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ARSENIC REMOVAL FROM WATER USING IRON IMPREGNATED ACTIVATED CARBON

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Abstract

The arsenic contamination in waste water is global. Apart from various treatment technologies, Zero-valent iron impregnated activated can be efficient adsorbent for the both arsenite and arsenate removal from waste water. In the present work, Fe (iron) was supported onto activated carbon by impregnating carbon with ferric chloride followed by chemical reduction with NaBH_4 . Approximately 89.09% of arsenite was removed under aerobic conditions as analysis by AAS (atomic absorption spectrophotometer). Initially the simulated synthetic arsenite As(III) concentration was 200ppb. The Fe impregnated AC was regenerated by 0.1 M NaOH.

Keywords: adsorption, arsenite, arsenate.

1. INTRODUCTION

Arsenic may enter into water from both natural such as arsenic minerals, activities like industrial waste discharge, mining activities and application of arsenic herbicide and pesticides [1]. There are many technologies use for the removal of arsenic from water like oxidation, sedimentation, coagulation and filtration (sportive media filtration and membrane filtration) [2, 3]. But, Iron removal processes are generally simple, reliable, and cost-effective. There are many factors that are being discussed in detailed for removal efficiency like surface area, adsorbent dosage, presence of acidic and basic anions, presence of others inorganic and organic anions and corrosion rate of Fe with water and air.

Activated carbon also use for the treatment of water. In this paper Fe modified activated carbon was used for effective process variables for the removal efficiency of arsenic.

2. MATERIALS AND METHODS

2.1.1. Synthesis of Fe/AC.

45 mesh size coconut shell activated carbon, concentrate nitric acid (65% merck), ferric chloride required for the modification of surface. Sodium borohydrate (NaBH_4), arsenic trioxide (As_2O_3), L-cystein, hydrochloric acid, NaOH required for analysis.

45 mesh size activated carbon was taken and dried in hot oven for 1 hours. Then it was washed in 1 molar of HNO_3 (merck 65% pure) solution for 1 day over stirrer. Then this solution was distilled repeatedly with distilled water and then dried in oven. This dried activated carbon was kept for five hours in 1 M of 100 ml of FeCl_3 solution in conical flask and it mouth was closed with rubber stopper. 0.4 M of NaBH_4 solution was injected in flask 2ml per hour. The slurry was filtered and washed with ethanol and acetone solution repeatedly. The dried mass was exposed to inert N_2 atmosphere. The ZVI/AC carbon was kept in silica gel desiccators.

2.2. Batch experiment.

The batch solution of 200 ppb was prepared using As_2O_3 (Merck standard solution). The two different amount of prepared Fe modified activated carbon was taken (0.5g/L and 1 g/L) for the treatment. The batch operation was performed for 45 hours. The small amount of solution was taken out at regular interval of time and taken for the analysis with L-cystein and without L-cystien. The analysis was carried out using AAS(200) Perkin Elmer at wavelength 193.7nm.

3. RESULT AND DISCUSSION

3.1 Effect of adsorbent dosage.

Different ZVI/AC dosages we used for the treatment purpose at approx pH 7.5 in aerobic condition. As shown in Fig. 1 (a-b), as the ZVI/AC dosage increases the %removal efficiency was increase. The maximum removal efficiency of arsenite 89.09% was found at 1.gm/L, while for arsenate was only

68% at pH 7.5. As we changed the adsorbent dosage removal efficiency was found 80.5% and 61% for As(III) and As(V) respectively for 0.5 gm/L load of adsorbent.

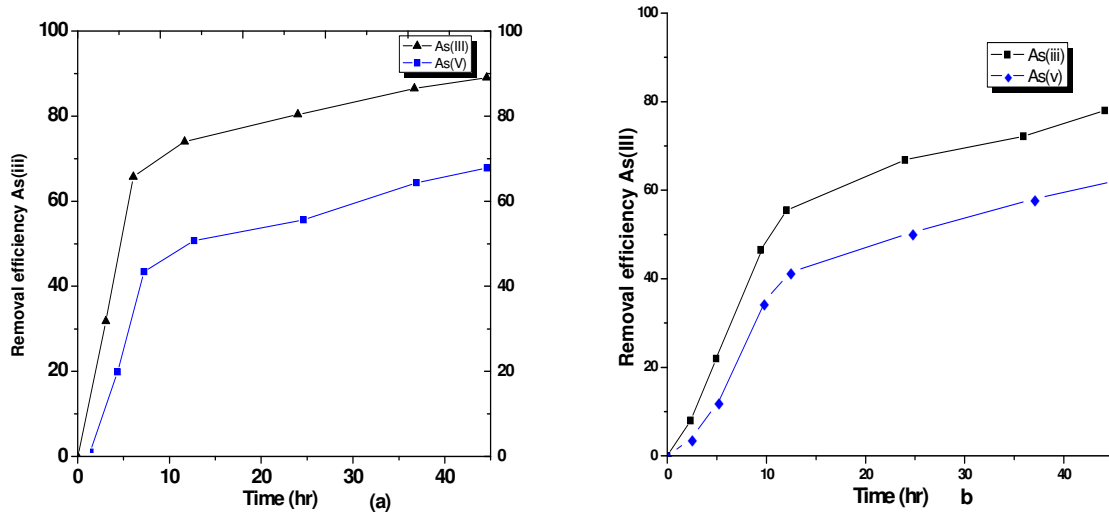


Fig.1 (a) Removal efficiency of As(III) and As(V) at 1 g/L ZVI/AC at pH7.4 in aerobic condition at 22 °C; (b) Removal efficiency of As(III) and As(V) at 0.5 g/L ZVI/AC at pH7.4 in aerobic condition at 22 °C.

3.2.1. Effect of ph on removal efficiency.

The arsenite and arsenate solutions on Fe/AC at different pH 2–12 were illustrated in Fig. 2. The arsenic removal efficiency was strongly dependent on media pH. The removal of arsenic from arsenite As(III) solution increased from pH 2 to pH 8 approx and then decreased sharply pH 8 onwards. As(V) shows different behavior when compared with As(III). The adsorption for arsenate solution, arsenic removal by Fe/AC went down on increasing pH from 2-12. The two lines intersect at approx pH ~5.1

above which arsenic removal efficiency was much higher for arsenite. It was proposed that adsorption of arsenite and arsenate onto the surface Fe/AC proceeds in three steps: (i) migration to the surface; (ii) dissociation of complexed aqueous arsenate or arsenite; (ii) surface complexation [5]. The first step

was largely controlled by electrostatic attraction or repulsion of the aqueous arsenate or arsenite species with the surface of the adsorbent. Hence, pH of zero point charge of the adsorbent and the speciation of aqueous arsenate and arsenite was governing factor. When pH was increases from acidic region to alkaline region (i.e. pH 2–12 in this work).

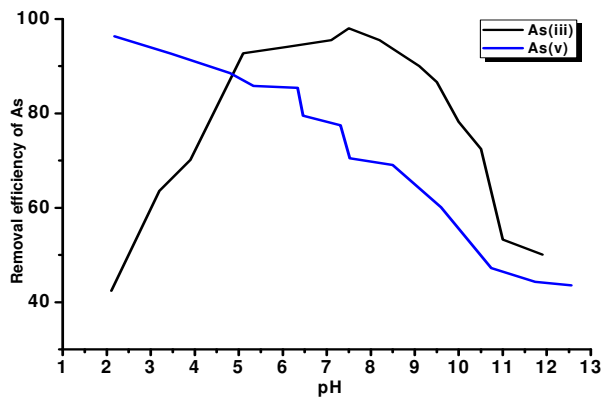


Fig.3. Effect on removal efficiency at different pH at 27 degree celcius in aerobic condition at 1.5 gm/L ZVI/AC.

It was known that solid surface was negatively charged at pH above pH_{ZPC} and positively charged at pH below pH_{ZPC} . Thus resulting was increased electrostatic attraction or repulsion with anionic arsenic species, hence leading to more or less readily adsorption. The pH_{ZPC} of the synthesized Fe/AC was determined to be pH 8, below which the surface is positively charged and favorable for the adsorption of anionic species. The surface of the adsorbent becomes less positively charged when pH increases hence shows less attraction towards anionic arsenate species. Therefore the adsorption of arsenate decreased all the way with increasing pH.

3.2. Regeneration of spent adsorbent

The regeneration of the spent adsorbent was done. The spent adsorbent was shaken in 0.1 M NaOH at 22° C for 7 hours. The removal efficiency of arsenic As(III) was decreased to 80% for 1g/L, while for As(V) 58 % obtained .

3. CONCLUSION

The batch adsorption studies showed that the modified adsorbent was effectively removed both As(III) and As(V). The maximum removal efficiency was 89.09% and the adsorption kinetics of As(III) would occur in two steps kinetic. Which included the fast step followed by slow step, Similar case identified for the adsorption of As(V). The effective conditions for the adsorption for arsenic was at pH 7.4 which was just near the point of zero charge. Above this pH value the removal efficiency of arsenic would decrease. The spent adsorbent could be efficiently regenerated by treating it with dilute 0.1 M NaOH (sodium hydroxide) solution. The removal efficiency was found to decrease very less.

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