



Using iron oxidation and decarbonation to enhance inorganic carbon removal in coal mine drainage

Brent Means¹, Richard L. Beam²

¹Hydrologist, U.S. Office of Surface Mining Reclamation and Enforcement, 215 Limekiln Road, New Cumberland, Pennsylvania, 17070,

bmeans@osmre.gov

²Geologist, U.S. Office of Surface Mining Reclamation and Enforcement, Three Parkway Centre, Pittsburgh, Pennsylvania, 15220, *rbeam@osmre.gov*

Abstract

Coal mine drainage in the Appalachian region of the United States often contains high concentrations of inorganic carbon, mostly in the form of carbonic acid (H_2CO_3) and hydrogencarbonate alkalinity (HCO_3^-). Both species deprotonate and release acidity when neutralizing chemicals are used to increase pH for metal precipitation. There are cases where deprotonation of inorganic carbon constitutes 80% of alkali chemical consumption. Treatment strategies are needed to minimize these nuisance reactions and lower chemical consumption.

Traditionally, a decarbonation step is employed before alkali addition to lower the H_2CO_3 concentration, thereby minimizing deprotonation and alkali addition. Typically, compressed atmospheric air is bubbled in a reactor for gas transfer to lower H_2CO_3 prior to alkali addition and metal removal. This widely used technique is effective if most of the inorganic carbon is in the form of H_2CO_3 but ineffective if HCO_3^- is the dominate form since only H_2CO_3 participates in the gas transfer reactions required for decarbonation. The industry needs a strategy to minimize the deprotonation of HCO_3^- since many of the large ferruginous coal mine discharges in Northern Appalachia are circumneutral pH and contain over a hundred milligrams per liter of hydrogencarbonate.

A 20,000 liter-per-minute facility in southwestern Pennsylvania treats coal mine drainage elevated in ferrous iron and hydrogencarbonate. Annual lime costs were unnecessarily high due to the deprotonation of hydrogencarbonate during pH adjustment. A novel treatment strategy was employed to reduce alkali consumption due to hydrogencarbonate deprotonation. The strategy involved using natural aeration or hydrogen peroxide to force iron to oxidize prior to decarbonation and pH adjustment. The acidity from iron hydrolysis converts a large percentage of the HCO_3^- to H_2CO_3 , thereby transforming most of the inorganic carbon into a form that can be removed by decarbonation prior to pH adjustment. The critical step of oxidizing the iron prior to decarbonation enhanced inorganic carbon removal from 26 to 56% and resulted in a net annual lime savings of 50%.

The site was successfully geochemically modeled proving a cost analysis can be performed at sites to evaluate whether the enhanced decarbonation, decarbonation, or conventional alkali addition is most cost effective for a given site. An evaluation should be completed at all sites where an alkali chemical is used to adjust circumneutral-pH mine drainage.

Keywords: Treatment, carbon dioxide, lime treatment, carbonic acid