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# Arsenic removal using synthetic adsorbents: Kinetics, equilibrium and column study

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Arsenic contaminations are seldom of anthropogenic origin (mining, wood preservatives,...) being generally caused by the natural dissolution of minerals in surface or underground waters. In natural waters, arsenic is present either as As(III) or As(V). Both ions are toxic and carcinogenic. High concentrations of arsenic in the groundwater (>1000 μg/L) of natural origin have been found in some areas in countries like Bangladesh, West Bengala, India, Mexico and some areas in Argentina, Chile and U.S.A.

The technologies commonly used are oxidation, coagulation-precipitation, ion-exchange and adsorption onto activated alumina, activated carbon and ferric hydroxides either in granular form or as coating material. Membrane technologies, namely reverse osmosis and nanofiltration, are also effective but they are not feasible for economic depressed areas. In the last decade the research has been focused on the development of cheap and easy-to-handle removal technologies especially for decentralized use in developing countries.

The main objective of this research is to establish a comparison between the performance of different sorbents for the removal of As(V): (i) a reference sorbent commercially known as ARM-300 (BASF Corporation) and two synthetic sorbents prepared at the laboratory, (ii) the hydrous ferric oxide (HFO) in suspension and (iii) loaded onto granular activated carbon (GAC). The research focused in the kinetics and chemical equilibrium using batch scale testing for the three systems. The results were adjusted to non-linear models and a statistic treatment was performed. Models were compared using the Fisher's test.

In general a pseudo-second order kinetics was followed. For the synthetic materials, most of the sorption occurred in the first minutes, indicating that they might be applied in batch treatment using short contact times, around 10 min. The kinetics of the reference material is slower.

The equilibrium isotherm of the HFO suspension was best described by Langmuir model; for the other two systems Langmuir and Freundlich models were statistically equivalent. The reference material exhibits the highest monolayer sorption capacity, 49±9 mg/g, followed by the HFO suspension, 38±2 mg/g, and by the HFO loaded onto GAC, 5.5±0.5 mg/g. This last sorbent was also tested using a downward continuous flow through a packed column operating at a constant rate of 8.0 mL/min; Yan's model exhibits the best fit to the experimental results and a loading capacity of 3.6±0.3 mg/g was obtained for an outlet concentration of 50% (after 500 min operation).

It can be concluded that both synthetic materials are promising for arsenic removal; however, when HFO is used in suspension, it should be followed by sedimentation and filtration (using e.g. sand/anthracite) in order to produced treated water without turbidity.