BEYOND BCRS: THE USE OF PEAT SORPTION MEDIA TO TREAT MINE DRAINAGE

Paul Eger
Global Minerals Engineering
Peggy Jones, Doug Green
American Peat Technology
Road Map

- Passive treatment of trace metals
- Peat sorption media
- Site
- Pilot testing
  - Design
  - Results
- Summary
Passive Treatment of Mine Drainage

- Biochemical Reactors (BCR)

- Constructed Treatment Wetlands
Biochemical Reactors

- Inflow
- Water Surface
- Organic-Depleted Zone
- Active Microbial Reaction Zone
- Organic Matter & Limestone Mix (Substrate)
- Un-reacted Organic Substrate
- Drainage System
- Discharge
Organic substrate
- Generally mixture
- Hay, wood chips, limestone, manure

Vertical flow

Anaerobic processes

Microbial driven
- Sulfate reducing bacteria
Constructed Treatment Wetlands

- Horizontal flow across surface
- Water depths generally 6-12"
- Aerobic Processes
- Primary removal - interaction with substrate
Limitations

- **Wetlands**
  - Large footprint
  - Winter performance
    - Flow distribution

- **BCRs**
  - Initial release of organic rich water
    - BOD
    - Nutrients
  - Color lasts ~ 3-6 months
  - Odors
    - Hydrogen sulfide

*Residence time ~ 1-2 days*
What is Peat sorption media?

- APTsorb™
  - Patented peat based sorption media
  - Hardened granule
Properties

- Size -10, +30 mesh (0.6 to 2 mm)
- Large surface area
- High hydraulic conductivity (~0.5 cm/sec)
- High metal affinity (1-15% max dry wgt)
Mechanisms

- **Dissolved Metal Removal**
  - Ion exchange
  - Adsorption
  - Chemisorption
  - Complexation
  - Adsorption-complexation

- **Particulate Metal Removal**
  - Filtration
  - Interaction with surface
  - Successful removal of 3 - 5 micron particles
The Site

- Base metal mine
Characterization

- Direct discharge from active underground mine
  - Water quality
    - Elevated and variable suspended solids
    - pH ~ 8
    - Pb controlling metal

<table>
<thead>
<tr>
<th>Metal</th>
<th>Total</th>
<th>Dissolved</th>
<th>Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>2100</td>
<td>150</td>
<td>11.5</td>
</tr>
<tr>
<td>Zn</td>
<td>115</td>
<td>70</td>
<td>137.3</td>
</tr>
<tr>
<td>Cd</td>
<td>0.8</td>
<td>0.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- Flow up to 8,000 gallons/min
Active Mine Discharge

- Sand filter
- Media tank
- Biocell
- Biocell
- Biocell
Pilot Test

Semi active

Passive
Passive – Biocells

Water

Peat Sorption Media

Gravel

1.5”

24”

6”
Biocells

- Input water filtered through sand filter
- Media, -10, +30 mesh
- Design

<table>
<thead>
<tr>
<th>Biocell</th>
<th>Flow rate gpm</th>
<th>Hydraulic loading gpm/ft²</th>
<th>Residence time min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
<td>0.25</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>2.4</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>0.5</td>
<td>30</td>
</tr>
</tbody>
</table>

10 month pilot test
Temperature -10 to 100
RESULTS
Biocells Solids Removal

- Sand filter did not remove all suspended solids
- Solids confined to top inches
Pb removal biocell 2

8 months
Cost per gallon treated

~30 cents per 1000 gallons

Bed Volumes

Cost per gallon treated $/gal

target cost

6400

Biocell 2

0 5000 10000 15000 20000 25000 30000

Cost

0.007

0.006

0.005

0.004

0.003

0.002

0.001

0
Pb removal biocell 2

- A, input
- B, after sand filter
- after APTsorb

~85% removal
Pilot Design

Active Mine Discharge

Sand filter

Biocell

Biocell

Zinc vs Bed Volume

Bed Volumes

Zn (ug/l)
<table>
<thead>
<tr>
<th>BV (min)</th>
<th>0.2</th>
<th>1.9</th>
<th>3.6</th>
<th>5.2</th>
<th>7.5</th>
<th>9.7</th>
<th>13.0</th>
<th>18.3</th>
<th>160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>2</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>65</td>
<td>85</td>
<td>115</td>
<td>160</td>
<td></td>
</tr>
</tbody>
</table>
Good News:
water meets discharge limits, but.....

What do we do with the exchange media?
Removing Media

- Light weight
- Easily moved by pumping or suction
Disposal Options

- Potential metal recovery
  - Pb ~1%
  - Ore 3%
- Disposal in tailings basin
  - Potential amendment to improve vegetation
- Off site disposal
  - TCLP
  - Metals strongly bound to media
TCLP – Stormwater

Metal Plating Facility; 3 years

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influent ug/L</th>
<th>Solid (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>526</td>
<td>1346</td>
</tr>
<tr>
<td>Cadmium</td>
<td>219</td>
<td>566</td>
</tr>
<tr>
<td>Zinc</td>
<td>565</td>
<td>1338</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Regulated Level (mg/L)</th>
<th>TCLP results (mg/L)</th>
<th>% metal released</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>1</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Chromium</td>
<td>5</td>
<td>ND</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Zinc</td>
<td>NR</td>
<td>2.8</td>
<td>4.6</td>
</tr>
</tbody>
</table>
The Big Question?

How long will the media last?
## Longevity – Single Cell Systems

<table>
<thead>
<tr>
<th>Application</th>
<th>Duration</th>
<th>Metals of concern</th>
<th>Time between media change</th>
<th>Bed volumes treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine water</td>
<td>1 year</td>
<td>Cu</td>
<td>&gt; 1 year</td>
<td>32,000</td>
</tr>
<tr>
<td>Mine water</td>
<td>9 months</td>
<td>Pb,</td>
<td>&gt; 9 month</td>
<td>28,000</td>
</tr>
<tr>
<td>Mine water</td>
<td>5 months</td>
<td>Zn, Pb, cd</td>
<td>4 months</td>
<td>12,500</td>
</tr>
<tr>
<td>Stormwater</td>
<td>9 years</td>
<td>Cr, Cd, Zn</td>
<td>1.5 to 3 years</td>
<td>500-1000</td>
</tr>
<tr>
<td>Roof runoff</td>
<td>3 years</td>
<td>Zn</td>
<td>&gt;3 years?</td>
<td>Unknown</td>
</tr>
<tr>
<td>Stormwater</td>
<td>7 years</td>
<td>Cu</td>
<td>&gt; 3 months</td>
<td>Unknown</td>
</tr>
<tr>
<td>Treatment</td>
<td>pH</td>
<td>Residence time</td>
<td>Nuisance parameters</td>
<td>Winter Operation</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
<td>----------------</td>
<td>--------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Wetland</td>
<td>6-8</td>
<td>1-2 days</td>
<td>Initial Fe, color</td>
<td>Problematic</td>
</tr>
<tr>
<td>BCR</td>
<td>3-8</td>
<td>1-2 days</td>
<td>Color, BOD, nutrients, odor</td>
<td>Needs insulation</td>
</tr>
<tr>
<td>Peat Sorption Media</td>
<td>6-8</td>
<td>15 min</td>
<td>Minimal color</td>
<td>Needs insulation</td>
</tr>
</tbody>
</table>
Summary

- Met permit limits
- Cost effective
  - 30 cents/1000 gallons
  - Reduce costs with lead/lag approach
- Transmits water like coarse sand
- Short contact time
  - 15 minutes
- No nuisance parameters
- Easy to replace
- Potential metal recovery
Got Questions?

paul.eger@globalmineralseng.com
218-969-6483