

Name of Process:

GeoMelt®

Status:

The GeoMelt® process has been in commercial use since the early 1990s.

Applicable Pesticide and related POP wastes:

Virtually all chlorinated organic compounds including solvents, pesticides, herbicides, 2,4-D, 2,4,5-T, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor, pentachlorophenol, chlordane, dieldrin, dioxins, furans, hexachlorobenzene, polychlorinated biphenyls. In addition, effective for remediating materials contaminated with heavy metals including arsenic, lead, cadmium, and chromium.

Numerous projects have been successfully completed in the US, Australia, and Japan. In the US, sites contaminated with pesticides, herbicides, solvents, PCBs, dioxins, furans, and heavy metals have been remediated with the process.

The US Environmental Protection Agency has issued a National Toxic Substance Control Act (TSCA) Permit to the GeoMelt process for remediation of sites with PCB-contaminated soils at concentrations up to 17,860-ppm (~1.8-wt%).

In Australia, the process was selected as the preferred technology for remediation of hexachlorobenzene wastes. In Japan, the process has been deployed to remediate an incinerator and associated site materials contaminated with dioxins and furans and a fixed plant has been built to treat POPs and other wastes; this plant currently is in commercial operation.

In the US, the process has successfully remediated soils contaminated with radioactive materials – including plutonium, uranium, caesium, strontium, americium, technetium, and iodine. Sites contaminated with hazardous heavy metals (e.g. – arsenic, chromium, cadmium, and lead) have also been successfully remediated using the process.

The following table lists melt tonnage associated with the POP treatment projects completed in Japan from 2001 to present. The Japan facility treats POPs using AMEC's In-Container Vitrification (ICV)™ process, the ex-situ version that involves batch melting in refractory-lined containers.

Year	Project	Treated POP Waste	Metric Tonnes
2001	Hashimoto	Dioxin debris	20
2002	Hashimoto	Dioxin soil	1056
2006	Nagano	Agrichemical	161
2007 to 2008	Nose	Dioxin soil	51
2006 to 2007	Tottori	Agrichemical	209
2006	Hokkai-Sankyo	Agrichemical	30
2006	Akita	Agrichemical	27
2006	Niigata	Agrichemical	425
2007	Hukushima	Agrichemical	6
2007	Miyagi	Agrichemical	71
2007	Nose	Dioxin sludge	6
Total			2062

Note: Treated Agrichemicals include:

BHC/HCH (lindane)
Chlordane
DDT
Various chlorobenzene herbicides
Aldrin, dieldrin, endrin
HCB

Technology Description:

The GeoMelt® process works by establishing a melt between pairs of electrodes inserted into the soil-bound waste materials. Initially, electrical current is passed through a relatively high-conductivity starter path staged in the soil/waste matrix. Heat dissipated in the starter path is transferred to the surrounding soils causing them to melt. Once molten, the soil becomes sufficiently conductive to support the flow of electrical current, thereby dissipating enough joule heat to sustain and propagate the melting process. Electrical energy is continuously supplied to the melt until such time that it has grown to encompass the entire treatment volume. Individual melts of up to approximately 1,000-tons can be formed. These range in size from 9 to 11 meters in diameter and up to 5 meters thick. With the GeoMelt® Subsurface-Planar Vitrification (SPV)™ method, the melting process can be initiated at virtually any depth below grade, and can be propagated from this initial start-up depth to the desired treatment depth.

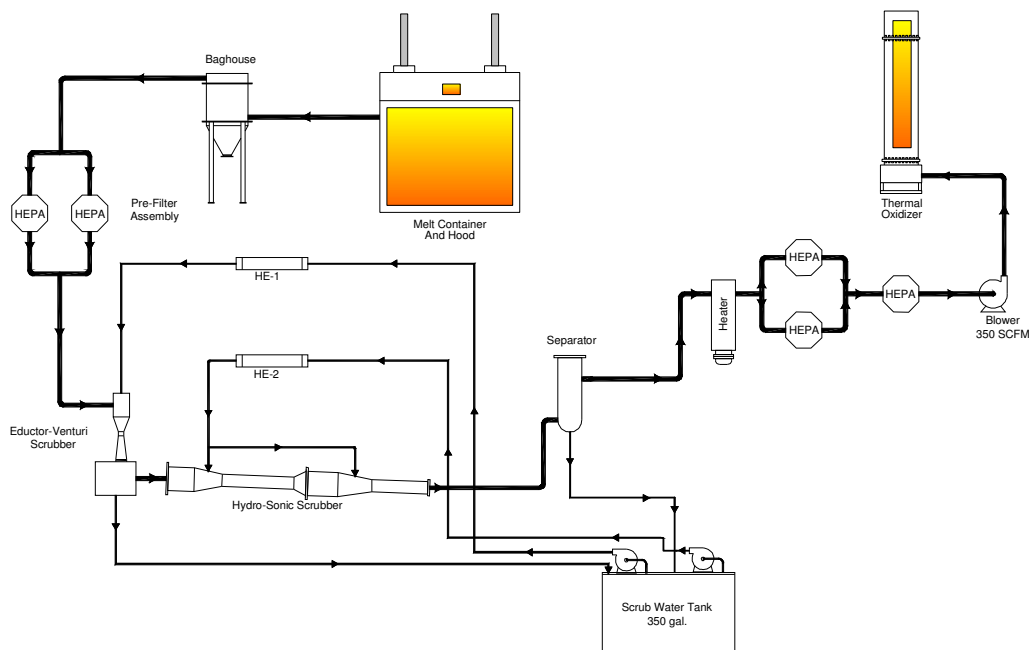
Off gases generated by the process are collected inside a stainless-steel hood covering the treatment area and are drawn-off for processing by an off-gas treatment system (OGTS). The OGTS consists of a combination of filtration, dry & wet scrubbing, and thermal treatment stages. The small quantity of secondary wastes generated by the OGTS (e.g. – filters, scrubber liquids, and personal protective equipment) can be loaded into subsequent applications for processing.

When electrical power is shut off, the molten mass cools and ultimately solidifies into a vitreous and crystalline, rock-like monolith. The process destroys organic contaminants such as dioxins, pesticides, and PCBs directly. Heavy metals, radionuclide, and other non-volatile constituents are retained in the melt and immobilised in the vitrified monolith. The vitrified product has exceptional physical, chemical, and weathering properties compared to alternative solidification/stabilisation technologies. It is typically ten times stronger than concrete and is extremely leach resistant.

The process generates a vitrified product that is far superior (orders of magnitude better) in terms of durability, strength, and leach resistance compared to other stabilisation or encapsulation technologies. The monolith can be safely left in place. Alternatively, it can be readily recovered for transport to a disposal site. In certain applications, the vitrified product can be recycled for subsequent use (e.g. – roadbed materials, breakwater riprap, and roofing tiles)

The process is used for in-situ treatment of soils contaminated by pesticides and other wastes. It is also used to treat exhumed wastes and wastes that were never buried, with ICV™, or using a staged batch in-situ approach. Soil is used in both in-situ and ICV applications to propagate electrical and thermal energy and as an inexpensive source of silica and alumina, the primary glass-formers used in all vitrification technologies.

Process Diagram:



PART I: Criteria on the Adaptation of the Technology to the Country

A. Performance:

1. Minimum pre-treatment:

For In-Container Vitrification (ICV)[™] batch melts, pre-treatment consists of blending POP waste with glass-formers and additives for the batch melt. Additional POPs may be fed into an existing batch melt, either as direct injection of the liquid waste or by feeding more blended solids or sludges.

For in-situ treatment of contaminated soils pre-treatment is generally not necessary. However in situations where there exists excessive moisture levels in the waste form (i.e. – super-saturated), the process is most effectively employed if this moisture is first reduced to at most fully-saturated levels by some other means (e.g. – pumping, drying, and/or sorbing the excess moisture onto additional soil). When the potential exists for significant groundwater recharge during processing on in-situ wastes, precautionary measures should be invoked prior to processing to either prevent or redirect the groundwater flow. This can be done by conventional methods in common use in the industry. For example, a system of wells placed can be installed at strategic locations around the region targeted for processing to alter the site's hydrological conditions. Alternatively, diversion barriers can be inserted up-gradient from the region targeted for processing so that the groundwater flow is suitably redirected.

2. Destruction Efficiency (DE):

The process achieves a very high destruction/retention efficiency (DRE) in the melt, which is the first step of the overall treatment process. The high temperature of the melt promotes pyrolysis and dechlorination reactions in the hot soil surrounding the melt. Consequently, organic destruction efficiencies ranging from 90 to 99.99% have been demonstrated by the melt itself in the process. Heavy metals, radionuclides, and other non-volatile constituents present in the soil/waste matrix are retained in the vitrified product where they are immobilised and effectively isolated from the surrounding ecosystems for perpetuity.

Off-gases generated during processing are collected within the stainless steel off-gas hood placed over the treatment zone. These are piped to the OGTS for subsequent processing. The wet and dry treatment systems making-up the OGTS contribute to further destruction and/or removal of the trace quantities of contaminants present in the off-gas flow. When combined with the destruction efficiency of the melt itself, overall DREs in the range of 99.99 to 99.9999% have been demonstrated by the process for a wide range of hazardous organic and inorganic contaminants. Consequently, the concentration of hazardous chemical constituents present in the off gas at the stack exit is typically at or near detection limits, and is two or more orders of magnitude below acceptable emission limits.

3. Toxic By-products:

CO, NO_x, HCl

4. Uncontrolled releases:

None

5. Capacity to treat all POPs:

Compounds treated:

Industrial chemicals and manufacturing by-products/wastes

PCBs, Dioxins and Furans.

Commercial Pesticides

BHC/HCH (lindane)

Chlordane

DDT

Various chlorobenzene herbicides

Aldrin, dieldrin, endrin

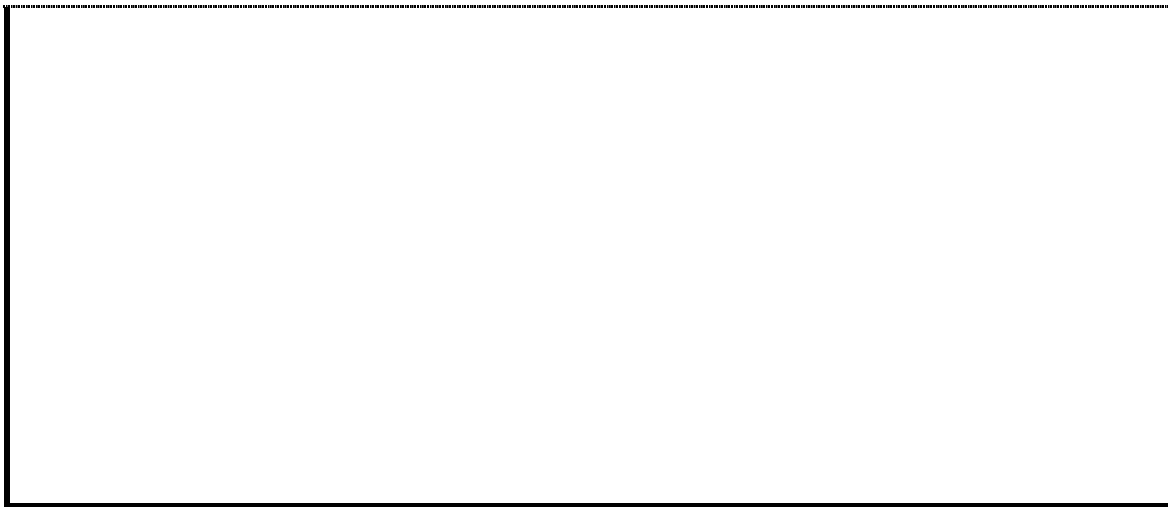
HCB

Heptachlor

Other Compounds treated

Volatile Organic Compounds

Chlorinated Solvents



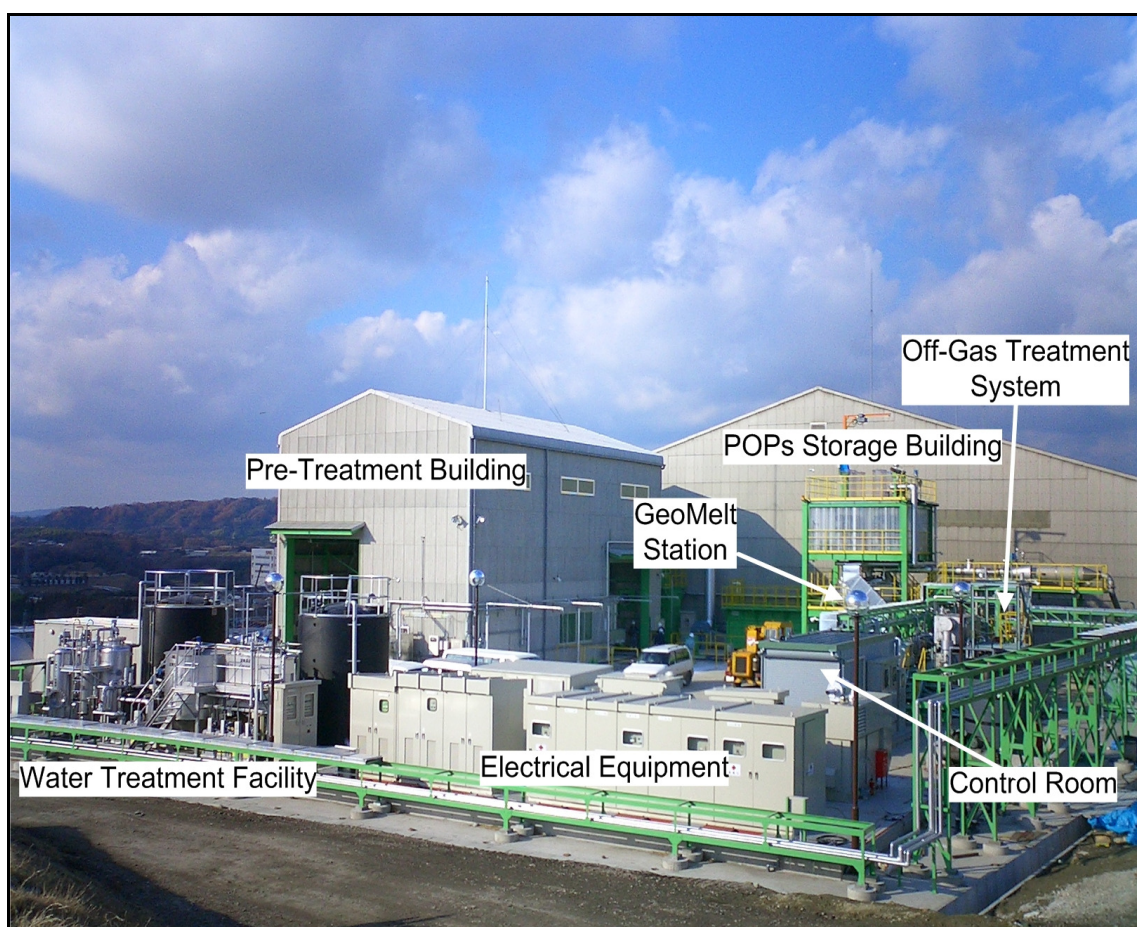
6. Throughput:

6.1 Quantity [tons/day, L/day]

Throughput is dependent of treatment batch size and waste loading. 4.75 tpd is routinely achieved in the existing Japanese commercial facility. This facility uses relatively small equipment (500 kW). The process has been successfully deployed with equipment sized for up to 3750 kW. The existing US and Australian large-scale vitrification systems have a demonstrated process rate of approximately 90-tons per day when applied to in-situ applications. Depending upon the composition and configuration of the waste matrix, a typical 800-ton large scale in situ melt requires approximately 10 to 14 days of operation. The US In-Container Vitrification unit can process wastes at a nominal rate of 45-tons per day. The Japanese staged-batch facility has a demonstrated process rate of approximately 30-tons per day. The Australian In-Container Vitrification facility was designed to achieve a processing rate of 25-tons per day.

6.2 POPs throughput : [POPs waste/total waste in %]

Up to 33 wt% of pure HCB has been treated by the process.



GeoMelt POPs Treatment Facility, Mie Prefecture, Japan

7. Wastes/Residuals:

7.1 Secondary waste stream volumes:

Typical waste streams generated by the process include scrub solution, particulate and carbon filter media, and personal protective equipment (e.g. – gloves, coveralls, and respirator cartridges). The quantities generated in each application are very case-specific. Solid secondary waste materials are typically staged in subsequent melts. Scrub solution can be condensed by evaporating-off excess water during the final stages of operation. Consequently, typical waste volumes for this component are on the order of 5,000-10,000 litres. These volumes are per PROJECT, not per melt.

7.2 Off gas treatment:

Off-gasses are treated by a combination of wet scrubbing and dry filtration with thermal oxidation. Thermal oxidation is performed either as a final polishing step at the process stack, or upstream of the wet scrubbers if the waste concentrations/waste loadings are particularly high.

7.3 Complete elimination:

Yes.

Detailed information and treatment examples:

The references listed at the end of this document provide extensive operational and analytical data for each of the commercial applications to which the process has been applied. The following table lists project examples.

Site	References	Location	Contaminants Treated
Parsons Chemical Works	[1],[2],[3]	Grand Ledge, Michigan USA	Agricultural chemicals including pesticides, herbicides, solvents, heavy metals
Spokane TSCA Demonstration	[4]	Spokane, Washington USA	PCBs
Wasatch Chemical	[5], [6]	Salt Lake City, Utah USA	Agricultural chemicals including pesticides, herbicides, fertilisers, acids, caustics, and solvents
Maralinga Taranaki Pits	[7]	Australian Outback in South Australia	Radioactive elements (principally Pu & U), barite bricks, steel, and concrete
Los Alamos National Laboratory MDA V Site	[8]	Los Alamos, New Mexico USA	Radioactive elements (principally Pu & Am), phosphates, and heavy metals
WCS Waste Treatment Facility	[9]	Andrews, Texas, USA	PCBs, radioactive elements (principally U), and heavy metals
POPs Treatment Facility, Japan	[10]	Mie Prefecture, Japan	BHC/HCH (lindane) Chlordane DDT Various chlorobenzene herbicides Aldrin, dieldrin, endrin HCB Heptachlor

To date, over 25,000-tons of contaminated soil and debris have been successfully remediated using the process. Examples of typical chemically-contaminated sites remediated with the process include:

- 4,350-tons of soil and debris contaminated with pesticides (e.g. – chlordane, DDT, dieldrin, and small concentrations of dioxins & furans) and heavy metals (e.g. – arsenic, cadmium, chromium, lead, and heavy metals (e.g. – arsenic, cadmium, chromium, lead, and mercury) in Grand Ledge, Michigan USA [1], [2], [3]
- 7,000-tons of PCB-contaminated soil and debris at a transformer repair site in Spokane, Washington USA [4]
- 5,440-tons of soil and debris contaminated with dioxins, pentachlorophenol, DDT, 2,4-D, hexachlorobenzene, and a range of other pesticides and herbicides at a chemical waste site near Salt Lake City, Utah USA [5], [6]

Two examples of sites contaminated with radioactive materials that were successfully remediated using the process include:

- 5,400-tons of soil, steel, barytes bricks, and other debris contaminated with plutonium and uranium at the Maralinga Taranaki Pits in southern Australia [7]
- 500-tons of soil and cobble contaminated with plutonium, uranium, americium, heavy metals, and phosphates [8]

In addition to these in-situ applications, a series of In-Container Vitrification (ICV)[™] demonstrations were performed in Australia on soils contaminated with 33-wt% hexachlorobenzene (HCB) wastes. The successful results obtained from these tests have led to the design of a facility to process the 60,000 208-L drums of HCB wastes present at a chemical processing plant there. Government approvals for the project have been obtained.

The process achieves a very high destruction/retention efficiency (DRE) in the melt, which is the first step of the overall treatment process. The high temperature of the melt promotes pyrolysis and dechlorination reactions in the hot soil surrounding the melt. Consequently, organic destruction efficiencies ranging from 90 to 99.99% have been demonstrated by the melt itself in the process. Heavy metals, radionuclides, and other non-volatile constituents present in the soil/waste matrix are retained in the vitrified product where they are immobilised and effectively isolated from the surrounding ecosystems for perpetuity.

Off-gases generated during processing are collected within the stainless steel off-gas hood placed over the treatment zone. These are piped to the OGTS for subsequent processing. The wet and dry treatment systems making-up the OGTS contribute to further destruction and/or removal of the trace quantities of contaminants present in the off-gas flow. When combined with the destruction efficiency of the melt itself, overall DREs in the range of 99.99 to 99.9999% have been demonstrated by the process for a wide range of hazardous organic and inorganic contaminants. Consequently, the concentration of hazardous chemical constituents present in the off gas at the stack exit is typically at or near detection limits, and is two or more orders of magnitude below acceptable emission limits.

For example, at the Parsons Chemical Site in Grand Ledge, Michigan USA [1], initial soil concentrations of 4,4'-DDT (@ 340,000-ppb) and dieldrin (@ 4,600-ppb) were reduced to non-detect levels in the vitrified product. This is to be expected as neither of these compounds can survive the extreme thermal conditions imposed by the vitrification process. Analysis of the concentration of these constituents in the stack emissions generated during processing indicated non-detect levels. Prior to processing, samples of the site soils were subjected to Toxicity Leach Test Procedure (TCLP) testing to assess its propensity for leaching heavy metals. The vitrified product generated by the process was also subjected to TCLP testing for this purpose. The concentration of arsenic, barium, chromium, and lead present in the leachate from these tests was 8 to 1300 times lower for the vitrified product than for the site soil. In all cases, the concentration of these heavy metal constituents present in the leachate generated by applying the TCLP procedure to the vitrified product was well below the established regulatory limits.

At the TSCA Demonstration Test Site in Spokane, Washington USA [2], the concentration of polychlorinated biphenyls (PCBs) in the contaminated soil at the Site ranged from 170-ppm to over 17,860-ppm, with the average concentration being 14,377-ppm. The PCB concentration found in the vitrified product was below detection limits. Moreover, soil samples obtained from areas surrounding the vitrified block indicated no detectable concentration of PCBs, dispelling the notion that these contaminants can migrate away from the advancing melt front into the surrounding, non-contaminated soils. Samples obtained from the off-gas stack exit during processing were analysed to determine the presence of PCBs and TCDD equivalents. In all cases, the concentrations were essentially non-detect, with concentrations not statistically different from background, ambient airborne concentrations. The off-gases were also analysed to determine the concentration of polynuclear aromatic hydrocarbons (PAHs – e.g., naphthalene, fluorene, phenanthrene, fluoranthene, and pyrene) and other VOCs. The measured concentrations were in the low ppb range for these constituents. Consequently, the concentrations were typically three orders of magnitude below their respective accepted United States NIOSH (National Institute for Occupational Safety and Health) exposure limits. Finally, the off-gas effluent was analysed for particulates, chloride, CO, and NO_x emissions. PM₁₀ particulate emissions were in the range of 0.23 to 7 -mg/dscm; HCl emissions were in the range of 0.6 to 14-ppm. These emission levels are at least one order of magnitude lower than US federal guideline values. NO_x emissions were in the range of 30 to 40-ppm; CO concentrations were below detection limits. Again, these values are well below established guideline levels. These combined results indicated that the overall PCB DRE for the process ranged from greater than 99.99962% to greater than 99.99998%. Discounting the off-gas treatment system's contribution to the overall DRE, these results indicate the PCB DRE for the melt itself was in the range of 97.11 to 99.77%.

The table below indicates the effectiveness of the process for remediating the assortment of hazardous chemical wastes present in the soils at the Wasatch Chemical Site near Salt Lake City, Utah USA. Analysis of the off-gas effluents at the stack exit indicated that the concentration of the pesticides and herbicides listed in this table was all below the part per trillion detection (ppt) limits. Similarly, dioxin analysis of the off-gas effluents indicated that the concentration of these constituents was also below the ppt detection limits. This included analysis for TCDD, PeCDD, HxCDD, HpCDD, and OCDD. The concentration of furans were similarly low. HpCDF and OCDF, if present, were at concentrations below the ppt detection limits. The concentration of TCDF, PeCDF, and HxCDF were 0.49-ppt, 0.21-ppt, and 0.07-ppt, respectively. Analysis of the off-gas effluent for the presence of VOCs indicated that the concentration of these compounds was below

the detection limit of 5.8-ppb. The PM10 particulate concentration in the off-gas effluent was measured at 0.54-mg/dscm. Finally, the concentration of HCl in the off-gas effluent was measured at less than 0.0054-mg/dscm.

Initial Waste Soil, GeoMelt Product & Surrounding Soil (post-GeoMelt) Contaminant Levels [2]				
Contaminant	Pre-GeoMelt (ppb)	Post-GeoMelt (ppb)	Surrounding Soil (ppb)	Regulatory Limit (ppb)
TCDD dioxin	11	< 0.12 ⁽¹⁾	< 0.0045	20
2,4-D	34,793	< 20	ND	NA(3)
2,4,5-T	1,137	< 14	ND	NA
4,4'-DDD	52	ND ⁽²⁾	ND	28,000
4,4'-DDE	3,600	ND	<2.4	19,000
4,4'-DDT	1,090	ND	ND	19,000
Total chlordanes	535,000	<80	<83.4	7,000
Heptachlor	137.5	ND	ND	2,000
Hexachlorobenzene	17,000	ND	ND	7,000
Pentachlorophenol	272,918	<10.3	<1.2	<10
Trichloroethene	36,875	ND	ND	103,000
Notes: < values indicate that contaminants were not detected at the reported detection limit				
(1) Non-detect				
(2) Not available				

Tests in Australia involving applying the In-Container Vitrification (ICV)TM process to treatment of soil contaminated with 33-wt% hexachlorobenzene (HCB) yielded an overall DRE of 99.9999%. When the influence of the off-gas treatment system is removed from this value, a DRE of 99.75% is obtained for the melt itself. The off-gas effluent at the stack was sampled and analysed during this test. The results indicated concentrations of 89-ppb for HCB, 1.2-ppm for bis(2-ethylhexyl) phthalate, and non-detect (less than 72-ppb) levels for the dichlorobenzene isomers, 1,2,4-trichlorobenzene, hexachloroethane, naphthalene, and hexachlorobutadiene. Total VOC and HCl concentrations in the off-gas effluent were less than 1.5-ppm and 0.7-ppm, respectively. Particulates were measured at 3.3-mg/dscm in the off-gas effluent. The concentration of CO in the off-gas effluent was in the range of 2 to 4-ppm, while NO_x concentrations ranged from 27 to 74-ppm.

Further detailed information and treatment example can be found in the Annex:

Table 1: Technology overview technology – Summary-Technical Details

Table 2- Part 1: Overview project experience per technology supplier

Table 3: Overview detailed project information per project – Project name (from Table 2):

Table 4: Client References for GeoMelt®

Table 5: Utilities Required for High-strength Pesticide Waste Treatment, Japan capacity 4.5t /day



PART II: Criteria on the Adaptation of the Country to the Technology

Note: This part has to be filled in every time the "suitability" of the technology has to be examined for a certain country situation!!

A. Resource needs:

1. Power requirements :

The systems vary from 300 kW to 3750kW depending on size. A typical system for In-Container Vitrification (ICV)TM of POP wastes, such as in operation in the Mie Prefecture, Japan requires 500-1000 kW for melt power and approximately 300 kW for ancillary equipment such as off-gas treatment.

2. Water requirements:

Minor amounts of water are used in the off-gas treatment system. This water is recirculated during operations and treated afterwards.

3. Fuel volumes:

Propane or natural gas is used for the thermal oxidizer. Fuel consumption rates depend on the size of thermal oxidizer, which varies depending on the size of the system being used. The thermal oxidiser specified for the ICV plant at the US Department of Energy Hanford Site uses approximately 60 kg/hr propane.

4. Reagents volumes:

Approximately 200 L/day of caustic soda for scrub water adjustment.

5. Weather tight buildings:

Weather tight but ventilated.

7. Sampling requirements/facilities:

Waste is characterized to determine appropriate glass formulation. Other sampling requirements depend on client needs and government regulations, and depending on disposal requirements.

9. Laboratory requirements:

On site requirements:

None.

Requirements in country:

None. Samples can be shipped internationally for analysis is necessary.

11. Number of personnel required: This depends on the project scope/equipment size. A minimum requirement is approximately 6 people for operations.

11.1 Number of Technicians required (skilled labour):

2 per shift and one manager

6. Hazardous waste personnel requirement:

Only when handling or treating hazardous waste.

8. Peer sampling:

The sampling has been conducted by AMEC, and independently by others such as PNNL, ANSTO, etc.

10. Communication systems:

The system is fully automated and is PLC controlled.

Mobile network:

Fixed network:

11.2 Number of Labourers required (unskilled labour):
1-2

B. Costs: Cost depends on project scope, location, waste types and quantities, etc. The technology provider does not supply generic estimates.

1. Installation and commissioning costs [US Dollars]:

2. Site preparation costs [US Dollars]:

3. Energy & Telecom installation costs:

4. Monitoring costs:

5. Complying costs:

6. Reporting costs:

7. Running costs with no waste:

8. Running costs with waste:

9. Decommissioning costs:

10. Landfill costs:

Unknown.

11. Transport costs of residues:

C. Impact:

1. Discharges to air:

None above regulatory limits. Off-gas is treated before discharge.

2. Discharges to water:

None above regulatory limits. Waste water is treated before discharge.

3. Discharges to land:

None

4. Soil impact (noise etc):

None

D. Risks:

1. Risks of reagents applied:

Low. Caustic soda is incompatible with skin, eyes, and internal organs. PPE is required for use. This is a common reagent used in many industries.

2. Risks of technology:

Low. Geomelt vitrification is a mature, established technology.

3. Operational risks:

Low. Engineering and institutional controls are used to control operational risks. The systems are fully compliant with electrical and occupational safety statutes and codes in countries in which they are deployed (US, UK, Australia, and Japan).

E. Constructability:

1. Ease of installation/construction of plant:

Available as trailer-mounted, skid mounted, or fixed plant. Trailer-mounted and skid mounted equipment require simple hook-ups. Fixed plant requires construction. Thus, ease of installation varies on system type.

3. Ease of operation:

Operation requires training.

2. Ease of shipping/transit:

Available as trailer-mounted, skid mounted, or fixed plant.

4. Ease of processing:

To date, all commercial applications have successfully and completely processed the entire target volume of hazardous chemical wastes to which it has been applied.

F. Output/generation waste

1. Generated waste (% of input waste):

Low. 1-5%

3. Waste quality properties (pH, TCLP): The vitrified product is chemically inert-generally neutral in pH and exhibits excellent leach properties.

2. Deposited waste at landfill (% of input waste):

Low. 1-5%



Glass block from the GeoMelt POPs Treatment Facility on left and the same block broken open for sampling on right, Mie Prefecture, Japan

**Note: This Technology Specification and Data Sheet (TSDS) does not certify any particular technology, but tries to summarise the state of the art of the concerned technology on the basis of data delivered by the technology suppliers or other sources, which have been made available to the author and refers the reader to original documents for further evaluation. Without the efforts below listed technology suppliers it would not have been possible to set up this TSDS. Date: 08.06.2008*

Technology suppliers that have contributed to this TSDS:

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References:

- [1] US EPA. 1995. "Geosafe Corporation In Situ Vitrification Innovative Technology Evaluation Report " EPA/540/R-94/540.
- [2] Mostardi-Platt Assoc. 1993. "Particulate and Gaseous Emission Study Performed for Geosafe Corporation at the Parsons/ETM Superfund Site" Project No. 33109. Mostardi-Platt Associates, Inc. 945 Oaklawn Avenue, Elmhurst, Illinois USA 60126.
- [3] Mostardi-Platt Assoc. 1993. "Particulate and Gaseous Emission Study Performed for Geosafe Corporation at the Parsons/ETM Superfund Site" Project Nos. 32606 & 32717. Mostardi-Platt Associates, Inc. 945 Oaklawn Avenue, Elmhurst, Illinois USA 60126.
- [4] Geosafe. 1995. "TSCA Demonstration Test Performance Report", Geosafe GSC 2501, Geosafe Corporation, 2952 George Washington Way, Richland, Washington USA 99352.
- [5] Air Chem. 1995. "Report on Air Emissions Testing – Phase I" Air Chem Laboratories, 463 West 3600 South, Salt Lake City, Utah USA 84115.
- [6] Air Chem. 1995. "Report on Air Emissions Testing – Phase II" Air Chem Laboratories, 463 West 3600 South, Salt Lake City, Utah USA 84115.
- [7] Geosafe. 2002. "ISV Treatment Process Report – In Situ Vitrification of the Maralinga Taranaki Pits" GSA 40102. Geosafe Australia Party Ltd., Adelaide, South Australia.
- [8] Geosafe. 2001. "Non-Traditional In Situ Vitrification at the Los Alamos National Laboratory. Volume 1 –Hot Demonstration Report" GSC 30101. Geosafe Corporation, Columbus, Ohio USA.
- [9] AMEC, 2006. "The Treatment of Mixed Waste with GeoMelt In-Container Vitrification". Waste Management 2006 Conference, March 2, 2006, Tucson, AZ, USA.
- [10] Unpublished data: internal communication between ISV Japan, Ltd., and AMEC.

Trademark Information:

GeoMelt® is a registered trademark of Geosafe Corporation
In-Container Vitrification (ICV)™ is a trademark of AMEC
Subsurface Planer Vitrification (SPV)™ is a trademark of AMEC.