The Use of Solar-Powered Float-Mix Aerators to Increase Iron Retention in Topographically Limited Passive Treatment Oxidation Ponds[1]

D.M. Dorman* and R.W. Nairn[2]

Abstract: In the passive treatment of mine drainage, oxidation ponds are the primary cells used to promote oxidation and retention of metals such as iron. Aeration techniques are often applied to increase the oxidation rate by entraining more oxygen into the water column. Aeration in passive treatment of mine drainage is commonly achieved by dissipation of energy from hydraulic head differences. However, this type of aeration is not feasible for sites located in regions with limited topographic relief. This study investigated the effectiveness of custom-designed solar-powered float-mix aerators (FMAs) deployed at the Southeast Commerce Passive Treatment System in the Tar Creek Superfund Site to increase dissolved oxygen (DO) concentrations, degas carbon dioxide (CO_2) and promote iron (Fe) retention from multiple perspectives: (1) with respect to depth in the water column, (2) spatially with respect to the aerator, and (3) spatially within the oxidation pond to examine overall effect of aeration on the performance of the oxidation pond. The study found that the FMAs statistically increased DO saturation and pH at a depth of 0.4 meters and shallower, increased DO saturation up to 9 meters downstream compared to solely passive aeration and increased overall DO saturation by more than 100% compared to when the FMAs were off. The DO increase resulted in CO_2 degassing with subsequent pH increases. The increase in DO and pH promoted Fe oxidation indicated by a larger fraction of the Fe present in the particulate form compared to when the aerators were off. Data comparing influent water quality data to effluent water quality of the oxidation pond showed that the oxidation pond increased DO saturation by over 100%, degassed CO_2, and removed an average 93% of the influent Fe loading when the FMAs were on. Active FMA aeration increased Fe removal rates in the oxidation pond by 17% from 22 g m^{-2} d^{-1} without the FMAs to 26 g m^{-2} d^{-1} with the FMAs. This study shows that FMAs are a viable aeration technology for sites where gravitational energy driven aeration is not feasible due to topographic limitations.

Additional Key Words: aeration, net alkaline water, acid mine drainage, passive treatment systems.

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2. Dayton M. Dorman, PhD Student, and Robert W. Nairn, Professor, Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, OK 73019.

3. Work reported here was conducted near 36°55’34.04”, 94°52’30.98”.