Enhanced Decarbonation of Mine Drainage using Iron Oxidation

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Abstract: Ferruginous underground coal mine drainage in the Appalachian region contains elevated concentrations of inorganic carbon due to interactions between mine pools and alkaline recharge water. Inorganic carbon species in these waters are predominately either in the form of carbonic acid (H_2CO_3) or bicarbonate alkalinity (HCO_3^-). Alkali chemical costs are increased when mine water enriched in inorganic carbon is treated due to the acidity released when carbonic acid and bicarbonate deprotonate as pH is increased. A common strategy to minimize the deprotonation of carbonic acid is to use an aeration device to decarbonate the mine water before adding alkali chemical. Conversely, the mine drainage treatment community lacks a strategy to minimize the deprotonation of mine water enriched in bicarbonate.

A novel strategy to minimize deprotonation of both carbonic acid and bicarbonate was implemented at two active treatment plants. The strategy consisted of promoting ferrous iron oxidation and precipitation prior to, or in conjunction with, a decarbonation step. The acidity produced by iron hydrolysis serves to deprotonate bicarbonate producing carbonic acid, which then is decarbonated prior to alkali addition. The process aims to decrease the concentrations of bicarbonate and carbonate by transforming these species into carbonic acid before or during decarbonation, prior to pH adjustment.

One site used a 50% by wt. solution of Hydrogen Peroxide ($H_2O_{2)}$ to promote Ferrous iron oxidization while the other site used mechanical aeration. The strategy increased the removal of inorganic carbon from 26% to 56% and resulted in a net annual cost savings of 50%. Both sites were successfully geochemically modeled proving a cost analysis can be preformed at sites to evaluate whether enhanced decarbonation, decarbonation, or conventional alkali addition is most cost effective.

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