Use of Na-Ferrate (VI) to prevent acid drainage from uranium mill tailings based on the application of NA-Ferrate (VI).

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The operation of uranium mining and milling plants gives rise to huge amounts of wastes from both mining and milling operations. When pyrite is present in these mining and milling wastes, the generation of acid drainage can take place and result in the contamination of underground and surface waters through the leaching of heavy metals and radionuclides. Presently, millions of tons of sulfuric acid generating tailings are being generated globally. To solve this problem, many studies have been conducted to find cost-effective solutions to manage acid mine drainage; however, no adequate strategy to deal with sulfide-rich wastes is currently available. Ferrate (VI) is a powerful oxidizing agent in aqueous media. Under acidic conditions, the redox potential of the Ferrate (VI) ion is the highest of any other oxidant used in wastewater treatment processes. The standard half-cell reduction potential of ferrate (VI) has been determined as +2.20 V to + 0.72 V in acidic and basic solutions, respectively. Despite innumerous beneficial properties in environmental applications, ferrate (VI) has remained commercially unavailable. Starting in 1953, different methods for producing a high purity, powdered ferrate (VI) product were developed. However, producing this dry, stabilized ferrate (VI) product required numerous process steps which led to excessive synthesis costs (over $20/lb) thereby preventing bulk industrial use. Recently a novel synthesis method for the production of a liquid ferrate (VI) based on hypochlorite oxidation of ferric ion in strongly alkaline solutions has been discovered (USPTO 6,790,428; September 14, 2004). This on-site synthesis process dramatically reduces manufacturing cost for the production of ferrate (VI) by utilizing common commodity feedstocks. This breakthrough means that for the first time ferrate (VI) can be an economical alternative to treating acid mining drainage generating materials. The objective of the present study was to investigate a methodology of preventing the generation of acid drainage by applying ferrate (VI) to acid generating materials prior to the disposal in impoundments or piles. Oxidizing the pyritic material in mining waste could diminish the potential for acid generation and its related environmental risks and long-term costs at disposal sites. The effectiveness of toxic metals removal from acid mine drainage by applying ferrate (VI) is also examined. Results presented in this paper show that the oxidation of pyrite by ferrate is a first-order rate reaction in Fe(VI) with a half-life of about six hours. The stability of Fe(VI) in water solutions will not influence the reaction rate in a significant manner. New low-cost production methods for making liquid ferrate on-site makes this technology a very attractive option to mitigate one of the most pressing environmental problems in the mining industry.