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Review

A mini review of preoxidation to improve coagulation

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HIGHLIGHTS

- Colloids and particles in natural water were comprehensively summarized.
- Efficiency of preoxidation to improve coagulation was evaluated.
- Mechanisms and drawbacks of preoxidation to improve coagulation were concluded.
- The future developments of preoxidation process were suggested.

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ABSTRACT

Preoxidation has attracted people's attention due to its effectiveness in enhancing coagulation. The mechanisms, drawbacks and applications in the improvement of coagulation were summarized in this work. Preoxidation can destroy the organic coating on the surface of particles to change the zeta potential, which is the vital reason for improving coagulation. Co-existing metallic ions, such as calcium, iron and manganese, play important roles in the improvement of coagulation due to the formation of metal-humate complexes or the in *situ* formed coagulant. However, preoxidation could degrade organic matter from high molecular weight to low molecular weight and damage cell membrane of algae, causing intracellular algal organic matter to release outside and producing hydrophilic functional groups to some extent, which has the potential to deteriorate the water quality. Additionally, disinfection byproduct formation is also affected significantly through changing the characteristics of the organic and inorganic precursors. Based on the recent publications, some future developments of preoxidation process were suggested in this study.

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1. Introduction

Colloids and suspended particles in water including inorganic and organic contents, virus, bacterial and algae, always contribute to turbidity, chromaticity, tastes and odors (Jeffrey et al., 1996). As shown in Fig. 1, the size of suspended particles in aqueous solution ranging from 0.5 μm to 100 μm includes algae, bacteria, red blood cells and pollens. While the size between 0.01 μm and 1 μm belongs to colloids, such as albumin protein, colloidal silica, virus and humic acids (Jeffrey et al., 1996). Coagulation-flocculation process described in terms of the destabilization of colloids and suspended particles initially present in a water supply is a vital method to remove them. Coagulants in water treatment always contain inorganic ions with positive charges (e.g. iron and aluminum), inorganic polymers (e.g. polymerization aluminum chloride) and organic polymers with long chain and high molecular weight. Although all the coagulants could be used to destabilize colloids and suspended particles in aqueous solution, there are different coagulation mechanisms for different coagulants. According to the classic theory, coagulation can be accomplished through any of the four mechanisms including the compression of double-charged layer, adsorption & charge neutralization, inter-particle bridging and sweep-floc coagulation (Reynolds and Richards, 1995; HDR Engineering Inc., 2001; Jin, 2005). As for the coagulants containing positive charges, the compression of double-charged layer, adsorption & charge neutralization and sweep-floc coagulation are expected to contribute to coagulation (HDR Engineering Inc., 2001; Jin, 2005). However, inter-particle bridging and sweep-floc coagulation are suggested to be the main reasons for coagulation-flocculation when using polymers with long chain and high molecular weight (HDR Engineering Inc., 2001; Jin, 2005).

Electrical potential of most colloids and suspended particles including inorganic and organic compounds as well as algae in natural water is negative, and the electronegativity can be elevated under certain conditions such as that organic matter is adsorbed on the surface of the colloids and suspended particles (Parent et al., 1996; Clasen et al., 2000). Due to the hydrophilic and steric effects, electrostatic repulsion and the small size (Fig. 1), most colloids and particles in water present excellent stability (Edzwald, 1993a; Jeffrey et al., 1996). So it is difficult to remove them by traditional coagulation-sedimentation-filtration process, subsequently resulting in a lot of problems including the occurrence of colors, tastes and odors, the increase of turbidity, precursors of disinfection byproducts (DBPs), and the increase of coagulant demands (Knappe et al., 2004; Pieterse and Cloot, 1997; Fang et al., 2010a, 2010b; Lui et al., 2011; Schneider and Tobiason, 2000).

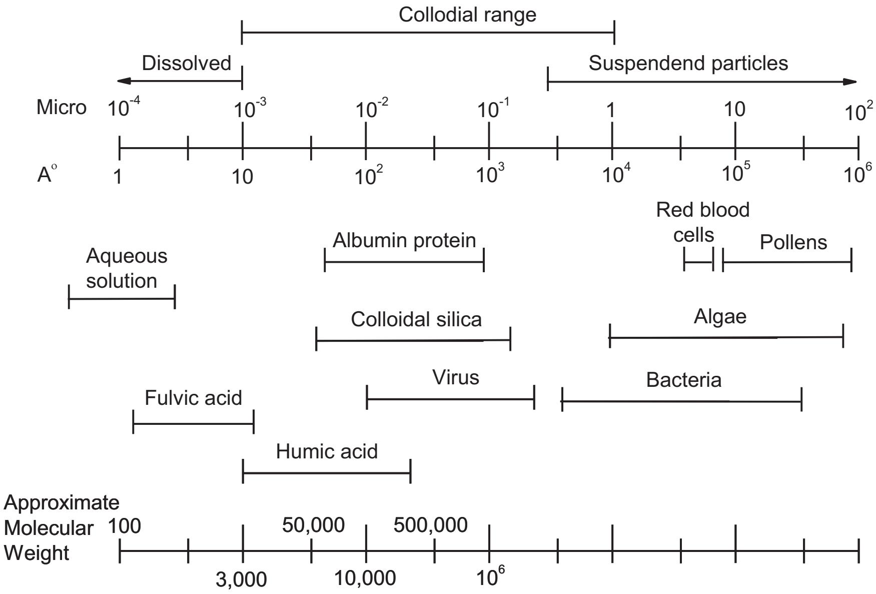

Fig. 1. –Size distribution of aqueous particles. Micrometer (μm) and Angstrom (Å) units are shown using a logarithmic scale, while the nominal molecular weights are approximate and are not scaled (Jeffrey et al., 1996).

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