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Effect of potassium ferrate (K_2FeO_4) on sludge dewaterability under different pH conditions

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HIGHLIGHTS

- ▶ The SRF values decreased with the decrease of sludge pH value pretreated by K_2FeO_4.
- ▶ K_2FeO_4 = 1200 mg/L at pH 3 is an optimal condition for improving sludge dewatering.
- ▶ EPSs content and sludge disintegration degree increased pretreated by K_2FeO_4 at pH 3.
- ▶ EPSs content and sludge disintegration degree were positively correlated with SRF.

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ABSTRACT

The potential effects of potassium ferrate (K_2FeO_4) on sludge dewatering under different pH values (between 3 and 8) and the mechanism of its reaction were investigated in this study. Specific resistance of filtration (SRF) was used to evaluate sludge dewaterability. Sludge water distribution was measured by the drying test. Sludge floc structure was observed by microscopic examination. Soluble chemical oxygen demand (SCOD), extracellular polymeric substances (EPSs) content, sludge disintegration degree and sludge particle size were measured to explain the observed changes in sludge dewaterability. The results indicated that the potassium ferrate pretreatment at pH 3 enhanced sludge dewaterability, while potassium ferrate pretreatment caused deterioration of sludge dewaterability at pH values of 4–8. At pH 3, sludge dewaterability increased with the increase of potassium ferrate, then decreased slightly when the dosage of potassium ferrate was greater than 1200 mg/L. The results showed that a potassium ferrate dosage of 1200 mg/L at pH 3 was an ideal condition, yielding maximum sludge dewaterability characteristics by generating sludge with optimal disintegration, and EPSs concentration. However, particle size changed slightly after potassium ferrate pretreatment at pH 3.

1. Introduction

Large amounts of waste activated sludge (WAS) are produced from wastewater treatment plants (especially the municipal wastewater treatment plants). Dewatering is one of the fundamental steps in sludge processing as it reduces sludge volume and, consequently, the cost of sludge transportation and disposal. However, the high water content and biological gel structure properties of sludge lead to difficulties in dewatering. Because of more stringent disposal regulations, appropriate sludge conditioning processes should be chosen prior to dewatering.

Various methods have been investigated as potential pretreatment technologies to enhance sludge dewaterability, such as the addition of calcined aluminum salts [1], acids and surfactants [2], seawater and brine [3], Fenton's reagent pretreatment [4,5], fungal treatment [6], ultrasonication [7], microwave irradiation [8], electrolysis [9,10], and explosive explosion shockwave pretreatment [11]. Most of these processes improved sludge dewaterability characteristics by disrupting extracellular polymeric substances (EPSs), one of the main components with a strong affinity for water [12,13]. Polysaccharides and proteins, which entrap the water and cause a high viscosity, are the main components of EPSs [14]. By binding cells and particulate matter together, EPSs also change the particle size distribution of the sludge, again influencing the dewatering properties.

For decades, advanced oxidation processes (AOPs) utilizing free radicals as a primary oxidant [5,12], have been given increasing amounts of attention for sludge dewatering [15,16], in view of the short treatment time and high dewatering efficiency. From previous researches, AOPs improved the sludge dewaterability by affecting of the EPSs in two ways: (1) AOPs have the potential to degrade EPSs and; (2) AOPs influence the multifunctional groups of EPSs and promote their participation in several interactions [12,17]. The responsible mechanism is not fully understood, but

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