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# Roles of Fe(III) and Fe(VI) in enhancing dewaterability of sewage sludge based on floc size grading

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**ABSTRACT**

Ferric chloride and potassium ferrate have been proven to improve the dewaterability of sewage sludge. Flocs are flocculated by forming an $Fe(OH)_3$ colloid under the condition of ferric chloride. Furthermore, potassium ferrate can enhance dewaterability by solubilizing extracellular polymeric substances (EPS) and releasing bound water through oxidation. However, previous studies were all based on raw sludge consisting of a complex matrix, which increases the difficulty of analyzing the mechanism of a treatment. Although studies have shown that the main factors affecting the performance of dewatering are mainly related to EPS, surface charge, and particle size, they did not reveal the changes in the performance of EPS induced by ferric chloride and potassium ferrate. The primary functions of the influencing factors were also not compared. Our pre-experiments have shown that ferric chloride is more effective than potassium ferrate in improving dewaterability. To address these issues, size grading was adopted in the current study to screen raw sludge into samples with different particle sizes (0.5, 0.25, 0.1, and 0.075 mm). These samples were separately added with 4 mg/g of $FeCl_3$ or 0.2 g/L of $K_2FeO_4$ with pH = 4. All experimental parameters were derived from previous experimental results. Capillary suction time was used to characterize sludge dewatering. Zeta potential, particle-size distribution, Fourier transform infrared spectroscopy, and 3D excitation–emission matrix fluorescence spectroscopy were used to explore the influencing mechanisms. When conditioned by $FeCl_3$, parts of EPS were released due to the oxidability of $Fe^{3+}$. The floc surface charge was reduced, and the tiny particles formed large particles as a result of the flocculation of ferric iron and the small amount of soluble EPS. For samples conditioned by $K_2FeO_4$, EPS was dissolved, and a large amount of soluble EPS was released and further degraded. In this process, the floc surface charge decreased, and tiny particles were flocculated due to the presence of small amount of $Fe^{3+}$. Comparison of the experimental groups with different particle sizes showed that the flocculation of tiny particles in the sludge (<0.075 mm) improved the dewatering performance of the sludge and accounted for the superior effect of ferric chloride compared with that of potassium ferrate.

*Keywords:* Dewaterability; Iron compound; Particle size; Excitation–emission matrix; Tiny floc

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