In Situ CO$_2$ Sparging to Neutralize a Caustic Brine Plume and Reduce Mercury Levels

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Site Background

- Former chlor-alkali facility
- “Caustic Brine Plume”
  - Depth: 25 to 50 feet bgs
  - pH > 10.5; typically 11 to 12
  - Specific gravity: 1.02-1.05
  - TDS: 30,000 to 60,000 mg/L
  - Mercury: 50 to 1000 μg/L
  - Silica: 50 to 17,000 mg/L
CO₂ Sparging Concept

Injection of CO₂ gas just above the aquifer bottom (the variably-cemented sandstone)

CO₂ reacts with alkali (OH⁻); pH is neutralized & a pH buffer (HCO₃⁻) is produced which prevents excessive pH decline

\[ \text{CO}_2 + \text{OH}^- \rightarrow \text{HCO}_3^- \]

When the pH is lowered, mercury is immobilized as mercury sulfide, HgS(s).

Before

After

CO₂ Injection
CO$_2$ Sparging Lab Study

Lab Study Objectives:
- Determine the pH response of CBP water upon sparging with CO$_2$(g)
- Assess the extent of solids production upon pH adjustment with CO$_2$(g)
- Determine the effect of CO$_2$(g) sparging on dissolved metal concentrations.
CO₂ Titration Curves

Sparging Duration (sec.) vs. pH
Proof of Concept Test Area
Proof of Concept Test: Plan View
Pre-Sparge pH and Hg
CO\textsubscript{2} Delivery

CO\textsubscript{2} Trailer

Vaporizer
Sparge Well

Flow Control Valve

Pressure Gage

Sparge well (SW-1)

Flow Meter
Monitoring Well Network

Each monitoring well also equipped with a Solinst Levelogger™ to continuously monitor water levels.

- Monitoring wells with extensions
- Hach continuous-recording pH electrodes and meter
- Sparge well
Typical pH Response in Monitoring Wells

Well: MW-29
Distance from SW-1: 13.5 ft; distance from MW-1C: 21.4 ft
Depth of screen: 30 - 35 ft bgs

Well: MW-519B
Distance from SW-1: 20.8 ft; distance from MW-1C: 15.1 ft
Depth of screen: 42 - 48 ft bgs
Typical Response of Deep, Middle, and Shallow Well Potentiometric Surface

- Peak rise in piezometric surface in basal aquifer
- Gradual decline in piezometric surface once CO₂ channels are fully established
- Rapid decline in piezometric surface upon cessation of sparging
- Rebound in piezometric surface

Water Elevation (ft)

Time of Day
Maximum Level of Groundwater Table in Shallow Satilla Aquifer during Sparging
pH after Two Weeks of Sparging into SW-1
pH after a Third Week of Sparging into MW-1C

Satilla Formation

Variably Cemented Sandstone

Legend:
- pH
- Hg (μg/L)
- % removal

MW-3A
MW-S19A
MW-1
MW-2
MW-11S
MW-115A

MW-11C

MsL

Elevation in Feet Above Mean Sea Level

Horizontal Scale in Feet

Mutch Associates, LLC
Environmental Engineers and Scientists
Mercury/pH Relationship
Long-term Monitoring Results: pH

![Bar chart showing pH levels for different wells and monitoring periods.]

- Pre-sparge (low-flow)
- Pre-sparge (cont. monitoring)
- 1 week (cont. monitoring)
- 1 week (low-flow)
- 3 months (low-flow)
- 6 months (low-flow)

All samples taken from mid-point of well screen unless otherwise noted.

- Indicates top of screen

Well: MW-519B, MW-1C, SW-1, MW-2C, MW-115C
Long-term Monitoring Results: Hg
Conclusions of Proof of Concept Test

- The pH of the CBP within a radial distance of at least 20 feet could be reduced to 6.5-7.0 within 7 days of sparging (8 hrs./day) at approximately 50 scfm
  - A radius of influence of at least 20 feet was achieved at the top of the CBP (approximately 30 ft bgs) and greater than 60 feet at the water table
- Mercury levels declined from 110-120 ug/L to 11-33 ug/L (70 to 90% reductions) two weeks after the sparging
- Significant mounding of potentiometric surfaces was observed, particularly in the deep wells.
  - The piezometric surface in the deep wells rose 3 to 4 feet above ground surface. At its highest, the groundwater table rose to within about one foot of the surface.