Anodic Reactivity of Ferrous Sulfide Particles Generated in Wastewater Treatment

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Abstract

Ferric phosphate (FePO₄) sludge is routinely generated in wastewater treatment by addition of ferric chloride to remove phosphates and precipitate suspended solids. After the addition of sulfide to the FePO₄, sludge, insoluble FeS particles are generated, leaving behind a phosphate-rich liquid, which can potentially be used as fertilizer. Electrochemical oxidation of FeS can lead to recovery of ferric iron for reuse in the process. In this study, the reactivity of FeS particles for anodic oxidation at pH 4 was studied as a function of sludge age, showing significantly greater reactivity for young FeS particles. Sulfate formation at E>0.8 V vs. SHE was observed.

Results and conclusions

Figure 1 shows the CVs of fresh and 2-month-old FeS particles. It can be observed that FeS particles are reactive at pH 4 for anodic oxidation. The liquid phase samples confirmed the formation of SO₄²⁻ above 0.8 V vs. SHE in both CVs. As oxidation to sulfate is irreversible, operating at potentials greater than 0.8 V would lead to permanent loss of sulfur. Greater reactivity of the fresh FeS particles was seen compared to the 2-month-old ones. This could be a consequence of the stabilization and size increase of FeS particles with time. Sulfur balance revealed that elemental sulfur was the main oxidation product.

Materials and Methods

A modified 250 ml Schott bottle was filled with graphite granules as working electrode up to 100 ml. Two graphite rods were used as current collector and counter electrode, respectively. 150 ml of a 3.6 mM FeS suspension in 0.1 M acetate buffer (pH 4.0) was fed into the reactor and continuously recirculated by means of a peristaltic pump. The solution was deoxygenated with nitrogen prior to starting the experiment. An Ag/AgCl reference electrode was constructed and immediately used. Cyclic voltammograms (CV) were recorded with a Biologic potentiostat at a scan rate of 0.1 mVs⁻¹ between 0 and 1.3 V vs. SHE. During CV, the pH was controlled to 4.0 and samples were taken to determine sulfur speciation using Ion Chromatography (IC).

Figure 1. Cyclic voltammogram of 3.6 mM FeS solution at pH 4 and scan rate of 0.1 mVs⁻¹. Solid line: fresh FeS, dashed line: 2-month-old FeS, dotted line: acetate buffer control.

References