Use of Stream Analyzer for Solubility Predictions of Selected Hanford Tank Waste

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Stream Analyzer was used to predict the solubility of several components in Hanford tank wastes in order to evaluate a newly implemented, graded solubility model. Small changes in waste phase distribution can have large impacts on the quantities of waste glass produced, the mission duration at Hanford, and the project lifecycle cost; therefore, the integrated solubility model (ISM) is an important step in predicting waste phase distribution. The ISM groups the components into four categories based on their impact during waste treatment. Each category is characterized by sub-models of varying levels of complexity, ranging from simplified correlations to a set of Pitzer equations used for the minimization of Gibbs Energy. Analyzer results were compared to experimental tank waste analyses, studies, literature data and ISM predictions. Due to the complexity of Hanford tank wastes, predictions within an order of magnitude were deemed good estimates.

Our finding was that chloride, nitrate, nitrite, sodium, phosphate, fluoride (high impact); silver, bismuth (medium impact); manganese, magnesium, lanthanum, and zirconium (low impact) are predicted well (within one order of magnitude) by Stream Analyzer and the ISM. Stream Analyzer predicts chromium well, but the ISM is off by 1-2 orders of magnitude. Hydroxide, oxalate, and sulfate are accurately predicted 80% of the time, while aluminum is accurately predicted 60% of the time. Calcium, iron, and nickel are off by 2-5 orders of magnitude.

Based on the results, the calcium, iron, nickel and especially chromium equations in the ISM should be reevaluated and possibly modeled in more detail. The oxalate, sulfate, and aluminum (high impact) parameters should be further explored. Even though fluoride and phosphate were predicted well, some data trends indicate they should also be further explored. The solubility data used to predict the Pitzer model coefficients for these high impact components may need to be expanded to better represent tank waste conditions. Focusing on solubility data for solids predicted by the Pitzer model is recommended, specifically Na7F(PO4)3•19H2O, Na3FSO4, Al(OH)3, and NaC2O4.

Abstract

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