Biochemical Reactors for Treating Mining-influenced Water

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Advancing Environmental Solutions
National Conference on Mining-Influenced Water

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&
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Biochemical Reactors Team

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Today’s Objective

- Brief ITRC and Team introduction
- Problem introduction & Explanation of a BCRs usefulness
- Guidance Introduction
- Discussion of Implementation Targets

We need your help to identify example targets!
ITRC & The BCR Team

- ITRC is a state-led coalition which works to achieve regulatory acceptance of environmental technologies and innovative approaches.
- ITRC Team on Biochemical Reactors for Treating Mining Influenced Water

Bar chart showing:
- State Govt: 14
- Private Sector: 18
- Federal Govt: 7
- Academia: 6
- Stakeholder: 3
# The BCR Team

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What is the problem we face?

- There are over 500,000 abandoned mine sites in the U.S.
- MIW impacts state lands, federal lands, public land, private lands
- Many sites are in remote areas with extreme climates
- Negative environmental impacts extend miles downstream
- Liability lingers for years
One Possible Solution.

- Biochemical Reactor (BCR)

Penn Hill #2 BCR, PA
What is a Biochemical Reactor (BCR)?

- ...engineered treatment system that uses an organic substrate to drive microbial and chemical reactions to reduce concentration of metals, acidity, and sulfate in MIW.

Golinsky Mine, Shasta County, CA
Biochemical Reactor
Advantages

- Low energy requirements
- May be low maintenance if designed properly
- Can be used in remote situations
- Removes metals
- Flexible and versatile
- Treats wide variety of MIW
- Will improve ecological function of receiving stream
Cautions

- BCRs may not consistently meet strict water quality standards
- BCRs are not \textit{walk away} systems
- Monitoring is required
- Maintenance may be needed periodically
Biochemical Reactors for Mining Influenced Water

The purpose of this guidance is to help you understand and apply the physical, chemical, and biological mechanisms that occur in a biochemical reactor (BCR) to treat mining-influenced water (MIW). MIW includes wastewater generated by ore extraction and processing, as well as mine drainage and tailings runoff. MIW handling, storage, and disposal is a major environmental problem in mining districts throughout the U.S. and around the world. During the development of the guidance document Mining Waste Treatment Technology Selection (MW-1), biochemical reactors (BCRs) were assessed in case studies as a promising technology.

This document supplements MW-1 and includes an in-depth analysis and overview of BCR applicability and design, including a decision tree, testing, design, construction, and monitoring. The decision tree presents the basic factors used to evaluate the efficacy of BCR treatment for a particular MIW. Several case studies present a clear evaluation of diverse site conditions and detailed analysis and evaluation of several different chemical mixtures. The guidance presented here will help you to evaluate BCR technologies to treat MIW on site and improve the ambient water quality in many watersheds. If you are using this web-based document for the first time, please review these frequently asked questions (FAQs).

What are BCRs?

BCRs are engineered treatment systems that use an organic substrate to drive microbial and chemical reactions to reduce concentrations of metals, acidity, and sulfate in MIWs. While this chemistry is fairly well understood, advances over the last 20 years have improved the effectiveness, hydraulic permeability, and longevity of these systems. BCRs can address a wide range of flows, acidity, and metals loading, and also be designed to operate in gravity flow or available powered mode. BCRs operate with or without external energy and chemical input and can often be sustained for months at a time without human intervention.

BCRs can be designed as engineered systems that use separate tanks or zones for the bioprocesses, chemical reactions, and solids separation. Metals recovery at active mining and mineral processing sites can be achieved using microbial sorption or precipitation. These systems accommodate reasonably high flow rates and integrate pH adjustment into the water when needed.

BCR systems can also be engineered to incorporate the processes chemical...
What This Guidance Can Do for YOU!

- Assess the suitability of using a BCR
- Support
  - Planning
  - Testing
  - Monitoring
  - Operating
  - Maintaining
- Provides examples of real world application of BCRs

TO REFERENCE THIS GUIDANCE
Topics Covered by the Guidance

- Applicability
- Testing
- Design
- Construction and startup
- Monitoring, operation and maintenance
- Challenges
Applicability

- [http://itrcweb.org/bcr-1/](http://itrcweb.org/bcr-1/)
Is My Water BCR-Worthy

Periodic Table of Treatable Elements

Elements in **Blue** can be treated in a BCR

Figure courtesy of Jim J. Gusek, 2009
Treatability Testing

- Proof of Principle
- Bench Testing
- Pilot Testing

- Solid Substrate
- Liquid Substrate
Design

Downflow Biochemical Reactor

Upflow Biochemical Reactor

Horizontal Flow Biochemical Reactor

Appendix C – BCR Calculation Examples
Operation & Monitoring of BCRs

- BCRs designed:
  - To run on their own with periodic oversight,
  - To be low maintenance
  - To be Low energy/passively driven systems

- Conduct monitoring for,
  - Physical conditions
  - Performance evaluations
  - Compliance requirements
Substrate Monitoring

- Chemistry (compare to design conditions)
- Substrate testing – ORP & Physical collection
- Substrate test for disposal
- Substrate replacement or additional amendment
Troubleshooting

- Chemical trends
- Physical Trends

Adjustable Elevation Head Weir for BCR Effluent

ITRC BCR-1, 2013: Section 6.3.2
Challenges

- There are technical, regulatory and stakeholder challenges, including:
  - Permitting and ability to attain strict water quality standards
  - Noise, attractive nuisance/safety, hydrogen sulfide odor
  - Long term liability concerns / Good Samaritan legislation
  - Reuse
Example Implementation Targets

- 1, 2, 3, 6
- 4
- 7
- 10, 14, 15
- 11
- 13
- 5
- 8
- 1, 2
- 3, 6
Key Message

1. BCRs are *viable alternatives* for treating MIW, even in remote areas
2. BCRs are *site-specific*
3. BCRs are not *walk away* systems
4. The guidance is a convenient *resource* when considering a BCR