An experimental study on manganese(II) removal with manganese dioxide recycling

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ABSTRACT

Manganese dioxide (MnO₂) particles have a catalytic effect on removing Mn(II) from contaminated water. On the basis of this effect, a manganese removal process was proposed in this paper. For this purpose, the oxidation of Mn(II) was studied first in batch reactor and then in continuous reactor. The experimental conditions for batch reactor were Mn(II): 3 mg/l, Mn(IV): 0–800 mg/l, pH: 9.6, temperature: 25 °C and for continuous system, the conditions were kept the same except Mn(II) concentration. A quadratic equation was obtained as a function of Mn(IV) concentration to determine the catalytic reaction rate constant. It was experimentally demonstrated that there was no significant effect of Mn(IV) on the Mn(II) oxidation at Mn(IV) concentrations beyond 800 mg/l. Furthermore, reaction kinetics was derived from the data of batch experiments. Based upon the reaction kinetics, it has been theoretically demonstrated that the volume of aeration tank can be significantly reduced by keeping a high concentration of Mn(IV) in the reactor. Lastly, manganese oxidation was studied in a continuous flow lab scale system with and without MnO₂ sludge recirculation. In this system, until Mn(IV) concentration had reached 300 mg/l, Mn(II) removal rate had increased linearly, but beyond this level increase had continued decreasingly. This study shows that, instead of using stronger oxidants in the drinking water treatment systems, recycling of MnO₂ flocks provides important advantages like low investment cost, minimization of treatment area and, because of the lack of using oxidants, low operation cost.

Keywords: Autocatalytic effect; Catalytic effect; Manganese removal; Manganese oxygenation; Reaction kinetics