

Report as of FY2007 for 2006WV81B: "Chloride Sorption to Acid Mine Drainage Solids (WRI-84)"

Publications

Project 2006WV81B has resulted in no reported publications as of FY2007.

Report Follows

Final Report: Chloride Sorption to Acid Mine Drainage Solids

Project Number: 2006WV81B

Louis M. McDonald

Division of Plant & Soil Sciences

West Virginia University

Introduction

Reports suggest that chloride concentrations are increasing in mine water and surface waters affected by mining operations. Chloride concentrations above the in-stream limit of 250 mg L^{-1} would require treatment, but chloride is a particularly difficult ion to remove from aqueous solution. The results of this project would be of interest to the State Department of Environmental Protection, Coal Operators and others interested in meeting existing and emerging water quality standards.

Stated Nature, Scope and Objectives

Because of the need to control experimental conditions, all experiments will be conducted in the laboratory using fully characterized solutions and solids. Chloride and sulfate sorption to AMD solids will be characterized using competitive sorption isotherms. Experimental conditions will span the range of anticipated field conditions. The objectives are 1) to quantify chloride sorption to AMD solids as a function of sulfate concentration, pH, and the absence and presence of the specifically sorbing cation Mn^{2+} . Aluminum will be included because it often occurs in AMD. 2) To determine the extent to which chloride is part of the occluded water in AMD precipitates.

Actual Nature, Scope and Objectives

An earlier WWRI had suggested that chloride could be removed from AMD by sorption to precipitating solids. However, before proceeding to the full experiments described above, preliminary experiments were conducted to confirm these results.

Materials and Methods

One liter of each experimental solution was prepared as shown in Table 1. Iron was added as $\text{Fe}(\text{NO}_3)_3$, sulfate as $\text{Na}_2(\text{SO}_4)$, chloride as NaCl . Sodium nitrate (NaNO_3) was added as an indifferent electrolyte to control ionic strength. The remaining solution was adjusted to approximately pH 2 and then titrated to pH 10 with NaOH in nine increments using an Accumet pH meter (Model No. 15, Fisher Scientific, Pittsburgh, PA) and a Ross Sure-Flow combination electrode (Fisher Scientific, Pittsburgh, PA). At each pH increment, visible absorbance at 450 nm was determined with a fiber-optic dip probe attached to a spectrophotometer (Cary 50 UV-Vis, Varian Inc., Palo Alto, CA) to determine the onset of precipitation. Chloride activity was determined at each titration point using a chloride specific electrode (Accumet, Fisher Scientific, Pittsburgh, PA). Maximum chloride removal was calculated by difference and assuming that all initial iron in solution precipitated.

Table 1. Ion concentrations and ionic strength for each experimental solution.

Solution	Iron (III)	Chloride	Sulfate	Nitrate	Sodium	Ionic Strength
		----- mM -----				----- M -----
A	10	1.7	10	30	21.7	0.047
B	10	1.7	0	60	31.7	0.047
C	10	1.7	20	30	41.7	0.077
D	10	1.7	0	90	61.7	0.077

Results

For all solutions precipitation was essentially complete by pH 3 (data not shown). When comparing solution A to B and Solution C to D (Table 2), it is apparent that the presence of sulfate in solution depressed chloride removal. The average maximum

amount of chloride removed from solution, under these experimental conditions was 0.046 mg per gram Fe(III) precipitated.

Table 2. Maximum chloride removed at constant ionic strength.

Solution	I	Sulfate	Chloride Removed
		----- mM -----	-----mg Cl/g Fe -----
A	0.047	0	0.044
B	0.047	10	0.038
C	0.77	0	0.060
D	0.77	20	0.040

Conclusions

A second year of funding to investigate AMD flocs as a removal technology for chloride was not requested. In our preliminary work with iron-sulfate flocs, using a chloride selective electrode for chloride determinations, the average chloride removal was 0.046 mg chloride per g iron precipitated, an amount considered too low for a practical treatment technology. In addition chloride removal was strongly inhibited by the presence of sulfate.