

Characteristics of arsenic sorption on furnace slag in groundwater

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Abstract

Furnace slag, a steel industry waste, has been converted into an inexpensive and efficient adsorbent. The product obtained has been utilized for the removal of arsenic from ground water. Kinetic studies have been described with the mechanism of adsorption. The results from batch studies showed that the As(III) can be removed from the ground water within the pH range 3-7. However the maximum removal was experienced at pH 7.0. Equilibrium was attained within 24 hours. Adsorption data of arsenic correlate well with the Freundlich and Langmuir adsorption models. The maximum sorption capacity as calculated using Freundlich adsorption isotherm was found to be of 0.004 mg g⁻¹ at pH 7 and 25°C.

Introduction

Since arsenic is carcinogenic and extremely toxic, it may cause neurological damage at aqueous concentrations as low as 0.1 mg/L (Chunming and Robert, 2001). The new European community and World Health Organization (WHO) recommended guideline value is 10 ppb. Recent research at ERL (KJIST) is focused on the development of low cost carbon alternatives using various industrial wastes to remove arsenic from the groundwater. Keeping this in view efforts have been made to utilize blast furnace slag a steel industry waste. The main purpose of this study is to investigate the removal of As (III) from aqueous solutions by the adsorbent developed from furnace slag.

Materials and Methods

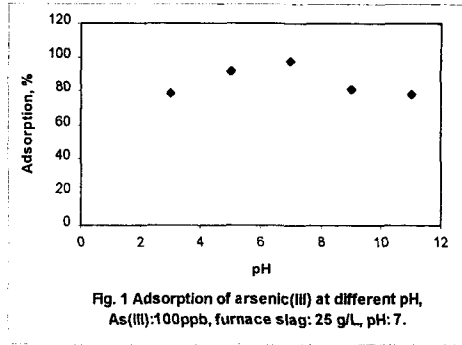
The furnace slag used in this study is a waste obtained from Pohang Steel Industry, Korea. All the chemicals used were of analytical grade, unless otherwise specified. Stock solutions of As(III) were prepared from reagent grade NaAsO₂ (Aldrich). 0.5 g of furnace slag was added to 50 mL polypropylene copolymer centrifuge tube (Corning, USA) containing 20 mL solution of desired concentration of As(III). The samples were placed on a water bath shaker (150 rpm) at required temperature. After completion of reaction, the suspensions were centrifuged and the supernatant solutions were filtered through 0.2 m membranes and determined by HGAAS.

Results and Discussion

Effect of pH

The effect of pH on As(III) adsorption by furnace slag was studied in the initial pH range

between 3-11 at contact time of 24 hours. It is seen from the Fig. 1 that As(III) is effectively adsorbed at neutral pH (at pH 7.0). Adsorption decreases at both lower and higher values of pH ranges employed. In the pH range 3-7 the predominant species is H_3AsO_3 . As the pH increases, the amount of negative arsenic species rises, which may decrease the adsorption. Similar observation has been described in the adsorption of arsenic on red mud (Altundogan et al, 2000).

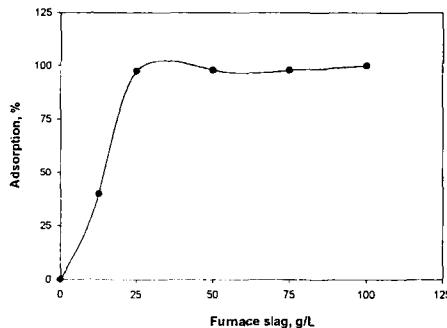


Effect of contact time and initial concentration

Experiments were conducted at different initial arsenic concentration (100, 250 and 500 g/L). Experiments at low concentration (100, g/L) indicated the complete removal of arsenic from the test solutions using 25 g/L of the adsorbent in 24 hr of contact time. As the concentration of As(III) increases from 100 to 500 g/L the adsorption of As(III) decreases. This may be attributed due to decrease in active site at the surface of furnace slag available for the removal of As (III). Hence, further experiments were carried out with 100 g/L of initial arsenic concentration.

Effect of sorbent dose

As depicted in Fig. 2 the percent removal of arsenic increases with the increasing slag concentration. The similar results have also been reported by Lopez and his coworkers while working on blast furnace sludge (Lopez-Delgado et al, 1998). Experimental data have been successfully fitted into the Freundlich isotherm at pH 7.



Conclusion

The results show that furnace slag a steel industry waste can be successfully utilized for the removal of As(III) under the defined optimized condition. The present research shows that arsenic can be removed from groundwater at neutral pH using furnace slag. The removal of As (III) is 98% at 100gL⁻¹ initial concentration.

References

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2. Altundogan, H. S, Altundogan, S. Tumen, F. and Bildik, M. 2000. *Waste Management*. 20, 761-767.
3. Lopez-Delgado, A. Perez, C and Lopez, F. A. 1998. 32, 989-996.