Adsorption of Fluoride Aqueous Solution by Waste Iron Oxide

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Abstract

Fluoride (F⁻) is an essential component for the dental and bone health of mammals. However, the excess fluoride in drinking water causes harmful effects such as problems relating to dental and skeletal fluorosis[1]. The World Health Organization has set a guidance value of 1.5 mg L⁻¹ for fluoride in drinking water, and the Taiwan drinking water standard for fluoride has been amended to 0.8 mg L⁻¹. Consequently, the treatment of fluoride has currently become an important subject worldwide. Recently, interest in low-cost, high-surface-area materials, especially metal oxides, and their unique applications, such as adsorption and chemical catalysis, has been growing. Iron oxide has a relatively high surface area and charge; numerous researchers have used iron oxide as an adsorbent to treat heavy metals and anions from wastewater. This study elucidates an iron oxide adsorbent (BT3), which is a by-product resulting from the FBR–Fenton process[2, 3], for use in treating wastewater from leather plants in Taiwan.

In this work, the main objectives of this research were (1) to test and use BT3 as adsorbent for the removal F⁻ of from water are carried out. The BT3 was further used to study the influence of thermal treatment on the F⁻ adsorption capacity. For this, the BT3 calcined at different temperatures(100, 200,300, 400, 500, 600 and 700 °C) in nitrogen for two hour in a muffle furnace, cooled and stored in desiccator, to prevent the absorption of any moisture from ambient air. (2) to determine the influence of the pH on fluoride removal, and (3) to evaluate its Fluoride ion capacities and to examine the influence of co-existing anions on F⁻ removal.

The preliminary result show that calcination up to 300 °C led to an increase in the specific surface area of BT3. This was accompanied by an increase in the pore size and pore volume. Calcination above 300 °C resulted in a decrease in the specific surface area due to sintering and/or phase changes occurring at higher temperatures. The calaination temperature of BT3 have huge influence to adsorption capacity of fluoride. The effect of pH experiment showed the results of fluoride adsorption on BT3 with varying pH at 303 ± 1 K. The adsorption of fluoride from aqueous solution by BT3 increased with increasing solution pH from 2.0 to 4.0 and Maxima occurred at pH = 3.9, and decreased thereafter. Four oxyanions (SO₄²⁻, Cl⁻, NO₃⁻, PO₄³⁻) were
selected to assess the effects of co-existing anions on fluoride removal. At fixed pH of 3.9±0.2 the effects of four oxyanions at three concentration levels (6, 60 and 600 mM). The results showed F⁻ removal was affected to a similar extent by each of four oxyanions. Phosphate caused the greatest percentage decrease in fluoride adsorption among the anions at each concentration level. The adsorbent follows the selectivity pattern phosphate > sulfate > chlorine > nitrate.

Keywords: Adsorption, iron oxide, fluoride