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Can iron oxides remove Cr(VI) from drinking water at sub-ppb levels?

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Hexavalent chromium [Cr(VI)] has long been recognized as a potential carcinogen via inhalation, in contrast to trivalent chromium [Cr(III)] which is 100 times less toxic and also a necessary nutrient, essential to human glucidic metabolism. Nowadays there is an increasing concern that Cr(VI) is also carcinogenic by the oral route of exposure, while an increased number of publications indicate that Cr(VI) is a common natural pollutant. Hexavalent chromium formation is attributed to natural oxidation of Cr(III) in ultramafic derived soils and ophiolithic rocks. To verify this theory, drinking water samples were collected from targeted areas of Greece e.g. areas in which the geological background is predominated by ultramafic minerals and the water supply depends mainly on groundwater resources. Valuable guide for the samples collection was the geological map of Greece and emphasis was given to regions where the natural occurrence of Cr(VI) is thought to be more possible. A wide range of Cr concentrations (2-100 μg/L) were detected in the areas studied, with most of them ranging below the current limit of 50 μg/L, and the Cr(VI) concentration being more than 90% of the total. Since the Cr(VI) affects significant part of population worldwide, a debate was established concerning the enforcement of stringent regulation, which also demands the drinking water treatment processes re-evaluation in view of Cr(VI) removal at sub-ppb level. In this regard, adsorption has evolved as the front line of defense for chromium removal.

The motivation of this work was to investigate the efficiency of iron oxides for the adsorption of Cr(VI) from drinking water and its removal at sub-ppb levels. The adsorbents examined included iron oxy-hydroxides and magnetite prepared using common low cost iron salts. Their effectiveness as Cr(VI) adsorbents was evaluated through the decrease of a Cr(VI) concentration of 100μg/L prepared in NSF water at pH 7.

Preliminary batch experiments did not show any promising results. However, under rapid small scale column conditions, magnetite presented an ability to decrease residual chromium concentration at sub-ppb levels for a satisfactory period of time. Additionally, in regard to the current regulation limit for chromium in drinking water (50μg/L), magnetite's adsorption capacity was greater than 5mg Cr(VI)/g$_{ads}$. Such results encourage further investigation regarding the parameters influencing magnetite's ability to absorb Cr(VI) i.e. the method of its synthesis and particle size.

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