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Demonstration Bulletin

COLD Top Ex-Situ Vitrification Process

Geotech Development Corporation

Technology Description: The Geotech Development Corporation Cold Top Vitrification technology is an ex-situ, submerged-electrode, resistance-melting technology designed to convert contaminated soil into an essentially monolithic, vitrified mass. According to Geotech, a development engineering firm including four patents in the field of applied electrical power, vitrification transforms the physical state of contaminated soil from assorted, crystalline matrices into a glassy, amorphous solid comprising interlaced polymeric chains that typically consist of alternating oxygen and silicon atoms. Geotech claims that chromium can substitute for silicon in these chains, rendering the chromium immobile to leaching by aqueous solvents and, therefore, non-toxic.

For the past 15 years, Geotech has operated a pilot plant that has vitrified a wide variety of materials, including granite, blast furnace slag, fly ash, spent catalyst, and flue dust. Several production plants based on the Geotech technology are now being used to produce mineral fiber and other commercial products. The heart of the system is an electric resistance furnace capable of operating at melting temperatures of up to 5,200 °F (2,870 "C). The furnace is cooled by water circulating within its hollow jacket and is equipped with an off-gas treatment system, which may include a baghouse, cyclone, and wet scrubbers, depending on waste characteristics.

A schematic diagram of the Cold Top Vitrification system used during the SITE demonstration is shown in Figure 1. The furnace is initially charged with a mixture of sand and alumina/silica clay. Through electrical resistance heating, a molten pool forms; the voltage to the furnace is properly adjusted; and, finally, contaminated soil is fed into the furnace by a screw conveyor. Geotech removes the furnace plug from below the molten product tap when the desired soil melt temperature is achieved. As the soil melts, additional soil is added to maintain a "cold top." During the demonstration test, the outflow was poured into refractory-lined and insulated molds for slow cooling. Excess material was discharged to a water sluice for immediate cooling and collection before off-site disposal.

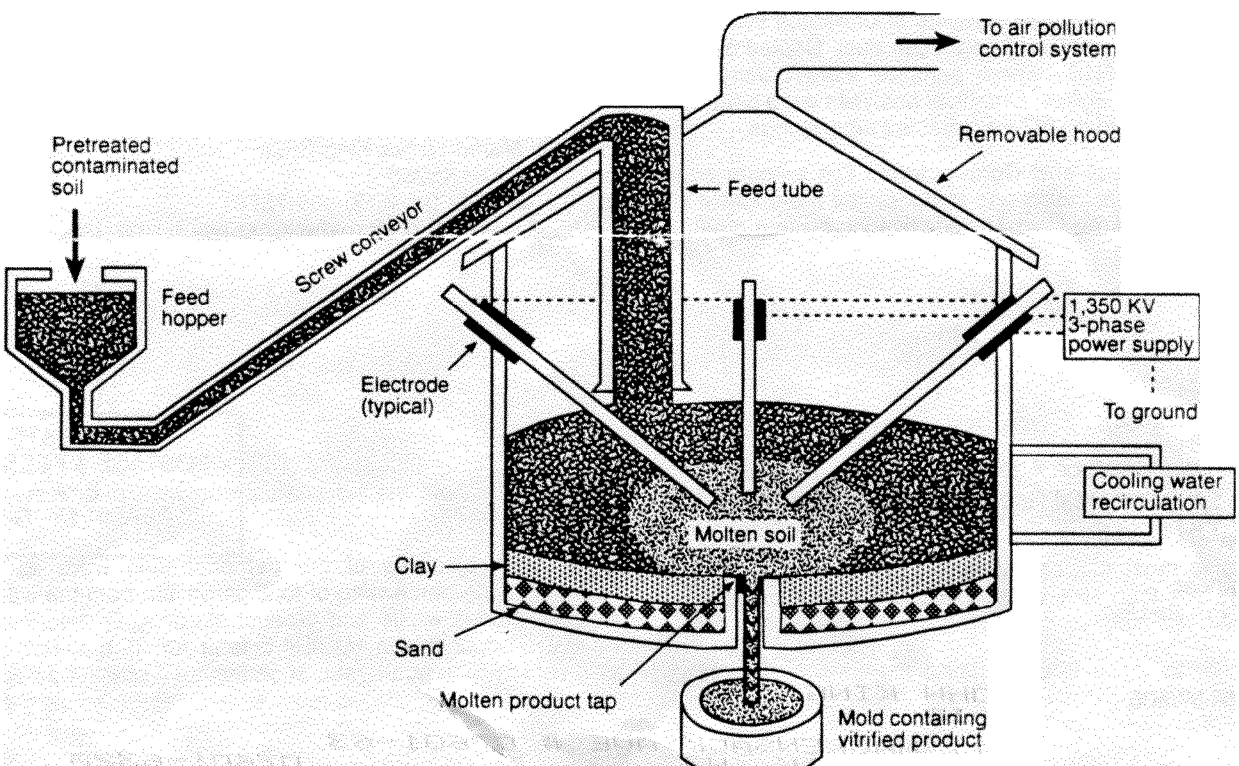

Figure 1. Cold Top Vitrification System schematic.

Waste Applicability: According to Geotech, the Cold Top Vitrification process has been used to treat soils contaminated with hazardous heavy metals such as lead, cadmium, and chromium; asbestos and asbestoscontaining materials; and municipal solid waste combustor ash residue. Waste material must be sized to pass through a 1-to 1 .5-inch mesh screen. The Cold Top Vitrification process is most efficient when feed materials have been dewatered to less than 10% water and organic chemical concentrations have been minimized.

Wastes similar to those treated during the demonstration may require the addition of carbon and sand to ensure that the vitrification process produces a glass-like product. According to Geotech, in the molten state, inorganic contaminants fuse with the silica to become an integral part of the fused material. The vitrified product from the Cold Top process is designed to cool slowly to form a highdensity, noncrystalline glass with physical properties suitable for commercial use. Geotech claims that the vitrified product has many uses, including shore erosion blocks, decorative tiles, roadbed fill, and cement or blacktop aggregate, and that radioactive wastes can be treated with this technology.

Demonstration Procedures: Key participants in the planing and execution of the Cold Top demonstration included the Getech Development Corporation, New Jersey Institute of Technology (NJIT), New Jersey Department of Environmental Protection (NJDEP), and the U.S. EPA SITE Program. Additional support was provided by the New York State Department of Environmental Conservation (NYSDEC) and Stevens Institute of Technology.

Demonstration tests were performed on soils from two sites, representing residue from two types of chromite-ore processing. The sites were selected by NJDEP under an ongoing program to clean up over 150 hexavalentchromium-contaminated sites. Excavated soils from Liberty State Park and Site 130 were crushed, sieved, dried, and amended with carbon and sand at a facility in New Jersey. “Supersacs” containing the pretreated material were then shipped to the Geotech facility in Niagara Falls, NY, where demonstration runs were conducted on February 1 and March 11, 1997. The SITE team collected samples of untreated soil, offgas generated during treatment, and baghouse dust. Cooled castings were transported to NJIT, where samples were crushed and ground for chemical analyses. Chemical analyses were performed in triplicate by NJIT and by SITE-contracted laboratories.

Demonstration Results and Conclusions: The primary objective of the SITE demonstration was to determine if the waste and products produced by the Cold Top Vitrification system meet the Resource Conservation and Recovery Act (RCRA) definition of a characteristic hazardous waste because of their chromium content. The Toxicity Characteristic Leaching Procedure (TCLP) was performed on both treated product and untreated waste to meet this objective.

Secondary objectives of the demonstration were as follows: 1) evaluate the partitioning of total chromium from the waste feed into the various waste and product streams; 2) determine if the vitrified product meets NJDEP criteria for fill material, such as road construction aggregate; 3) determine if process air emissions meet NYSDEC compliance requirements; 4) determine the uncontrolled air emissions of oxides of nitrogen, sulfur dioxide, and carbon monoxide; and 5) determine costs for treating the type of waste treated during the demonstration.

A summary of preliminary SITE analytical results appears below:

	Liberty State Park		Site 130	
	Total Cr (mg/kg)	TCLP Cr (mg/L)	Total Cr (mg/kg)	TCLP Cr (mg/L)
Feed soil (dried)	6,900	29	5,100	58
Vitrified product	10,000	1.0	5,500	0.31

These results indicate that the vitrified product is not a characteristic hazardous waste according to the RCRA definition. Field observations and measurements made during the demonstration indicate that several operational issues must be addressed during technology scale-up. First, a consistent and controlled feed system needs to be developed and spreads the waste feed uniformly over the surface of the molten soil. This feed system must also minimize dust generation. Second, an emission control system needs to be configured to control any particulate and gaseous emissions from the furnace and feed system.

A Technology Capsule and Innovative Technology Evaluation Report will be available in late 1997.

For Further Information:

Marta K. Richards
U.S. EPA SITE Project Manager
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7692; fax (513) 569-7676
Email richards.marta@epamail.epa.gov

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

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