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Effects of ultrasound pretreatment on the characteristic evolutions of drinking water treatment sludge and its impact on coagulation property of sludge recycling process

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Abstract: Large amounts of drinking water treatment sludge (DWTS) are produced during the flocculation or flotation process. The recycling of DWTS is important for reducing and reclaiming the waste residues from drinking water treatment. To improve the coagulation step of the DWTS recycling process, power ultrasound was used as a pretreatment to disintegrate the DWTS and degrade or inactivate the constituents that are difficult to remove by coagulation. The effects of ultrasound pretreatment on the characteristics of DWTS, including the extent of disintegration, variation in DWTS floc characteristics, and DWTS dewaterability, were investigated. The capacity of the recycling process to remove particulates and organic matter from low-turbidity surface water compared to a control treatment process without DWTS was subsequently evaluated. The coagulation mechanism was further investigated by analyzing the formation, breakage, and re-growth of re-coagulated flocs. Our results indicate that under the low energy density applied (0.03~0.033 W/mL) for less than 15 min at a frequency of 160 kHz, the level of organic solubilization was less elevated, which was evidenced by the lower release of proteins and polysaccharides and lower fluorescence intensities of humic- and protein-like substances. The applied ultrasound conditions had an adverse effect on the dewaterability of the DWTS. Ultrasound pretreatment had no significant impact on the pH or surface charge of the DWTS flocs, whereas particle size decreased slightly and the specific surface area was moderately increased. The pollution removal capacity decreased somewhat for the recycled sonicated DWTS treatment, which was primarily ascribed to organic solubilization rather than variability in the floc characteristics of sonicated DWTS. The main coagulation mechanism was floc sweeping and physical adsorption. The breakage process of the flocs formed by the recycling process displayed distinct irreversibility, and the flocs were stronger and more resistant to breakage compared to those from the control treatment.

Keywords: Ultrasonic pre-treatment; Drinking water treatment sludge; Organic solubilization; Dewaterability; Recycling; Floc characteristics

1 Introduction

Coagulation–flocculation is one of the most common and important water treatment processes for the removal of particulate and organic matter [1]. The toxicity of the residual coagulant and sludge production are the two main concerns with using conventional Al and Fe salts as coagulants [2, 3]. The large amount of drinking water treatment sludge (DWTS) produced during water treatment must either be disposed off in landfills or dumped into the ocean. The reuse of DWTS is an important alternative approach for reducing and reclaiming the waste residues from drinking water treatment. In addition to reducing waste disposal, the reuse of DWTS can

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