

Manganese Removal From Neutral Mine Drainage Through a Trial Scale Passive Treatment System

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Design of passive treatment systems to remove manganese from water is difficult because manganese is highly soluble in acidic and circum-neutral waters. We present results of trial systems for the passive treatment of Mn rich, reduced, neutral mine drainage from a non-operational gold mine. The discharge has a pH ~ 6, alkalinity ~150 ppm, dissolved oxygen (DO) <1 ppm and elevated Fe, Mn, As and Zn. Interpretation of the NMD indicates four important factors: (1) the dissolved Fe concentration is ~20 ppm and is all Fe(II), (2) Fe(II) is controlled by saturation with respect to siderite (FeCO₃), (3) remaining Fe is all colloidal Fe(OH)₃, and (4) Mn concentration is saturated with respect to rhodochrosite (MnCO₃).

Equilibrium of Fe and Mn concentrations with minerals means that dissolved concentrations are stable and a treatment system can be optimised to the water chemistry. A pilot scale passive treatment system has been installed that includes an oxygenation cascade, a settling/reaction pond and a slag leaching bed. The system treats Fe(II) by oxidation to Fe(III) followed by precipitation and settling of Fe(OH)₃. While this reaction is net acid producing, the high alkalinity prevents acidification, and release of dissolved CO₂ causes the pH to increase. Manganese is removed by precipitation of Mn oxides and oxy-hydroxides in the slag leaching bed at elevated pH and high DO. Zinc and As are removed through adsorption onto Fe(OH)₃.

The oxygenation cascade and settling/reaction ponds remove 82-96% of the Fe, 10% of the Mn, 89% of the As, and 59% of the Zn. The slag leaching bed removes 99% of the remaining Mn. Increase in DO concentrations through the cascade of V-notch weirs closely matches predicted values, and oxidation rates of Fe(II) through the reaction chambers relate well to iron oxidation kinetics.