Manganese removal from coal mine drainage using limestone leaching beds

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Abstract

Limestone leaching are utilised as passive treatment systems for removal of Mn(II) from mine drainage. Oxidation of Mn(II) by O^2 is kinetically inhibited at circumneutral pH, however it can be catalysed by Mn oxidising microorganisms and by mineral surfaces, particularly those of Mn oxides. Although limestone treatment can be effective, the mechanism of Mn removal is not well understood.

Six laboratory-scale reactors were set up to probe the relative importance of microbial Mn oxidation and autocatalytic Mn oxidation in limestone leaching beds. Duplicate reactors were constructed using limestone, limestone with pyrolusite, and quartz (as a control). Acid mine drainage (AMD) containing 2 mg/L Mn, 0.3 mg/L Zn, and 0.08 mg/L Ni was collected from Fanny Creek on the West Coast of New Zealand. The 'biotic' set of reactors had AMD leaching through the rock bed, while AMD treated with biocide was percolated through the 'abiotic' reactors.

The limestone, and limestone with pyrolusite reactors removed Al, Mn, Ni an Zn from the AMD solution. Removal of Mn by limestone alone is minimal, and is enhanced by the presence of pyrolusite in a reactor. The most effective removal of Mn was achieved in the biotic limestone reactors, and microbial Mn (II) oxidation appears to be important for optimal removal of Mn from solution. Inoculating the limestone beds with pyrolusite boosted removal efficiency of the reactors. Ni and Zn removal appeared coupled to Mn removal, and is likely due to sorption onto Mn oxide surfaces. Pyrolusite addition to limestone beds could be considered if maximum Mn removal is required immediately, however once microbial communities are established any benefit will be negligible.

Keywords: Coal mine drainage, limestone bed, manganese oxide, nickel, zinc.