics, nanoelectromechanical systems, sensors, polymer composites, catalysis. As graphene does not possess its native oxide, GO is routinely obtained via the chemical treatment of either graphene or widely available regular graphite. Chemically exfoliated graphene with various oxygenated functional groups bound to sp^2 basal plane and edges of graphene sheet is called graphene oxide (GO). The surface sites on commercial sand used in water treatment are dominantly negative (pH = 2.7), and chemically inert. Therefore, they show a low affinity for most of the contaminants present in drinking water. However, conventional sand filters are used in water turbidity removal. Graphene oxide (GO) was synthesized using the modified Hammer's method and purified sand was coated with GO dispersion to make super sand which can be used for many purposes including water purification. Single GO coated super sand (GO1) and multiple coated super sand (GO2, GO3, GO4, GO5) were prepared. Optimization studies were done for the fluoride removal process by super sand. Multiple coated super sand and fluoride adsorbed super sand were characterized using Scanning Electron Microscopy (SEM), energy dispersive X-ray absorption (EDXA) spectra, Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD). When increasing the coating times, the Enhancement of the GO coatings on the sand surface was clearly depicted by the SEM images and later by later coatings of the GO were observed on the sand surface. Respective EDXA spectra were also taken from both samples which show higher carbon content for sand/GO5 sample than sand/GO1. EDXA spectra of the Fluoride adsorbed five times coated sand show a small percentage of F in addition to the C, O and Si in the spectrum. The FT-IR spectrum for graphite oxide shows major peaks at wavenumbers of 3427, 1744, 1630, 1186, and 875 and 576 cm -1 due to the functional groups such as –OH, C=O, C-O. More or less similar peak patterns were observed on GO coated sand and peak intensities have been decreased when increasing the coatings. A noticeable decrease of the intensity of the peak at 1070 cm -1, which is assigned to be originating from sand, is a clear indication of the formation of layers of GO covering the sand. A noticeable peak of the FT-IR spectrum of Fluoride adsorbed 3 times coated sand observed around 3500 cm^{-1}. It may be due to the Fluoride bond with Hydrogen in the GO. The highest performance of fluoride removal is shown at pH 3.22 and 7.21 for Sand-GO-1 and Sand-GO-5, respectively. In both instances, the fluoride removal efficiency is around 70 % when 3 ppm initial fluoride was used. So finally it can be concluded that five times coated Sand-GO is most suitable for fluoride removal from the contaminated drinking water.

Keywords: Sand; Graphite; Graphene oxide; Fluoride; surface modification

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