Preliminarily Assessing Ferrate (Fe(VI)) as an Acid Mine Drainage Treatment Option[1]

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Abstract: Ferrate (Fe(VI)) is a strong oxidant with alkaline properties that has been recently gaining traction in water treatment applications. However, despite its growing prevalence, promising properties, and relative ease of formulation, it has not yet been explored as an acid mine drainage (AMD) treatment option. Our study was executed to preliminarily assess the viability of ferrate as an option for the treatment of net-acidic AMD from a partially flooded coal mine in western Pennsylvania. We focused on the oxidation of Mn and Fe as well as the subsequent precipitative removal of both Mn, Al, and Fe. Two different dosing approaches were applied: Fe(VI) only, and Fe(VI) with sodium hydroxide (NaOH) added simultaneously. When only Fe(VI) was added, the oxidation of Mn and Fe was incomplete, even at stoichiometrically excessive amounts, indicating Fe(VI) auto decay or forced formation (e.g. activation) of Fe(V/IV) were competitive pathways in low pH matrices. When NaOH and Fe(VI) were added simultaneously, the oxidation of Fe was complete, an Mn oxidation approached the theoretical stoichiometry of a net 2 electron transfer resulting in Fe(III) and Mn(IV). The formation of Mn(VII) was noted at Fe(VI) dosages above this stoichiometric requirement, which would be problematic in full-scale systems that are not continuously monitored and adjusted. Resultant Fe(III) and Al(III) particles were relatively large, suggesting success in subsequent removal through gravity-driven clarification. Resultant Mn(IV) particles were relatively small and settled water turbidity approach 50 NTU, indicating that additional particle destabilization and aggregation may be required to meet Mn effluent and other water quality goals. Overall, Fe(VI) seems viable for the treatment of AMD especially when sourced through the wet-oxidation method due to the coexistence of NaOH in the product stream. However, much more research is required to answer extant fundamental mechanistic and application questions[3].

Additional key words: oxidants, chemical addition, dosing

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1. Oral paper presented at the 2019 National Meeting of the American Society of Mining and Reclamation, Big Sky, MT. Welcome Back to Montana: The Land of Reclamation Pioneers, June 3–7, 2019. Published by ASMR, 1305 Weathervane Dr., Champaign, IL 61821.
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3. Work reported here used waters from a mine discharge near 40.367135°, -78.646209°.

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