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Treatment of arsenic-contaminated groundwater by a low cost activated alumina adsorbent prepared by partial thermal dehydration

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ABSTRACT

Experimental investigations were carried out to remove arsenic from contaminated groundwater by low cost activated alumina based adsorbent prepared by partial thermal dehydration. Activated alumina based adsorbent with high surface area was prepared following partial thermal dehydration of gibbsite precursor and an attempt was made to study the effects of dehydration temperature, residence time, rate of increase of temperature and particle size on development of active surface area of the adsorbent. The operating parameters were found to have significant effect on active surface area development. BET Surface area (by nitrogen adsorption) and ignition losses were determined for all the samples. It was found that an adsorbent of surface area of around 335–340 m^2/g could be developed when dehydrated at 500°C for a residence time of 30 min in a rapid heating system (rate of increase of temperature 200°C/min) with particle size of 200 mesh (85%). The arsenic adsorption capacity of this adsorbent was determined both in batch and column studies. The adsorbent was found to be very effective in removing arsenic. The adsorbent placed in column could successfully remove arsenic from water up to a level below 10 μg/L for more than 6000 bed volume water.

Keywords: Activated alumina; Arsenic adsorption; Adsorption surface; Thermal dehydration

1. Introduction

Contamination of groundwater by arsenic leachate is now a worldwide problem affecting millions of people from South-West U.S.A. to India, Bangladesh, Taiwan, Vietnam, and Nepal [1]. Through extensive studies [2–5] carried out over the last few decades on removal of arsenic from drinking water, adsorption, chemical coagulation-precipitation, ion exchange and membrane separation have been established as the broad technology options of purification. Pal et al. [6] have shown that for large scale treatment, physico-chemical separation technique is possibly the best for the developing South-East Asian countries, for small scale treatment facilities like the community water filters, however, activated alumina-based adsorption technique could be a favourable option provided it is produced at low cost as adsorbent needs periodic replacement. Clifford [7] Fox and Sorg [8], Hathway and Rubel [9], Chen et al. [10], Lin et al. [11] have all shown that activated alumina based adsorption could be a very effective point-of-use water treatment device by virtue of its good mechanical properties, stability under most reaction conditions and high surface area [12]. Different studies for state of the art technologies were discussed by many researchers [13–18]. The moot question that needs to be solved is how to the produce activated alumina at low cost. There are different methods for manufacture of active alumina adsorbents. It is produced mainly by gel precipitation of gibbsite powder with sodium hydroxide and sulfuric acid. This method gives more chemically pure activated alumina

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