Biologically Treating Mining Impacted Water Within the Mine Void

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MIW Characteristics

Mining Influenced Water (MIW) typically a product of pyrite oxidation.

Usually characterized by low pH and high sulfate and high dissolved metals.

Mine works are usually intimately connected with groundwater allowing MIW to discharge into surface waters.
Classical Approach to Treating MIW

“Downstream” treatment typical due to lack of identified “source”.

Treating dilute material easier than concentrated material.

Reaching “source” difficult in many cases.

National Tunnel Discharge, Black Hawk, CO

Lady Leith BCR Influent Stream, Jefferson County, MT
Photo ITRC BRC Team
Classical treatment Options

Based on water treatment chemical technologies – i.e. increase pH through the addition of lime. Since the reactions are load dependent, volume of treated water is less of a cost concern but capital investment an O&M are high.
Iron Mountain Mine Water Treatment System, Shasta County, CA, Photo ITRC BCR Team
Iron Mountain Mine Water Treatment System,
Shasta County, CA, Photo Google Earth
Classical treatment Options

Natural processes based on a combination of biological and chemical processes to eventually isolate the pyrite. These have been reproduced in systems referred to as Biochemical Reactors (BCRs).
BCR at Big 5 Mine, Idaho Springs, CO, USEPA Photo

BCR at Golinsky Mine, Shasta County, CA, Photo ITRC BCR Team
A New Paradigm – In Situ Treatment

Takes a page from the treatment of chlorinated solvents – add organic to manipulate pH and REDOX.

Makes use of substrates that can be preferentially injected.

Reduces the number of locations where treatment is applied, reduces capital and O&M costs.
Standard Mine Adit, Crested Butte, CO

“Three Sisters” seeps, PA, Photo ITRC BCR Team
Initial Tests – Batch Reactors


Photo CDM Smith
Batch Reactors

Evaluated over three months.

- Metal removal efficiency
- Sulfide production
- Sulfate reduction
- ORP
- pH
- Alkalinity
Batch Study MIW

MIW-1, strongly acidic (pH 2.52), high metals (450 mg/L aluminum, 250 Cd). High sulfate (14,000 mg/L).

MIW-2, near neutral (pH 5.05), low metals (Zn 36 mg/L), low sulfate (230 mg/L).

MW-3, Strongly acidic (pH 2.76), high metals (370 mg/L Al, 62 mg/L Cu, 30 mg/L Zn), high sulfate (9,400 mg/L).
Results of Batch Study

ChitoRem® chitin complex – a mix of readily soluble organics, slowly soluble organics, and carbonates performed “consistently well” when compared with other substrates (ethanol, ethylene glycol, beer, methanol).

Easiest to use and required no pH adjustment and no inoculation with manure to provide sulfate reducing bacteria.

Photo CDM Smith
Column Tests

Goal to mimic biochemical activity of the placement of chitin complex substrate directly into the mine void or in situ into MIW flow.

Dual columns in series, 1\textsuperscript{st} with chitin complex and 2\textsuperscript{nd} without.

Recirculating columns to mimic water flow.

Photo Courtesy of CDM Smith
Results Column 1 – Active Biochemical Column

Column 1 at 37 days
Photo CDM Smith
Results Column 2 – Transferred Treated Water

1st Water Transfer

Column 2 at 37 days
Photo CDM Smith
Conclusions

Use of chitin complex to manipulate pH, ORP, and pH to reduce the impact of MIW in both a static and a dynamic environment is a viable option to treat MIW.

Chitin complex was capable of establishing and maintaining circumneutral conditions in highly acidic MIW in both the reactor vessel and a simulated downgradient environment.
Next Step – Take it to the field!
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ITRC Biochemical Reactors for Mining Influenced Waters Team