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Effects of Permanganate on Arsenite Oxidation: Heterogeneous oxidation of As(III) by permanganate and the reaction byproduct

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Arsenic contamination of soil, surface- and groundwater is of serious concern over the world because of its toxicity and carcinogenicity. The common oxidation states of As under surface environments are +III and +V, which affect its mobility and toxicity in natural systems and thereby its removal efficiency in treatment processes. Arsenite, As(III), is metastable under oxic conditions due to its slow oxidation kientics by oxygen and is generally more mobile and more toxic than arsenate, As(V). Consequently, one of the most effective ways to remove As from water is to oxidize it to less mobile and less toxic As(V), which can be subsequently immobilized by sorption to various sorbents. The extent and mechanisms of As(III) oxidation to As(V) have been substantially investigated with various oxidants such as TiO_2, chlorine, chloramines, and ozone. Although permanganate has been extensively used as an effective oxidant for various organic contaminants, its effectiveness on As(III) oxidation has been rarely examined. This study investigates the effects of permangante on the oxidation of As(III) at pH 4 and 8 at varying doses of As(III) and permangante under batch conditions. The oxidation of As(III) by permanganate with the stoichiometirc ratio of As(III) to Mn(VII) or with excessive Mn(VII) is instantaneous. When As(III) dose exceeds Mn(VII) concentration, the excess As(III) is further oxidized by the reaction product, probably manganese oxide or oxyhydroxide until the byproduct is completely reduced to Mn(II). This subsequent heterogeneous reaction between the excess As(III) and the manganese solid byproduct is also reasonably fast. These results indicate that permanganate may be an effective and efficient reagent for As(III) oxidation in water treatment processes.

Key Words : Arsenic removal, As(III) oxidation, permanganate, manganese reduction, manganese oxide/oxyhydroxide

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