

Moving Bed Biofilm Reactor for Selenium Reduction in mine effluents

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Abstract

Selenium, present in mine effluents as selenate and selenite, has recently become a concern. Selenium is highly toxic to aquatic life and the discharge limitations for total selenium are becoming increasingly stringent. Some discharge criteria for release of mine effluent into fresh water systems have been set to $< 4.7 \mu\text{g/l}$ Total Se.

Selenate is challenging and costly to remove with physico-chemical methods, but biological treatment has presented itself as a viable alternative over the past years. The process of biological reduction of selenate and selenite is very similar to denitrification. During biological selenium reduction, microorganisms utilize selenate and selenite as electron acceptor, reducing selenate and selenite to particulate elemental selenium. The particulate selenium can then be separated from the wastewater by traditional liquid-solid separation methods. As with denitrification, biological treatment of selenate and selenite requires anoxic conditions and the presence of an electron donor, usually an organic carbon compound.

The MBBR process (Moving Bed Biofilm Reactor) has been used successfully to treat mine effluents. The MBBR utilizes a polyethylene carrier with a high protected surface area for biofilm development. The carriers are maintained in continuous motion in the reactor, thereby avoiding the need for backwashing or issues with gas entrapment.

In mine applications, the process will typically consist of a two stage MBBR reactor followed by solids separation step. Denitrification and partial selenium reduction will occur in the first stage MBBR whilst the second stage will be used to remove any residual selenium.

The process has been extensively tested in the laboratory, down to operating temperature of 37 °F and has been used at full scale to treat a mine effluent in West Virginia to achieve a total selenium concentration of less than $4.7 \mu\text{g/L}$ as a monthly average.

Results from our recent operating experience will be presented.

SeleniumZero® is a novel patented iron-oxide based media which can be used as a polishing step downstream of MBBR or as a stand-alone technology for the removal of selenate and selenite. The adsorption media is installed in an upflow column and can consistently remove selenium below the $2 \mu\text{g/l}$ detection limit.

Results from laboratory trials using the SeleniumZero® process will be presented.