



612/E2

Investigation of the effect of iron oxide nanoparticle impregnated activated carbon on removal of arsenic from aqueous solution

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Arsenic (As) contamination in water, especially in groundwater, has been recognized as a major problem of catastrophic proportions. After the arrival of nanotechnology, significant progress has been made to utilize the chemistry of nanomaterials for As removal from aqueous systems. Iron oxide nanoparticles (IONPs) with their high affinity for the adsorption of arsenite and arsenate have been shown to be extremely efficient at removal of As from contaminated water. In our work, we synthesized IONPs impregnated activated carbon composites using granular activated carbon (GAC) and powdered activated carbon (PAC) and conducted initial experiments to identify the As adsorption potential of the composites. For the preparation of these composites, three methods namely, insitu coating, post coating and spray method, were used and the iron content in each composite sample was tested by digesting the samples. None of these methods required sophisticated equipment. According to our results, neat IONPs, which were synthesized according to our own procedure, were extremely efficient at removal of As from contaminated water. This potential of neat IONPs was not lost due to impregnation. However, As adsorption ability of the IONP-activated carbon composite decreases gradually when the percentage of IONPs decreases. Although, the composites with PAC exhibit higher potential in As adsorption than that with GAC, the draw back in using PAC is, it is not suitable for packed-bed use because of the tight packing of the material. Column studies were conducted using IONPs impregnated GAC composites. The adsorbent material does not tend to corrode when it is in contact with water and iron oxide does not "flake" off of the composite media. At room temperature, the adsorption isotherm studies have revealed a better correlation with the Freundlich isotherm. Adsorption isotherm results clearly indicate that the best method for the preparation of IONPs impregnated activated carbon composites is spray method because in spray method, IONP loading on to GAC is higher than the other two methods and hence the composite exhibits the highest adsorption capacity (103.81 L/g). Also, by varying IONP: activated carbon ratio, 100% adsorption of As(V) could be obtained. The synthesized products were identified and characterized using FT-IR spectra, X-ray diffractometry (XRD) and transmission electron microscopy (TEM). Arsenic analysis was carried out by Graphite Furnace Atomic Absorption Spectrophotometer (GFAAS).