Testing a Novel Water Purification Method: Synthesis and Iron Modification of Zeolitic Imidazolate Frameworks for the Adsorption of Hexavalent Chromium

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Heavy metal water contamination, specifically by hexavalent chromium (Cr(VI)), a carcinogenic byproduct of textile, rubber, and artificial fertilizer production, severely harms marine organisms and human health. According to the Environmental Protection Agency, the maximum contaminant level of aqueous chromium is only 0.1 mg/L in drinking water for safe consumption. This heightens the need for an efficient aqueous Cr(VI) separation method. Metal-organic frameworks are porous, crystalline solids composed of a three-dimensional network of metal ions connected by organic linkers. Zeolitic imidazolate frameworks (ZIFs) are a subclass of MOFs with a zeolite structure. This project aims to synthesize and modify ZIF-8 with a novel iron ($FeCl_2$) method to study its adsorption capabilities of Cr(VI). Unmodified ZIF-8 was synthesized and ferrous chloride was incorporated into the ZIF-8 framework via ultrasonication. Both samples were separately dispersed in 50 ppm Cr(VI) solution whose pH was varied from 4 to 8. UV-Vis spectroscopy revealed that the highest Cr(VI) adsorption rate from the unmodified ZIF-8 sample occurred at a pH value of 5, with decreased adsorption at higher pH values due to the competitive interactions between chromate ions and OH- ions for adsorption sites on the positively charged ZIF-8 surface. The $FeCl_2$ @ ZIF-8 sample demonstrated lower removal efficiency percentages than the unmodified ZIF-8 due to increased competitive interactions for adsorption sites upon the introduction of Cl-. It too performed optimally at a pH value of 5, confirming that a pH value of 5 is ideal for aqueous Cr(VI) adsorption.

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