

**EPA ACKNOWLEDGES
SOLUCORP
TECHNOLOGY...**

**MBS® Sets New Standard In
Heavy Metals Remediation**

The results are in...U.S. Environmental Protection Agency confirms the cost efficiency, effectiveness and safety of Solucorp's MBS Technology. Now you can effectively treat contaminated heavy metal wastes at your site or production facility and begin saving money immediately.

MBS is the newest of a select group of technologies evaluated by the U.S. Environmental Protection Agency. From thousands of applicants over the past 10 years, only 124 technologies were selected for final evaluation by the EPA - and of the nine selected for heavy metals, MBS was the only sulfide based treatment process.

MBS reduces the leachability of all heavy metals by rapidly converting them into insoluble metallic sulfides. At the Midvale Slag Superfund Site, MBS surpassed TCLP, SPLP, and MEP test standards for arsenic, lead and cadmium, the EPA's three highest priority metals. MBS treated six waste streams in all, with results exceeding proposed UTS requirements and most reaching non-detectable levels.

For additional information on MBS, please call Bob Kuhn or Hank Lorencz at (914) 623-2333 or visit our website at www.solucorpltd.com.

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Breakthrough
Heavy Metals
Technology
Acknowledged

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Demonstration Bulletin

Molecular Bonding System® for Heavy Metals Stabilization Solucorp® Industries Ltd.

Technology Description: The patent-pending Solucorp® Molecular Bonding System (MBS®) utilizes a solid-phase chemical stabilization process to reduce the leachability of heavy metals in soils, slags, and other solid wastes. Arsenic (As), cadmium (Cd), chromium, copper, lead (Pb) mercury, and zinc are rapidly converted to less-soluble metallic sulfides. The technology was applied ex situ during the demonstration but may be utilized with standard in situ mixing equipment; this bulletin discusses only ex situ applications.

Soil is excavated, then pretreated by screening to remove debris larger than two inches in diameter. As with other ex situ technologies, wet or clayey soils may need to be dried to improve material handling characteristics. The MBS agent, a proprietary chemical mixture, is added to the pugmill where it is blended with the soil (Figure 1). Moisture also may be added at the pugmill, to increase the moisture content of the soil to 15 to 25 percent to promote uniform mixing. Treated soil exits on a conveyor and is stockpiled.

Leachability of target metals in the treated soil is determined using the Toxicity Characteristic Leaching Procedure (TCLP) or other appropriate test, such as the Synthetic Precipitation Leaching Procedure (SPLP). Depending on chemical

feed and water requirements, the volume expansion of the treated soil may range from 3 to 16 percent. The total metal concentrations in and the physical characteristics of the soil are not significantly changed by treatment. Hydrogen sulfide gas formed during the process is collected and vented through drums of specially-coated carbon; a packed tower scrubber, which is more efficient, may replace the carbon if air emission standards are more stringent.

Waste Applicability: The MBS process is designed to reduce leachable heavy metals concentrations from soils or solid wastes. Certain metals present in reduced forms (e.g., As) may require treatment with an oxidizing agent to improve treatment effectiveness. As with other ex situ processes, this technology is most cost-effective for treatment of contaminants in shallow soils because the soils are readily accessible. However, excavation to greater depths, or use of in situ mixing may provide cost-effective applications of the MBS technology at certain sites. Soils or wastes with high chloride content (in excess of 15 to 20 percent) cannot be effectively treated with this technology.

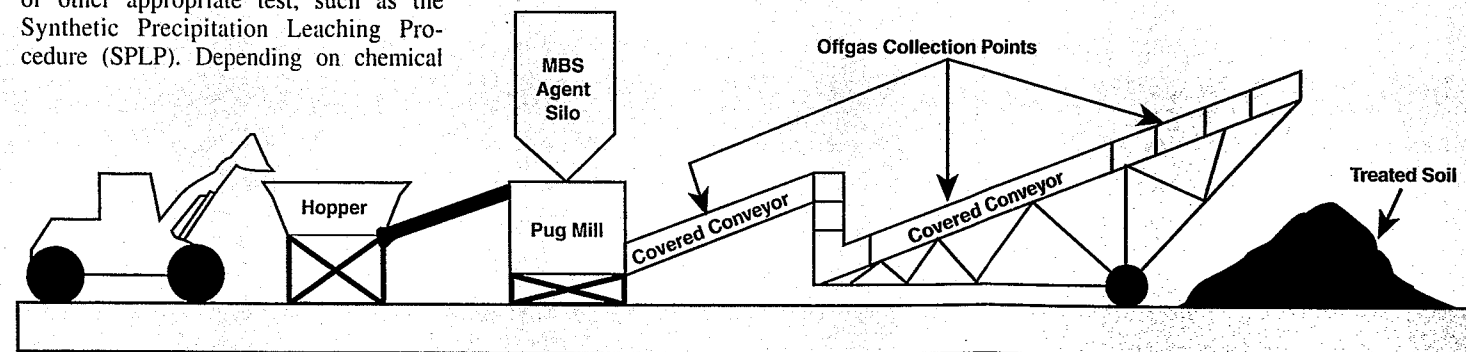


Figure 1. MBS® Soil Remediation Process

Demonstration Results: The U.S. EPA National Risk Management Research Laboratory (NRMRL) Superfund Innovative Technology Evaluation (SITE) Program conducted a demonstration of the Solucorp MBS process at the Midvale Slag Superfund Site in Midvale, Utah during the Spring of 1997. Three waste streams, contaminated with As, Cd, and Pb, were treated: Soil/Fill (SF), Slag Pile B (SB), and Miscellaneous Smelter Waste Without Brick (SW). Approximately 500 tons of each waste/soil was treated. A second test of 500 tons of SW was performed independently by Solucorp using a higher purity sulfide component in the MBS formula, after the initial demonstration of SW resulted in TCLP leachable Cd concentrations exceeding the regulatory limit of 1 mg/L. For the SW retest, Science Applications International Corporation (SAIC) performed sampling and provided oversight and analytical support under contract to Solucorp. All procedures were identical to those used by SAIC during the initial demonstration that was performed for EPA-NRMRL. EPA-NRMRL provided independent oversight and review of the SW retest results.

Because EPA-NRMRL's Quality Assurance Program has not yet reviewed the demonstration results, this bulletin presents preliminary results only. The key

finding from the Solucorp MBS demonstration is that the mean TCLP leachable Pb concentration in each of the three wastes/soils was reduced to less than the TCLP regulatory limit of 5 mg/L. Table 1 presents the mean TCLP leachable Pb concentrations in the untreated and treated wastes/soils.

Table 1. Mean TCLP Leachable Pb Concentrations, mg/L.

| WASTE/SOIL | UNTREATED | TREATED |
|-------------|-----------|---------|
| SF | 28 | 0.18 |
| SB | 17 | 0.70 |
| SW | 36 | 2.68 |
| SW (Retest) | 15 | 0.33 |

Other demonstration results include:

- The mean TCLP leachable As concentration increased slightly with treatment, but were below the TCLP regulatory limit of 5 mg/L in each of the untreated and treated wastes/soils.
- The mean TCLP leachable Cd concentrations were below the TCLP regulatory limits of 1 mg/L in both the untreated and treated SF and SB; the mean TCLP Cd concentrations in the untreated and treated SW were 2.1 and 1.1 mg/L, respectively. In the SW retest, mean TCLP Cd values decreased from 0.5 to 0.01 mg/L.
- SPLP As, Cd, and Pb concentrations were below their respective regulatory limits in the treated and untreated SF, SB, SW and SW retest.
- The mean volume increases in the treated SF, SB, SW, and SW retest were 16, 4, 13, and 14 percent, respectively, as compared to the excavated, untreated waste/soil.

- Other than dilution effects, total metals concentrations were not affected by the treatment process.
- Process throughput of untreated waste/soil averaged 52, 59, 56, and 61 tons/hour for the SF, SB, SW, and SW retest, respectively.
- Treated wastes/soils passed EPA's Multiple Extraction Procedure (As, Cd, and Pb); however, no conclusion could be drawn regarding the effect of treatment on long-term stability because there was no change in the measured leachable metal concentrations from the treated to the untreated wastes/soils.

Total costs for treatment of approximately 2 million tons of SF, SB, and SW were estimated assuming a system capacity of 10,000 tons per day. Based on scale-up from the demonstration and information from Solucorp and other sources, costs were estimated at approximately \$16/ton of waste/soil at the Midvale Slag Site.

The EPA will publish an Innovative Technology Evaluation Report (ITER) and a Technology Evaluation Report (TER) in the fall of 1997. These reports will address final test results in detail, including a complete analysis of analytical and geophysical results, estimated processing costs, and observations on process reliability and operating conditions made during the demonstration.

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INDUSTRIES

MBS® **(MOLECULAR BONDING SYSTEM)** **PROCESS DESCRIPTION**

MBS® is an EPA "SITE" (Superfund Innovative Technology Evaluation) Program accepted technology. It has been designed to stabilize a variety of media contaminated with heavy metals in a superior and cost effective manner. The process employs a proprietary mixture of non-hazardous chemicals which convert the heavy metal contaminants from their existing reactive and leachable form (usually oxides) into an insoluble, stable, non-hazardous metallic sulfide compound that will achieve TCLP levels far below regulatory limits. In addition to the TCLP test, MBS has passed other regulatory testing methods such as SPLP, SWEP, CAL WET and MEP.

MBS operations may be completed either in-situ or ex-situ using standardized mixing equipment. MBS mixing systems can easily be installed in a manufacturing line to stabilize a hazardous heavy metal waste and have it reclassified as non-hazardous. This means a safer facility with lower insurance, compliance, training and disposal costs.

Unlike competitive heavy metal technologies, MBS is not pH dependent. This insures the solubility of the treated metal(s) is not significantly altered by the addition of acids or caustics to the media. MBS has been designed (and proven successful in commercial-scale applications) for wastes classified as D004 through D011, as well as K-listed wastes. Furthermore, its ability to chemically transform the hazardous contaminants into a non-hazardous compound provides a unique, cost effective and permanent solution to the treatment of heavy metals. MBS treated material has been subjected to the Multiple Extraction Procedure (MEP) test that is designed to measure the long term stability of a treated waste. In every instance, MBS passed this test, which according to EPA protocol, proves MBS treated material will not leach for 1,000 years.

As depicted in the attached process flow diagram, the MBS treatment process is completely mobile and easily transportable to allow for on-site treatment. Processing rates range from 25 tons per hour to in excess of 500 tons per hour. Waste material is screened and crushed to reduce particle size to an average 2" diameter. The waste media is then mixed with MBS powdered reagents in a closed hopper pugmill system (the reagent mixture is established through treatability studies for the site specific conditions). Water is then added to catalyze the reaction and to ensure homogeneous mixing. The treated media is then conveyed to a stockpile.

Volume change is usually only 2% - 3% with volume reduction also possible. Unlike other heavy metal treatment processes, there is no curing time or change in the physical characteristics of a treated waste. Solucorp's fully enclosed pugmill is provided with a negative pressure system which pulls the exhaust vapors through a regenerable wet scrubber prior to discharge to the atmosphere. The treated media can then be either returned to the original site or disposed in a Subtitle D landfill. MBS has also been approved for beneficial reuse in a landfill as cover, fill or contouring material.

PROCESS RESULTS

The MBS process underwent extensive bench and pilot scale testing prior to its successful full-scale commercialization, where the same dramatic reductions in the TCLP levels of hazardous contaminants achieved in the laboratory were achieved in the field. Table 1-1 outlines results obtained from several recent commercial projects.

Table 1-1 Commercial Project Summary

| LOCATION | CONNECTICUT | NEW YORK | CANADA | MASS | SCOTLAND | MISSOURI |
|--------------------------|--|------------------------|--|------------------------|--|------------------------|
| WASTE TYPE | Lead & Cadmium Contaminated Soil With Elevated Levels Of Zinc And Copper | Lead Contaminated Soil | Lead, Cadmium And Zinc Contaminated Soil | Lead Contaminated Soil | Chromium Contaminated Soil | Lead Contaminated Slag |
| SOURCE OF POLLUTION | Brass Manufacturer | Lead Paint Chips | Steel Production | Skeet Shooting Range | Metal Plating | Lead Smelting |
| PRE-TCLP | Lead 33 mg/l Cadmium 6 mg/l | Lead 66 mg/l | Lead 188 mg/l Cadmium 3.78 mg/l Zinc 1300 mg/l | Lead 34 mg/l | Tri Chrome 111 mg/l Hex Chrome 100 mg/l | Lead 5 mg/l - 600 mg/l |
| POST TCLP ⁽¹⁾ | Lead 0.10 mg/l Cadmium <0.01 mg/l | Lead 0.34 mg/l | Lead 0.9 mg/l Cadmium 0.29 mg/l Zinc 128 mg/l | Lead <0.1 mg/l | Tri Chrome <0.03 mg/l Hex Chrome <0.02 mg/l | Lead <0.50 mg/l |
| REGULATORY LIMIT | Lead 5.0 mg/l Cadmium 1 mg/l | Lead 5.0 mg/l | Lead 5.0 mg/l Cadmium 1.0 mg/l Zinc 500 mg/l | Lead 5.0 mg/l | Tri Chrome 5.0 mg/l Hex Chrome 5.0 mg/l | Lead 5.0 mg/l |
| VOLUME ADDITION | 1.6% | 1.85% | 3.4% | 1.75% | 7.5% (Including Reduction) | 2.8% |

(1) Analysis conducted daily by independent, state certified laboratories.

COMPARISON WITH OTHER TREATMENT TECHNOLOGIES

The *MBS* process is the most effective system to chemically alter the form of heavy metal contaminants into a non-hazardous, stable compound. Conventional solidification or stabilization methods require the addition of large volumes of reagents (e.g. cement, CKD, lime or silicate-based additives) to the treated waste which significantly increases off-site transportation and disposal costs. If increases in compressive strength or reductions in permeability are desired, *MBS* is completely compatible with cement or bentonite.

In summary, due to the inherent process simplicity of *MBS* combined with its modular/ transportable design and fully enclosed operational system (preventing the release of contaminants or secondary wastes), one will obtain lower operating costs, enhanced safety and reduced emissions/secondary wastes. Table 1-2 provides a comparison of various remediation technologies to the *MBS* process. As demonstrated, *MBS* is far superior to other remediation technologies in every category including long term stability. Its inherent ability to transform hazardous contaminants into a non-hazardous, insoluble compound can facilitate on-site disposal as well as reduce the owner's future liability.

When off-site disposal is called for, *MBS* results in much lower T&D costs since the treatment process does not require the addition of large volumes of reagents. Table 1-3 demonstrates a comparison of the costs advantages of using *MBS* versus landfill disposal

Table 1-2 Remediation Technology Comparison Matrix

| VARIABLE | MBS PROCESS | LIME/PORTLAND CEMENT/CKD |
|------------------------------------|--|---|
| CHEMISTRY | Chemical reagents are combined with metals to form an insoluble metallic sulfide compound which prevents leaching in the TCLP test and in the natural environment. | Chemical additives neutralize the acid in the TCLP test (or in an acidic disposal environment) to produce a final pH that is near the minimum solubility for the metal concerned. |
| CHEMICAL COST | Chemical expense is usually lower due to low chemical dose. | Chemical expense usually high due to high dosage requirements. |
| VOLUME/BULKING | <2% volume change. | Typically 15% - 30% or more increase in bulk. |
| MATERIALS HANDLING | No physical change in soil characteristics; low volume addition improves production thus shortening project duration. No curing time. | High bulking factor increases material handling which decreases production rate resulting in a longer project duration. Curing time necessary. |
| TRANSPORTATION AND DISPOSAL | Lower transportation and disposal cost due to less material to be transported and disposed. | High transportation and disposal cost due to significant increase in treated material. |
| TOTAL COST | Saving of up to 50% or more are feasible. | Higher costs due to chemicals, material handling, volume increases, transportation and disposal expenses. |

Table 1-3 Comparison of MBS versus Hazardous Landfill

| ELEMENT | MBS | HAZARDOUS LANDFILL | VARIANCE |
|---|------------------|--------------------|------------------------|
| Stabilization Cost 10,000 Tons Processing @ \$35/Ton | \$350,000 | -0- | [\$350,000] |
| Transportation and Disposal | | | |
| Total Product Weight | 10,200 | 10,000 | [200 Tons] |
| Transportation and Disposal | \$45/Ton | \$150/Ton | \$105/Ton |
| Total T & D Cost | \$459,000 | \$1,500,000 | \$1,041,000 |
| Total Stabilization and T&D Cost | \$809,000 | \$1,500,000 | \$691,000 46.1% |

MBS[®] REMEDIATION PROCESS

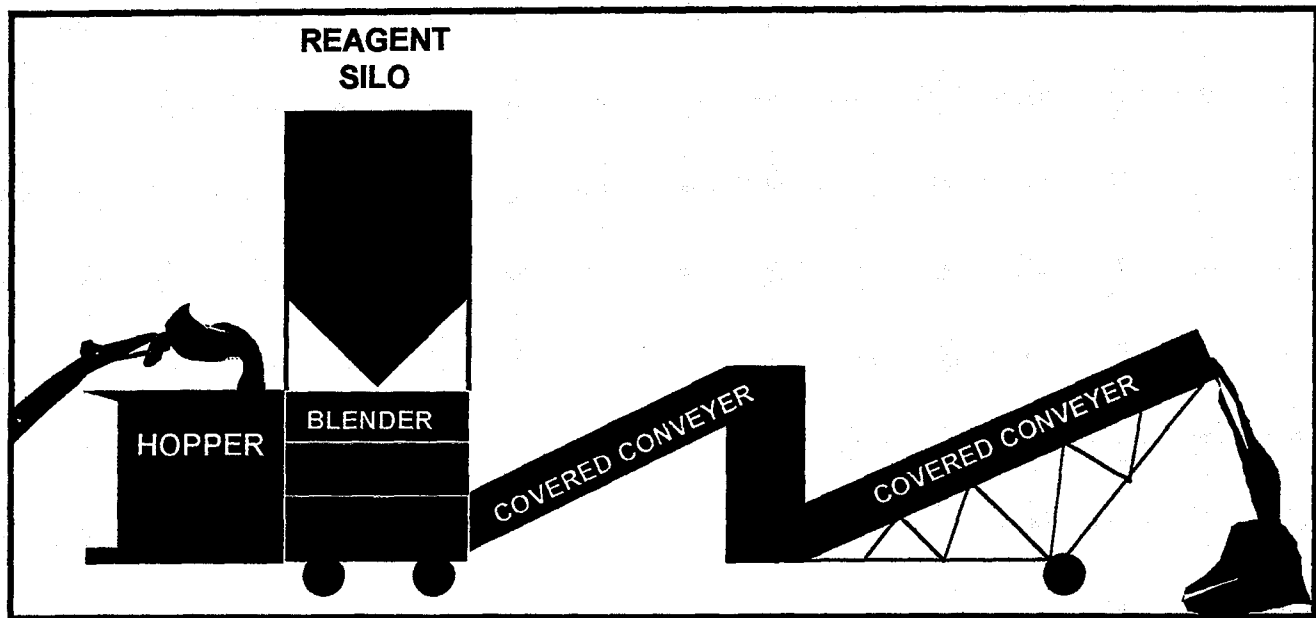


Illustration 1. MBS[®] On-Site Flow Chart

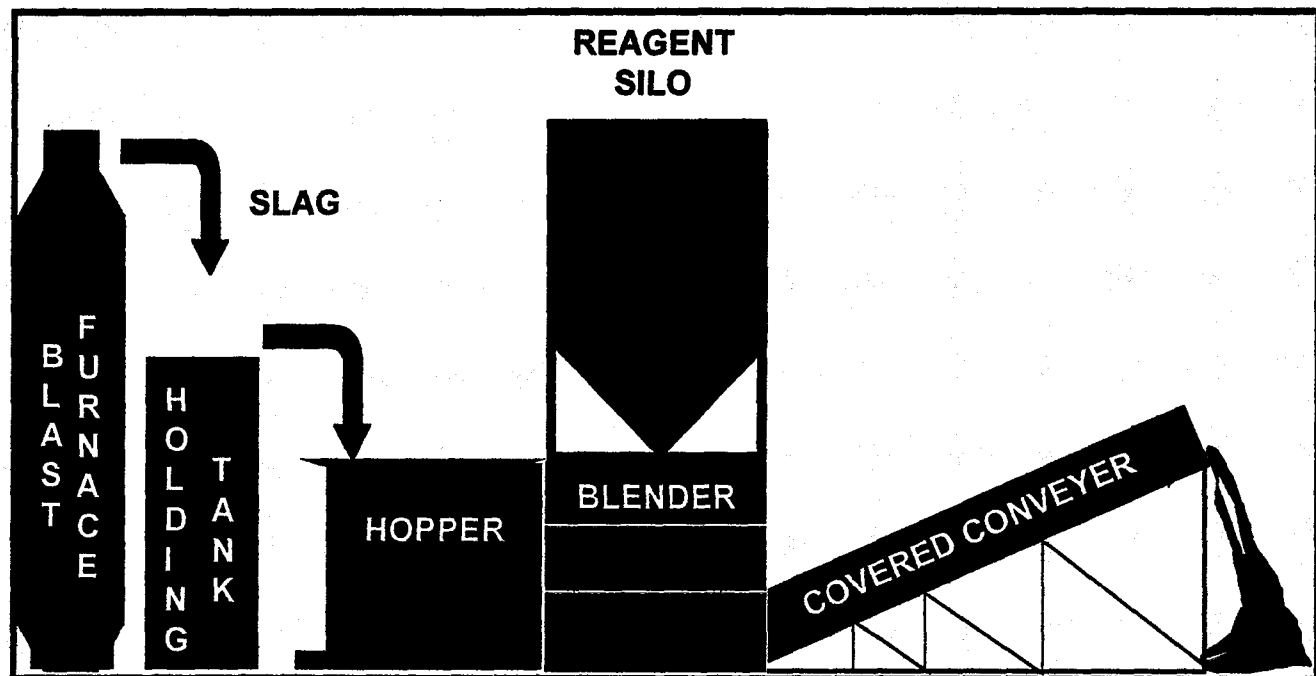


Illustration 2. MBS[®] In-Line Flow Chart