Challenges of Iron in Groundwater Remediation: A Case Study

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Agenda

• Iron Overview
• Case Study Site & Challenges
• Evaluation Process & Analysis
• Selected Technology & Results
• Questions
The Culprit: Iron (Fe)

Exists in two oxidation states:
- **Ferrous Iron** (Fe$^{2+}$) Dissolved
- **Ferric Iron** (Fe$^{3+}$) Insoluble
Reasons for Iron Removal

Surface & Storm Sewer Discharge Requirements

- Consumes oxygen; strains aquatic life
- Discharge regulations can be lower than naturally occurring concentrations

Iron Fouling of Remediation Systems

- Requires frequent backwashing and media & filter replacement
- Precipitate plugs up equipment, piping and sewer lines
Water Parameters:
- BTEX Compounds <200 ppb
- Iron 10-15 ppm
- Manganese 1.4 ppm
- Total Hardness 550 ppm

Location:
- Downtown waterfront property
- Recently re-developed into park & green space

History:
- Bulk Oil Storage facility - 1930 to 1990
- Coal Gasification Plant in 1854 to 1947

The Site: Belleville, ON
Groundwater Treatment

Collection System
  • Semi-permiable barrier wall
  • Groundwater trenches
  • Three remote pumping stations

Treatment Process: 132 GPM
  • Oil Water Separator
  • Two #12 Bag Filters
  • Active Carbon Vessels

Downstream
  • Discharge to municipal sewer system
Operational Challenges

Total Mass of Iron Collecting in Treatment System

- Inlet: 10-15 ppm

System Implications

- Iron sludge build up in Oil Water Separator
- Bag Filters plugging within 1 hour
- Lead Carbon Vessel plugging within 72 hours
Thorough Evaluation

Step 1: Jar & Lab Testing

- On-site jar testing for:
  - Total & Dissolved Iron

- Lab samples tested for:
  - Total & Dissolved Iron
  - Hardness, Alkalinity
  - pH, TDS, TSS
  - Aluminum, Silica
Process Stream Evaluation

Flow of Iron

Tot: 667 ppm
Dis: 640 ppm
Ox: 27 ppm
Process Stream Evaluation

Buildup of Iron

Captured Iron: 6.1 ppm 146 lb/day, 5% Solids Vessel plugs in 4-6 days

Captured Iron: 2.0 ppm 48 lb/day, 5% Solid

Settled Iron: 2.3 ppm 55 lb/day, 5% Solid

MH2B Pumping Station

MH5B Pumping Station

MH7B Pumping Station

INLET TANK

OIL/WATER SEPARATOR

BAG FILTER

LIQUID PHASE CARBON

TO SANITARY SEWER
Technology Options

1. Iron Management Solutions
2. Particulate Filtration Solutions
3. Concentration Solutions
4. Chemical Treatment of Full Water Stream
Thorough Evaluation

Step 2: Bench Testing
Evaluate viability of:
• Particulate filtration
• Chemical treatment of concentrated stream
• Chemical treatment of full stream

Key Learning
• Chemical treatment of full stream inferior to treatment of concentrated stream
• Multi-layer bag - best filter
• Bag filter removed 50% of precipitated iron
• Self-indexing paper too coarse
Cost Analysis - Year 1

- Chemical Dosing of DCA
- Bag Filters w/ Man Carbon BW
- Self-Indexing Filter w/ CP
- CALCO IRS
- Auto Carbon BW
- Air Strip & Iron Filtration
- Air Strip / No Filtration
- Air Strip w/ DCA

Legend:
- Green: Annual Labor
- Orange: Annual Filters
- Gray: Annual Chemicals
- Blue: Capital Purchase
Cost Analysis - Year 9

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Piloted Technology Results

1. Iron Management
   Chemical Dosing of Deposit Control

   Pilot Study Results
   - 50% of iron discharged
   - 40% of iron in carbon vessels
   - 10% of iron in bag filters
   - BW interval: 6 days vs 3 days
   - Additional equipment req’d
   - Significant increase in capital & operating costs

2. Concentration
   Calco Iron Removal System

   Pilot Study Results
   - Removed 80-95% of iron
   - Drastic reduction in O&M req’d
   - Carbon req’d infrequent BW
   - Modest increase in capital & operating costs
CALCO Iron Removal System
Utilizing Deferum Technology

Advantages

• High levels of iron removal
• Chemical-free iron oxidation
• Uses less backwash water
• Higher BW iron concentrations
• Small footprint
• Low O&M costs
CALCO Iron Removal Results

**System Water**
- Pre-Treatment: >15 ppm
- Post Treatment: <1 ppm

**BW Concentrate**
- Pre-Treatment: >1000 ppm
- Post Treatment: <1 ppm
  - Ready for filtration

**Iron Residual**
- Flocculated Iron: Ready for disposal
- Post Paper Filtration: 0 ppm
Questions?

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