SOLIDIFICATION/STABILIZATION CEMENT ADDITIVE and TEST METHOD

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AGENDA

- What is Solidification/Stabilization (S/S) ?
- History of S/S
- EPA Superfund Data Regarding S/S Technologies
- Materials for Solidification/Stabilization
- Treatability Mix Studies
- Case Study
What is Solidification/Stabilization (S/S) ?

- S/S treatment protects human health and the environment by immobilizing hazardous constituents within treated material
- Involves mixing a binding agent into contaminated media such as soil, sediment, sludge or industrial waste
- Physical and chemical changes to the treated material
History of S/S Treatment Uses

1950’s  Radioactive Waste Management

1970’s  Industrial Waste Management

1980’s  Remediation
  ► Superfund and other programs
  ► Brownfields
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<th>Other nonhalogenated semivolatile organic compounds</th>
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<th>Organic pesticides and herbicides</th>
<th>Other halogenated semivolatile organic compounds</th>
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<td>175</td>
<td>238</td>
<td>155</td>
<td>103</td>
<td>124</td>
<td>410</td>
<td>104</td>
<td>229</td>
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Contaminant Types Treated by S/S (EPA-542-R-00-010)

Exhibit 10:

Total Number of Projects = 163

- Metals and Organic (50) - 31%
- Radioactive Metals and Metals (4) - 2%
- Radioactive Metals (3) - 2%
- Organics Only (10) - 6%
- Metals Only (92) - 56%
- Nonmetals only (2) - 1%
- Organic and Nonmetals (1) - 1%
- Radioactive Metals and Organics (1) - 1%
S/S Binding Agents and Additives

- Portland Cement
- Cement kiln dust
- Slag
- Fly ash
- Organoclay
- Bentonite
Portland Cement

► Description
A generic material produced by over 50 companies at over 125 plants in the U.S. and Canada. The principal use of cement is in concrete for construction. Concrete is a mixture of Portland cement, aggregates (gravel and sand), and water. The cement used in S/S is the same as that used in concrete.

► Application and Benefit
Portland cement is used in waste management as a binding reagent and is mixed into contaminated media or waste in order to immobilize contaminants within the treated material.

► Comments
► Manufactured to ASTM specification which ensures uniformity.
► Used to treat the greatest variety of wastes since the 1950's.
► Readily available in all parts of U.S. and Canada. It is economical and can be purchased in small or bulk quantities.
Sodium Bentonite

► Description
High swelling clay composed primarily of the mineral sodium montmorillonite.

► Application and Benefit
Uses as an additive to Portland Cement to lower hydraulic conductivity.

► Comments
• Manufactured to API specifications to assure consistency.
• Available in large quantities from bentonite manufacturers and in small quantities from distributors.
Organophilic Clay

- **Description**
  Clay that is specially treated to convert it from hydrophilic to organophilic.

- **Application and Benefits**
  Uses as an additive to Portland Cement to reduce organic leaching and aid curing of cement.

- **Comments**
  - Manufacturer should provide manufacturing quality control, including treat content (ASTM D7626), to assure consistency.
  - Material used in construction should be same as material tested in treatability study to help assure effectiveness.
organophilic clay-based S/S Processes: Recent investigations indicate that these organophilic binders truly bond with organic wastes.

For certain organics, organophilic clay may improve cement-based or pozzolanic process performance.

In applying S/S for treating organic contaminants, the use of certain materials such as organophilic clay, either as a pretreatment or as additives in cement, can improve contaminant immobilization in the solidified/stabilized wastes.
S/S Typical Performance Criteria

- Unconfined Compressive Strength: 50 psi
- Hydraulic Conductivity: $1 \times 10^{-7}$ cm/s
- Leachability (varies based upon site risk assessment)
S/S Process: Feasibility and Mix Design Tests

Physical Testing

- Hydraulic Conductivity/ Permeability
- Unconfined Compressive Strength – measure of free liquids & durability
- Freeze-Thaw & Wet-Dry Durability
- Paint Filter Test (PFT) – free liquids
- Moisture Content
- Density

Solidified samples prepared for strength and permeability testing
Permeability testing apparatus
Unconfined compressive strength
S/S Process: Feasibility and Mix Design Tests

Chemical (Leaching)

- Toxicity Characteristic Leaching Procedure (TCLP)
- Synthetic Precipitation Leaching Procedure (SPLP)
- Semi-Dynamic Leach
Semi-dynamic Leaching Test

- US EPA Method 1315 (expected to be adopted by end of 2012)
- Determines mass transfer release rates of COC from low-permeability material under diffusion controlled release conditions.

- One of four leaching test methods of the LEAF Project, a collaboration of:
  - USEPA Office of Research & Development and Office of Solid Waste
  - Vanderbilt University
  - Energy Research Centre of the Netherlands (Petten, The Netherlands)
  - DHI (Horsholm, Denmark)
Flow through untreated soil versus treated soil

Untreated Soil
- Groundwater flow: 150 [m$^3$/yr]
- Water percolates through fill

S/S-Treated Material
- Groundwater flow: 150 [m$^3$/yr]
- Water flows around S/S mass on all sides
Semi-Dynamic Leaching Procedure

$n$ leaching intervals ($\Delta t_1$ thru $\Delta t_n$)

$A_1$ $A_2$ ... $A_n$

$L_1$ $L_2$ ... $L_n$

$1$ sample

$n$ leachates for chemical analysis

(d)
CASE STUDY
### Virginia Wood Treating Site Treatability Study Mix Design

<table>
<thead>
<tr>
<th>MIX ID</th>
<th>Total Reagent Dose</th>
<th>Portland-Slag Dose</th>
<th>Bentonite Powder Dose</th>
<th>GAC Dose</th>
<th>OC Dose</th>
<th>Basis</th>
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All data in wt%
Virginia Wood Treating Site Semi-Dynamic Leaching Study

Figure 4: Day-averaged PCP concentration profiles in close proximity to S/S-treated contaminated soil surface.
Summary

- Cement-based Solidification/Stabilization is a proven technology.
- Bentonite can be added to help decrease hydraulic conductivity.
- Organophilic clay has been shown to be an effective additive for sorbing organics.
- New leachability tests show that organophilic clay can be effective at low doses of 1-2%.