

Arsenic (III) Removal by Zerovalent Iron Nanoparticles Synthesized with the Help of Tea Liquor

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Abstract : Traditional methods of synthesis are hazardous for the environment and need nature friendly processes for the treatment of industrial effluents and contaminated water. Use of plant parts for the synthesis provides an efficient alternative method. In this paper, we report an ecofriendly and nonhazardous biobased method to prepare zerovalent iron nanoparticles (ZVINPs) using the liquor of commercially available tea. Tea liquor as the reducing agent has many advantages over other polymers. Unlike other polymers, the polyphenols present in tea extract are nontoxic and water soluble at room temperature. In addition, polyphenols can form complexes with metal ions and thereafter reduce the metals. Third, tea extract contains molecules bearing alcoholic functional groups that can be exploited for reduction as well as stabilization of the nanoparticles. Briefly, iron nanoparticles were prepared by adding 2.0 g of montmorillonite K10 (MMT K10) to 5.0 mL of 0.10 M solution of $\text{Fe}(\text{NO}_3)_3$ to which an equal volume of tea liquor was then added drop wise over 20 min with constant stirring. The color of the mixture changed from whitish yellow to black, indicating the formation of iron nanoparticles. The nanoparticles were adsorbed on montmorillonite K10, which is safe and aids in the separation of hazardous arsenic species simply by filtration. Particle sizes ranging from 59.08 ± 7.81 nm were obtained which is confirmed by using different instrumental analyses like IR, XRD, SEM, and surface area studies. Removal of arsenic was done via batch adsorption method. Solutions of As(III) of different concentrations were prepared by diluting the stock solution of NaAsO_2 with doubly distilled water. The required amount of in situ prepared ZVINPs supported on MMT K10 was added to a solution of desired strength of As (III). After the solution had been stirred for the preselected time, the solid mass was filtered. The amount of arsenic [in the form of As (V)] remaining in the filtrate was measured using ion chromatograph. Stirring of contaminated water with zerovalent iron nanoparticles supported on montmorillonite K10 for 30 min resulted in up to 99% removal of arsenic as As (III) from its solution at both high and low pH (2.75 and 11.1). It was also observed that, under similar conditions, montmorillonite K10 alone provided only <10% removal of As(III) from water. Adsorption at low pH with precipitation at higher pH has been proposed for As(III) removal.

Keywords : arsenic removal, montmorillonite K10, tea liquor, zerovalent iron nanoparticles

Conference Title : ICBWTTS 2020 : International Conference on Biological Wastewater Treatment Technologies and Systems

Conference Location : New York, United States

Conference Dates : June 04-05, 2020