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Acid neutralization by dissolution of alkaline paper mill wastes and implications for treatment of sulfide-mine drainage

Rafael Pérez-López,[1,2,*] Dino Quispe,[2] Julio Castillo,[2] and José Miguel Nieto[2]

[1]Institute of Environmental Assessment and Water Research, IDÆA-CSIC, Jordi Girona 18, 08034, Barcelona, Spain
[2]Department of Geology, University of Huelva, Campus "El Carmen," 21071, Huelva, Spain

Abstract

Metal removal and neutralization of acid mine drainage (AMD) in treatment systems is often controlled by addition of alkaline reagents and metal hydrolysis reactions. To overcome the disadvantage of high cost by conventional treatments, the use of paper mill wastes was evaluated as an alkaline additive to treat AMD at sites within the Iberian Pyrite Belt (IPB) through batch experiments in the laboratory. Paper wastes include three by-products from kraft pulping in a nearby mill: green liquor dregs, slacker grits, and lime mud. When paper mill wastes interacted with AMD, the initial pH increased up to circumneutral values and enhanced greatly the metal removal, reaching average ratios of up to 100% for Al, 98% for Fe, and 66% for Zn (major elements) and 100% for As, Cr, and Cu, 84% for Cd, and 75% for Ni (minor elements). After reaction, gypsum and poorly crystalline Fe-Al oxy-hydroxides and oxy-hydroxysulfates were the main precipitates identified by X-ray diffraction and scanning electron microscopy. Trace metal uptake is mainly attributed to co-precipitation and/or adsorption onto the newly formed Fe-Al precipitates. Geochemical modeling of solutions using the PHREEQC code predicted supersaturation of the observed phases. The experimental results were optimized with the PHREEQC code and combined with the annual production of each waste to quantify the extent of a possible treatment at field-scale. According to our estimations, the system proposed is able to treat effectively an annual total volume of 11.6 hm^3, which is equivalent to a mean discharge of 368 L/s. Green liquor dregs alone would be able to treat 86% of the total volume. This result demonstrates the possibility of using alkaline paper mill wastes for treatment and restoration of worldwide natural resources extremely contaminated by AMD such as the IPB.

Keywords: Acid mine drainage, treatment, paper mill wastes, Iberian Pyrite Belt