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Effect of aluminum speciation on silica removal during coagulation of heavy-oil wastewater using polyaluminum chloride

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ABSTRACT

Desiliconization techniques for heavy-oil wastewater are complex and costly. The effect of polyaluminum chloride (PACl) on silica removal during coagulation, however, has not been examined. In this study, the effect of PACl on the removal of soluble silica in heavy-oil wastewater was investigated by analyzing the major species of silica and aluminum during various stages of coagulation. Soluble silica could be divided into three species based on increasing molecular weight: monomer and dimer (Si_a), oligomer (Si_b), and polymer (Si_c). Likewise, aluminum hydrolysates could be divided into the species Al_a, Al_b, and Al_c, which correspond to oligomers of increasing molecular weight. Three PACl samples of specific basicities synthesized in our laboratory, with Al_a, Al_b, and Al_c being dominant in one of the samples, were used. Aluminum salts and preformed collosols of amorphous aluminum hydroxide were employed to explore the effect of Al_a and Al_c on soluble silica in wastewater. Results show that Al_a and Al_c promoted the removal of Si_c and Si_a, respectively. The interaction of Si_c and Si_a with Al_a and Al_c, respectively, can be described as absorption-modification, causing the formed admixtures of silica and aluminum to become more insoluble and more susceptible to coagulation. A mechanism involving electrostatic patch coagulation is introduced to explain the reaction of soluble silica and other substances with PACl.

Keywords: Heavy-oil wastewater; Soluble silica; Aluminum hydrolysates; Absorption-modification; Aluminosilicate sites

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