Constructed Wetlands for the Remediation of Blast Furnace Slag Leachates

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Air cooled blast furnace slag is a by-product of iron and steel production and is primarily composed of silica, aluminum, magnesium, sulfur, iron, manganese, and calcium with other trace elements. With nearly 13 million tons produced each year by the steel industry in the United States, the material is recycled and often used as fill material for roads and other transportation structures. Although the material has many benefits and uses, under certain conditions it can generate an unsightly greenish/yellowish, sulfurous leachate, exhibiting high pH and an extremely unpleasant smell. The leachate does not comply with state water quality standards and can be potentially toxic to aquatic ecosystems.

During construction of an embankment and overpass on I-65 in Hobart, IN, approximately 60,000 tons of slag was used as transportation support material. Sometime after construction, leachate began to emerge periodically from the embankment. The resulting reaction stems from under-weathered, “fresh” slag interacting with runoff and a possible perched groundwater table within the embankment. This leachate is considered a “nuisance” by IDEM and has forced INDOT to develop a remedial action. The use of constructed wetlands was seen as a viable treatment option for this water pollution problem.

The overall objective of this research was to explore the use of constructed wetlands as a passive means to biologically and chemically eliminate the negative properties of the leachate. Treatment is to be achieved via the prevalent anaerobic conditions and reductive processes of an organic substrate-based, subsurface flow wetland system. A field-scale engineered wetland was constructed to treat the slag leachate and to reduce total sulfur, high pH, and other pollutants, along with limiting open water exposure. A laboratory shaker study was conducted to test the leachability of the slag material and constituents of the leachate. Column and greenhouse studies also used to test possible substrates and plant combinations to use within the constructed wetland system. Results indicate that leachate from the study site is formed through a series of complex chemical reactions under fluctuating oxidized and reduced conditions. In addition, reduction of sulfate, metals, total dissolved solids, other inorganic constituents, and buffering of pH, was achieved by the abiotic and biotic processes of the engineered wetland systems. The distinct advantage of such an approach is that it is far less expensive than other clean-up alternatives.