Removal of Gaseous and Aqueous Biogenic Sulfide from Vertical Flow Bioreactor Effluent via Solar-Powered Blowers[1]

Robert W. Nairn* and Taylor Wall[2]

Abstract: Passive treatment system vertical flow bioreactors (VFBRs) may produce excess sulfide, a source of nuisance odors and toxicity. Aqueous sulfide concentrations greater than 0.002 mg/L are considered chronically ecotoxic and prolonged human exposure to gaseous concentrations greater than 20 ppmv leads to fatigue, poor memory, and dizziness. In this study, a novel sulfide removal approach using a custom-designed solar-driven system with activated carbon filter (ACF) was evaluated. The study site, the Southeast Commerce passive treatment system (SECPTS) at the Tar Creek Superfund Site (the Oklahoma portion of the abandoned Tri-State Lead-Zinc Mining District), addresses 380 L/min of net alkaline mine waters. The system consists of an oxidation pond, surface flow wetland, VFBR, and final polishing unit (FPU). VFBR effluent enters a closed odor control structure (OCS) from which the sulfide-rich atmosphere is pulled into the ACF (containing 180 kg of activated carbon media) using a solar-powered vacuum blower. Solar-powered pressure blowers re-aerate the water column through float-mix aerators in the post-VFBR FPU. Aqueous sulfide concentrations were determined by laboratory analyses of surface grab water samples and gaseous sulfide concentrations were field-measured using a handheld gas detector and Draeger hydrogen sulfide gas detection tubes. Throughout the sampling period (December 2017-October 2018) maximum aqueous sulfide concentrations in the VFBR effluent were 84 mg/L and gaseous sulfide concentrations in the OCS atmosphere were 950 ppmv, although values were typically lower. FPU effluent aqueous sulfide concentrations measured 0.13 ± 0.28 mg/L. ACF exhaust gaseous sulfide concentrations measured 41± 56 ppmv. Over the study period, approximately 14,000 kg S were retained by SECPTS, presumably mainly via bacterial sulfate reduction in the VFBR. Additionally, 100 kg gaseous S entered the ACF with 30 kg retained in the ACF media, 20 kg leaving the ACF as exhaust to the open atmosphere and 40 kg leaving the ACF in liquid form as sulfuric acid. Evaluation of the off-the-grid renewable energy-powered sulfide-removal and aeration systems indicates that they enhance water quality improvement effectiveness, efficiently remove gaseous sulfide and may be especially attractive for use in remote locations and/or at sites where operation and maintenance budgets are limited.

Additional key words: Bacterial sulfate reduction, sulfide production, activated carbon, sorption, toxicity,

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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.

2. Robert W. Nairn (* presenter), Professor, and Taylor Wall, Graduate Research Assistant (student), 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 N 36°55'35.04" and W 94°52'38.40"