The Interstate Technology and Regulatory Council

Biochemical reactors for treating mining influenced water

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Overview

- Interstate Technology Regulatory Council (ITRC)
  - What is it?
  - Why does it exist?
  - What does it do?
- Mine waste team
  - History
  - Mine Waste Guidance
- Biochemical Reactor guidance
Vision

To be the market-recognized “go-to” provider of guidance and training on innovative solutions to protect human health and the environment
Innovative Technologies

Or
Innovative Technologies

The BIG Question?

Can I get a permit for this?
We’re from the government and we’d like to help....
Addressing Regulatory Barriers and Technology Guidance

ITRC—Interstate Technology & Regulatory Council

State led organization

ITRC State Members

Host Organization

Federal Partners

DOE  EPA  DOD

Industry, Academia, Consultants, Citizen Stakeholders

ITRC Member State
Why ITRC?

► Large cleanups required at Department of Defense and Energy sites
► Conventional technologies were too expensive
► Innovative approaches were needed
► Common problems at sites throughout the country
► Once proven a method to streamline acceptance was needed
  • “Don’t reinvent the wheel”
► ITRC started in 1995
Goals

- Increase state acceptance of innovative technologies
- Streamline state permitting processes
Goals

- Achieve better environmental protection through innovative technologies
- Identify and remove technical or regulatory barriers to the use of innovative technologies
- Build confidence about using innovative technologies
ITRC Process

- Proposals developed and ranked by states
- Teams are formed to solve the priority problems
  - State led
    - Minimum of 5 states
  - Industry
  - Federal agencies
  - Academia
  - Public stakeholders
IATRC Process

Products

- Case studies
  - Applications
- Technology overview
  - Team evaluation
- Guidance document
  - Over 55 produced
  - Constructed Treatment Wetland
  - Phytotechnology
  - Permeable Reactive Barriers
ITRC Process

- Training
  - Free Internet
    - Over 90,000 participants
  - Classroom
Mine Waste

A BURNING ISSUE
History

- Mine waste team started 2007
  - White paper
  - State issues
- Problem based guidance
  - Identify and evaluate innovative & cost effective technologies
  - Solid mine waste
  - Mining influenced water
- First web based guidance
Web Advantages

- **Interactive**
  - Easy to navigate

- **Graphics**
  - Color images, photos, etc can be used for illustration

- **Flexible**
  - Easier to update site as new information or case studies become available
Mine Waste Guidance

► Web-address: www.itrcweb.org/miningwaste-guidance

► Quick tool to identify appropriate technologies
  • Flow charts
  • Technology overview
  • Advantages/ limitations
Why Biochemical Reactors

- Promising technology
  - More information needed
- Case studies
- Technology guidance
Biochemical Reactors

- Engineered treatment system that uses an organic substrate to drive microbial and chemical reactions to reduce concentration of metals, acidity, and sulfate in MIW (mining influenced water).
Table of Contents

1. Introduction
2. Determining the Applicability of a Biochemical Reactor
4. Design
5. Construction
6. System Start-up, Operation, and Maintenance
7. Technical and Regulatory Challenges and Solutions
8. Stakeholder Concerns and Issues
9. Tribal Concerns
10. References
How does a BCR work?

Guido Sarducci’s
5 Minute University

INTRO TO BCRS
What Does a BCR Do?

- Precipitate metals and metalloids
- Produce circumneutral waters

Iron precipitate in a BCR

Golinsky BCR, Lake Shasta, CA
How Does a BCR Do That?

- Sulfate reducing bacteria
  - Common bacteria
  - Present in soil
  - High concentrations in manure
- Remove sulfate by reducing it to sulfide
- Need oxygen free environment, sulfate, and an electron donor
  - Usually organic compound

Photo of sulfate reducing bacteria
Chemistry 101

- Sulfate reacts with organic carbon
  - Produce hydrogen sulfide and bicarbonate
  - Hydrogen sulfide reacts with metals
  - Produce metal sulfide and hydrogen

- Limestone is often necessary
  - Increase the alkalinity
  - Consume hydrogen
  - Thus raise the pH

- If there is not enough $M^{+2}$
  - $H_2S$ will be lost as a gas

$$SO_4^{2-} + 2 \text{CH}_2\text{O} = H_2S + 2 \text{HCO}_3^-$$
$$H_2S + M^{+2} = \text{MS (solid)} + 2\text{H}^+$$

$$2\text{H}^+ + 2\text{HCO}_3^{-1} = 2\text{H}_2\text{CO}_3$$
$$2\text{H}^+ + \text{CaCO}_3(\text{solid}) = \text{Ca}^{+2} + 2\text{HCO}_3^{-1}$$
Determining Applicability of BCR

1. Characterize the influent
2. Define treatment goals
3. Can the COCs be treated in a BCR?
   - Yes
   - No
   - Calculate loading
4. Is pretreatment necessary?
   - Yes
   - No
   - Estimate the size of a BCR
5. Is space available?
   - Yes
   - No
6. Is topography accommodating?
   - Yes
   - No
7. Is substrate available?
   - Yes
   - No
8. Considered public concerns!
9. Is cost acceptable?
   - Yes
   - No

- Can pre- or post treatment be implemented?
  - Yes
  - No
  - Go to Mine Waste Treatment Technology Selection

- Design BCR
Is My Water BCR-Worthy

Elements in Blue can be treated in a BCR

Figure courtesy of Jim J. Gusek, 2009
What is needed for treatability testing?

- Site MIW
- Substrates

- Hay
- Wood Chips
- Limestone
Testing

- Proof of Principle
- Bench
- Pilot
Design Inputs

- Detailed design inputs
- Characterization
  - MIW flow and quality
    - Average and extremes
  - Site
    - Workable area available
    - Detailed site map
    - Climate
      - Average
      - Extremes
  - Treatment goals
  - Pre-and post-treatment?
Performance Data

- Seasonal variability
- Loading range
- Residence time
- Substrate mixture
  - Thickness
  - Degradation rate
  - Metal removal efficiency
Construction

Gravel Drainage Layer

Subgrade

Drainage system

Organic Matter & Limestone Mix

Sampling Port

Light Weight Fill

Inoculum

Discharge

Geosynthetic liner

Geotextile

Topsoil

In flow

Down flow
Does It Have To Be So Complex?

- **Goals**
  - Best Management Practices or National Pollution Discharge Elimination System

- **Size**

- **Setting**

  We don’t need no stinkin permits!
## 6. System Start-up, Operation, and Maintenance

1. **6.1 System Start-up**
2. **6.2 Monitoring and Maintenance Activities**
3. **6.3 Maintenance**
   - **6.3.1 Substrate Nutrient Change Out**
   - **6.3.2 Troubleshooting**
4. **6.4 Sampling Protocol**
5. **6.5 Contents of an Operation and Maintenance Plan**
ISSUES

Technical

Regulatory
  • Permitting
  • Water Quality Standards
  • Disposal of Residual Materials
  • Wetlands

Stakeholder
  • Community, tribal concerns
  • Liability
  • Use of MIW as a Resource
Key Messages

1. BCRs are *viable alternatives* for treating MIW, even in remote areas
2. BCRs are *site-specific*
3. BCRs are not *walk away* systems
What does this guidance do for me?

- Convenient resource when considering a BCR
- Overview
- Audience
  - Practitioners
  - Regulators
  - Clients

http://itrcweb.org/bcr-1/

Next training: September 23, 2014  2:00 PM - 4:15 PM EST
The perfect should not be the enemy of the good
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 *walk away* systems
- Monitoring is required
- Maintenance may be needed periodically
Operation/Maintenance/Monitoring

- Troubleshooting
Disposition of residual materials (for example, spent substrate)

Wetlands
- Mitigation
- Attractive nuisance
- Decreased BCR performance

ITRC’s Wetlands documents
- Constructed Treatment Wetlands (WTLND-1, 2003)
- Characterization, Design, Construction, and Monitoring of Mitigation Wetlands (WTLND-2, 2005)
Stakeholder Concerns

- Community concerns
  - Noise
  - Attractive nuisance and safety
  - Hydrogen sulfide odor
  - Public outreach

BCR in Central City, PA.
Note the houses in the background
Stakeholder Concerns (cont.)

► Tribal concerns
  • Clean Water Act Authority

► Volunteer groups
  • Watershed groups
  • Abandoned mine sites

Fran Coal Mine MIW
Liability Concerns

- Liability of Good Samaritans
- Disposal of spent substrate
- Effluent compliance
  - NPDES versus Infiltration or Recharge

*The perfect should not be the enemy of the good*
What does this do for me?
BCR Case Studies

1. Beaver Creek, OK
2. Mayer Ranch, OK
3. Haile Mine, SC
4. Ferris Haggerty, WY
5. Fran Coal Mine, PA
6. Brewer Mine, SC
7. West Fork, MO
8. Leviathan, CA
9. Wheal Jane, UK
10. Peerless Jenny, MT
11. Golinsky Mine, CA
12. Dankritz Mine, Germany
13. Copper Basin Mine, TN
14. Lady Leith Mine, MT
15. Luttrell, MT

Not on map:
9 Cornwall, England
12 Sachsen, Germany

ITRC BCR-1, 2013: Appendix B
Approach

- Problem based technology/regulatory guidance
  - Multiple technologies solve problems
  - Select appropriate technologies

- Optimize your approach
  - Clean up the source
  - Clean up the media