ADSORPTION OF FLUORIDE AND ARSENIC (V) FROM AQUEOUS SOLUTION ON BONE CHAR MODIFIED WITH IRON SULFATE

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**Highlights**

* Arsenic and fluoride can be removed from water by adsorption on bone char modified with iron sulfate.
* Solution pH plays a key role on the adsorption of these anions onto bone char.
* Adsorption of arsenic and fluoride is due to electrostatic interactions and ion exchange.

**1. Introduction**

The concentration of the arsenic in natural waters varies depending on the presence of arsenic species in the soil [1]. Diverse epidemiological studies have found that the exposure to arsenic via the consumption of drinking water can cause the illness hyperkeratosis and cancer in bladder, lungs, skin, kidneys, liver and prostate. Besides, arsenic exposure has been associated with cardiovascular, pulmonary, immunological, neurological, peripheral vascular and endocrine diseases. The presence of fluoride in drinking water is a crucial issue since both low and high concentrations can affect human health. When the fluoride concentration is less than 0.5 mg/L, the incidence of dental cavities increases considerably; however, consumption of water with fluoride concentrations ranging between 1.5 and 4 mg/L can cause dental fluorosis [2]. Another severe health problem caused by the fluoride excess ingestion is skeletal fluorosis [2].

The removal of these pollutants from drinking water can be accomplished by several separation processes. Nowadays, adsorption is considered one of the best methods available to eliminate arsenic and fluoride from drinking water because it can reduce the arsenic concentration to trace levels and its easiness of operation. However, it is necessary to find novel adsorbent materials, which have a high capacity for adsorbing arsenic and fluoride, and the novel adsorbents have to be inexpensive and efficient.

**2. Methods**

The granular bone char (BC) used in this work is commercially manufactured from cattle bones. The BC was modified (BCM) by contacting with a solution of FeSO4 and NH4Fe(SO4)2**·**H2O, and the modification procedure was similar to that described by Asfarama et al. [3].

The point of zero charge (pHPZC) and surface charge distribution of the adsorbent was evaluated using the method described in Mendoza-Barron et al. [4]. The textural properties were determined using a surface area and porosimeter analyzer, Micromeritics, ASAP model 2020. A scanning electron microscope JEOL, model JSM-6610LV, was employed to analyze the surface morphology of BCM. The crystalline species were identified by employing an X-ray diffractometer Bruker, model D8 Advance.

**3. Results and discussion**

The pHPZC of BCM is 10.3 indicating that the surface of the BCM is basic. The XRD analysis confirmed the presence of calcite, hydroxyapatite and sodium sulfate in the BCM. The BCM has an irregular morphology due to the agglomeration of the hydroxyapatite sheets and the iron deposited on the BC. The characterization revealed the BCM is mesoporous, and its surface was basic.

The adsorption of isotherms of As(V) on BC and BCM are depicted in Figure 1, and the adsorption capacity of BCM towards As(V) was enhanced about 10 times at an equilibrium concentration of As(V) of 100 µg/L. As shown in Figure 2, the capacity of BCM was almost enhanced 4 times compared to that of the BC. The effect of the solution pH on the adsorption of fluoride on BCM is also presented in Figure 2, and the capacity of BCM was decreased by raising the solution pH from 5 to 11. Similar behavior was observed for the adsorption of As(V) on BCM. At pH below the pHPZC, the surface of BCM was positively charge due to the protonation of the phosphates and hydroxyl groups contained in the material and As(V) and fluoride were present as anions. Thus, the predominant adsorption mechanism was the electrostatic attraction between the anionic species in solution and the positive charge of the BCM.

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| **Figure 1.** Effect of modification on the adsorption capacity of BC towards As(V) at T = 25 °C | **Figure 2.** Effect of modification on the adsorption capacity of BC towards fluoride, and effect of pH on the adsorption capacity of BCM at T=25°C. |

**4. Conclusions**

The modification of BC by FeSO4 improved the adsorption capacity of BCM towards As(V) and fluoride considerably. The predominant adsorption mechanism was the electrostatic attraction between the anionic species in solution and the positive charge of the BCM. The adsorption capacity of BCM towards As(V) and fluoride was considerably reduced by increasing the solution pH.

**References**

1. B.K. Mandal, K.T. Suzuki, Talanta 58 (2002) 201-235.
2. N.A. Medellín-Castillo, E. Padilla-Ortega, L.D. Tovar-García, R. Leyva-Ramos, R. Ocampo-Pérez, F. Carrasco-Marín, M.S. Berber-Mendoza, Adsorption 22(7) (2016) 951-961.
3. A. Asfarama, M. Ghaedi, S. Hajati, A. Goudarzi, Ultrason. Sonochem 32 (2016) 418-431.
4. J. Mendoza-Barron, A. Jacobo-Azuara, R. Leyva-Ramos, M.S. Berber-Mendoza, R.M. Guerrero-Coronado, L. Fuentes-Rubio, J.M. Martinez-Rosales, Adsorption 17(3) (2011) 489–496.