

Comparison of heavy metal removal using adsorbing agents for acid mine drainage

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This study investigated the potential for utilizing 6 adsorbing agents for acid mine drainage (AMD) wastewater. These materials, with a high capacity for heavy metals, can be obtained and employed as alternative low-cost limiting substitutes. For investigating the neutralization capacity, the change in pH, Eh, and EC as a function of time was quantified. Results of column studies demonstrated that the removal rate of Fe and Mn by the tested agents was influenced by their chemical compositions. The results suggest that concrete can be used successfully in the treatment of acid mine drainages with mixed metal-contaminated wastes.

Heavy metals discharged by abandoned acid mine drainage (AMD) are one of the major causes of contaminated subsurface environments [1]. After release of low pH AMD, the geochemical behavior of metals released from the acidic tailing minerals depends on a number of different physicochemical parameters. The mobility of metal ions then is often determined by potentially forming particulate and colloidal species being stabilized and dispersed in the water.

Column experiments were conducted at room temperature. Adsorbing agent filings were then uniformly mixed with sand and packed into polyvinylchloride (PVC) columns. A total of 100 liters AMD were passed through each column for 90 days. The columns were slowly flushed from the bottom and mixed heavy metal solutions were introduced to each column with a specific discharge rate of 4.3 ml h⁻¹. Effluent samples were collected with small vials once a day for 10 min at the same time to measure pH, redox potential (Eh), electric conductivity (EC), and metal concentrations.

Of the agents, concrete showed the highest neutralization efficiency for AMD. The presence of such strongly reducing conditions is consistent with the chemical reduction of not only oxygen, but also iron and manganese [2]. The EC decreased as a function of time since metals in the system may precipitate due to high pH values, which enhances hydroxide precipitation.

With respect to Fe and Mn, Fe removed from the AMD was very high, above 90% for concrete. It should also be noted that limestone and starfish had a much higher affinity for removing Fe than Mn. While manganese can theoretically exist in numerous oxidation states, only the +2 and +4 valences are commonly found in natural waters [3]. Oxidation of the manganous ion (Mn²⁺) is pH dependent, being quite slow below pH 9 even though it is thermodynamically favorable.

[1] Akcil & Koldas (2006) *J. Clean. Product* **14** 1139-1145.
[2] Sposito (1989) *The Chemistry of Soils*. [3] Stumm & Morgan (1996) *Aquatic Chemistry*.

Dissolution of anorthite under supercritical CO₂ – water – mineral reaction system at a CO₂ sequestration site

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The objective of this study is to investigate the dissolution of Ca-feldspar (anorthite) when the mineral reacts with supercritical CO₂ and water at the CO₂ sequestration site. The dissolution of anorthite caused by the reaction with supercritical CO₂ and water at high pressure condition (100 bar and 50°C) was simulated in the high-pressure cell. Cleaved anorthite crystals from a fresh-single crystal (purchased from Hansol fossil & mineral specimens Inc.) were polished and cut a few millimeters. The stainless steel cell (104 ml in capacity; purchased from Thar Inc.) was used to simulate the subsurface condition for CO₂ sequestration. Several crystal samples were glued on a stainless steel plate, which was fixed in the high-pressure cell. Experiments for anorthite dissolution were performed in two different methods. At first, an anorthite was reacted with supercritical CO₂ and distilled water and its dissolution in water was investigated at different time intervals. For the next experiment, anorthite samples were exposed to only supercritical CO₂. For both experiments, the inside of the high-pressure cell was maintained at 100 bar and 50°C for 30 days and the surface of each sample was visualized by SEM (Scanning Electron Microscope) and the roughness of the sample was also measured by SPM (Scanning Probe Microscope) every 10, 20, and 30 days in the experiment. The main compounds dissolved in water were also analyzed on ICP/OES (Perkin elmer (U.S.A.), Optima3300XL) for the experiment. Results from the first experiment showed that the average roughness of sample surface was 0.155 nm before the reaction. It maintained for 20 days, but considerably increased to 2.493 nm after 20 days. In the second study, the average roughness of sample surface slightly decreased from 0.559 nm to 0.217 nm for 10 days, and maintained about 0.285 nm for the next 20 days.