

OXIDATIVE PRECIPITATION OF METALLIC ELEMENTS FROM ACID MINE DRAINAGE

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Acid mine drainage from active and abandoned coal and metal mines degrades aquatic habitat, water quality, and the aesthetics of streams. Conventional mitigation raises the acidic pH to 8.5-11 by adding large amounts of limestone and other bases. The water is then impounded in large sedimentation ponds to allow atmospheric oxygen to oxidize and precipitate the metallic elements. This two-stage process is necessitated by the slowness of oxidation by molecular oxygen in acid solutions. The slowness is caused by the large activation energy required to break the O=O bond. Because of the lower activation energy, oxygen molecules therefore form hydrogen peroxide (H-O-O-H) as an intermediate. Being innately unstable, however, H₂O₂ is quickly decomposed back to water and oxygen due to catalysis by Fe and Mn. The maximum Eh that aeration can achieve was found to be about 0.4 volts lower than the hypothetical equilibrium value for the O₂-H₂O reaction. Addition of H₂O₂ to acid drainage samples failed to increase the Eh achieved by extended aeration, proving that H₂O₂ is no more effective than O₂ in precipitating all the oxidizable metals.

Ozone is a much faster and stronger oxidizer than either O₂ or H₂O₂. In laboratory tests, ozone precipitated Mn, Fe, Ni, Co, Pb, and Ag rapidly even in acid solutions. A compact flow reactor may therefore be used instead of large impounding ponds, making metal recovery easy. In the absence of these metals, the discharge pH can be kept near neutral, decreasing the amount of sludge. Thus reduction and re-dissolution of metals by organic matter will be avoided.