TITLE: Surface Decontamination of Mercury (elemental) by DeconGel™

ABSTRACT

Surface decontamination efficacy determination of DeconGel™ on stainless steel, porcelain tile, composite tile (unwaxed), linoleum tile, and concrete surfaces contaminated with mercury (elemental) was performed with Mercury Vapor Analysis Sensor (Mercury Tracker 3000) according to Environmental Protection Agency (EPA) SW-846 Method: 7471B: "Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)".

HAZARDOUS MATERIALS RELEVANCE

Mercury is used in thermometers, electronics, lighting, gold and silver refinery, and combined with other metals to form useful amalgams. Mercury and most of its compounds are extremely toxic, causing neurological damage due to inhalation of vapors/dust or ingestion.

SUMMARY RESULTS

- As seen in Table 1, excellent to acceptable surface decontamination was achieved by applying DeconGel onto contaminated surfaces, resulting in encapsulation of mercury (elemental) by DeconGel's active components. Decontamination efficacies of poured DeconGel ranged from 66.0% (composite tile, using Zn-controlled contaminant loading) to 85.9% (porcelain tile, using Zn-controlled contaminant loading) to 90.8% (linoleum tile, using Zn-controlled contaminant loading) to 91.7% (composite tile, using pipet-controlled contaminant loading) to 95.4% (linoleum tile, using pipet-controlled contaminant loading) to 97.8% (concrete, using pipet-controlled contaminant loading) to 98.4% (stainless steel, using pipet-controlled contaminant loading) to 99.2% (porcelain tile, using pipet-controlled contaminant loading); decontamination efficacy of brushed DeconGel was 99.0%(linoleum tile, using Zn-controlled contaminant loading).
- Mercury (elemental) was evidenced to interact with most plastic surfaces such as un-waxed composite and linoleum tiles, adhering to the plastic surfaces and forming a fixed residue that was not able to be completely removed by DeconGel. Nevertheless, DeconGel showed excellent to acceptable decontamination efficacy of loose mercury (small beads <1 mm diameter) contamination from such surfaces (see Table 1).
- Optimized experimental and analytical methods were successfully developed following a standardized EPA analysis method as a guideline for determination of elemental mercury vapor on solid surfaces. When deemed necessary, experimental methods were customized to ensure accurate decontamination efficacy determination of DeconGel.

RESULTS

Table 1 shows the decontamination efficacies of DeconGelon stainless steel, concrete, porcelain tile, composite tile, and linoleum tile surfaces as determined by mercury vapor analysis.

Table 1. Decontamination efficacies of DeconGel on Mercury (elemental) on stainless steel, concrete, porcelain tile, composite tile, and linoleum tile surfaces as determined by mercury vapor analysis.

Mercury Vapor Analysis Testing (ppt)		Formulation
		DeconGel
Stainless Steel	Control [1]	18.6 ± 3.0
	Residual [1]	0.3 ± 0.12
	Decon. Efficacy (%) [1]	**98.4 ± 0.7**
Concrete	Control [1]	18.6 ± 8.9
	Residual [1]	0.4 ± 0.13
	Decon. Efficacy (%) [1]	**97.8 ± 0.7**
Porcelain Tile*	Control [1]	12.2 ± 1.5
	Control [2]	6.4 ± 1.2
	Residual [1]	0.1 ± 0.04
	Residual [2]	0.9 ± 0.6
	Decon. Efficacy (%) [1]	**99.2 ± 0.4**
	Decon. Efficacy (%) [2]	**85.9 ± 11.7**
Composite Tile*	Control [1]	72.1 ± 39.1
	Control [2]	5.0 ± 2.7
	Residual [1]	6.0 ± 1.4
	Residual [2]	1.7 ± 0.8
	Decon. Efficacy (%) [1]	**91.7 ± 2.1**
	Decon. Efficacy (%) [2]	**66.0 ± 11.7**
Linoleum Tile*	Control [1]	60.4 ± 6.6
	Control [2]	20.7 ± 10.0
	Control [3]	20.7 ± 10.0
	Residual [1]	2.8 ± 0.5
	Residual [2]	1.9 ± 1.1
	Residual [3]	0.2 ± 0.1
	Decon. Efficacy (%) [1]	**95.4 ± 0.9**
	Decon. Efficacy (%) [2]	**90.8 ± 5.8**
	Decon. Efficacy (%) [3]	**99.0 ± 0.2**

* Mercury (elemental) has an affinity for plastics, mercury in the form of small beads was noted to adhere to plastic test surfaces (composite tile and linoleum tile), resulting in a fixed residue on the contaminated surface that could not be completely removed by DeconGel.

[1] Contaminant administration controlled using pipet-aided removal of bulk mercury contamination to yield contaminant as very small liquid beads (<1 mm diameter); DeconGel was poured onto contaminated surface

[2] Contaminant administration controlled using zinc dust-assisted removal of bulk mercury contamination to yield contaminant as very small liquid beads (<1 mm diameter); DeconGel was poured onto contaminated surface

[3] Contaminant administration controlled using zinc dust-assisted removal of bulk mercury liquid to yield contaminant as very small liquid beads (<1 mm diameter); DeconGel was brushed onto contaminated surface

NOTES

- Application of homogeneously dispersed mercury (elemental) contaminant in the form of very small beads (<1 mm diameter) on the respective substrates facilitated an optimized interaction between contaminant and DeconGel, and an accurate measure of DeconGel's decontamination efficacy in a scaled-down yet real-world setting. Contaminant administration was controlled using either 1) pipet-aided test surface spreading and then removal of bulk mercury liquid (approximately 0.25 g) initially loaded onto test surfaces, or 2) zinc dust-assisted test surface spreading and then removal (using mercury removal kit, Lab Safety Supply Inc., Janesville, WI) of bulk mercury liquid (approximately 0.25 g) initially loaded onto test surfaces, to yield mercury contaminant in the form of very small liquid beads (<1 mm diameter) spread homogeneously throughout the test surfaces. No less than 6.0 g of DeconGel was used for each experiment to allow an optimized interaction between contaminant and DeconGel. Mercury (elemental) vapor was analyzed using a mercury vapor analyzer (see below).
- Mercury (elemental) was evidenced to interact with plastic surfaces such as coated porcelain, composite, and linoleum tiles, adhering to the plastic surfaces and forming a fixed residue that was not able to be completely removed by DeconGel. Nevertheless, DeconGel showed excellent to acceptable decontamination efficacy of loose mercury (small beads <1 mm diameter) contamination from such surfaces, as determined using a mercury vapor analyzer (see below).
- Standardized EPA SW-846 Sampling Method 7471B: "Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)" was followed as a guideline to prepare all samples and controls, to ensure both accurate and precise analytical testing results.
- Mercury Vapor Analysis using the Mercury Tracker 3000 (rented from Mercury Instruments USA; Littleton, CO) allows for the continuous measurement of mercury (elemental) concentration (parts per trillion (ppt)) in ambient air, instrument determination of mercury concentration utilizes mercury resonance absorption of 253.7 nm. The Mercury Tracker 3000 contains an internalized mercury lamp used for instrument calibration, and during use the instrument routinely performs instrument calibration to provide accurate analytical determination.

CALCULATIONS

Decontamination Efficacy (Mercury Vapor Testing) =

[(Contaminant (ppt) of Control) – (Contaminant (ppt) of Residual)/Contaminant (ppt) of Control] x 100%

MATERIALS AND METHODS

Sample Method

In a typical procedure, approximately 0.25 g of mercury (elemental) was pipetted onto 1) stainless steel (surface area: 56.3 cm^2), 2) plastic-coated porcelain tile (surface area: 48.8 cm^2),

3) non-waxed composite tile (surface area: 48.8 cm^2), 4) linoleum tile (surface area: 48.8 cm^2), or 5) concrete (industrial grade, surface area: 56.3 cm^2) coupons. Contaminant administration was controlled using either 1) pipet-aided test surface spreading and then removal of bulk mercury contamination initially loaded onto test surfaces, or 2) zinc dust-assisted test surface spreading and then removal (using mercury removal kit, Lab Safety Supply Inc., Janesville, WI) of bulk mercury liquid initially loaded onto test surfaces, to yield mercury contaminant in the form of very small liquid beads (<1 mm diameter) spread homogeneously throughout the test surfaces Approximately 6.0 g of DeconGel 1101 was poured onto the contaminated surface and let to dry for 24 hours. Dried DeconGel samples were peeled off the contaminated surface, and the surface was analyzed for mercury vapor using the Mercury Tracker 3000 (Mercury Instruments USA; Littleton, CO) (see below).

Control Method

For control samples, a respective amount of contaminant (see above in Sample Method) was evenly applied on 1) stainless steel (56.3 cm^2), 2) plastic-coated porcelain tile (surface area: 48.8 cm^2), 3) non-waxed composite tile (surface area: 48.8 cm^2), 4) linoleum tile (surface area: 48.8 cm^2), or 5) concrete (industrial grade, surface area: 56.3 cm^2) coupons and the surface was analyzed for mercury vapor using the Mercury Tracker 3000 (Mercury Instruments USA; Littleton, CO) (see below).

Reagents and Standards

Mercury (elemental) (CAS# 7439-97-6, Fisher Scientific; Fair Lawn, NJ) was used as received.

Analytical Instrumentation

A Mercury Tracker 3000 (rented from Mercury Instruments USA; Littleton, CO) was used to determine mercury (elemental) surface vapor concentration (ppt) of all samples and controls. Precise vapor measurements were conducted using a hand-held open-ended wand connected to the instrument detector, such that the wand was passed just above (<0.5 cm) the contaminated surface at a 45 degree, passing the wand first in a top-bottom, then in a left-right fashion.

APPLICATION INSTRUCTIONS FOR END-USERS

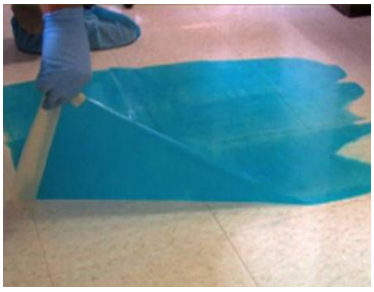
First, remove any visible mercury contamination. Use product directly as is from container. DO NOT DILUTE. Masking or painters tape can be applied along one edge of the area that is to be decontaminated to aid creating a peeled edge to grip for peeling the dried film. Apply DeconGel using a paint brush, a trowel, a handheld sprayer, or an industrial grade sprayer.

The thickness of the gel and the number of coats is dictated by the surface to be decontaminated. Coating thickness required for good peel characteristics varies with substrate and generally increases with substrate porosity. It is recommended that first time customers test DeconGel on a small sample area to confirm the required film thickness and dry time for their specific application. If the film is difficult to peel, please apply an additional coat. A razor blade is useful to start the peel. Lay the blade nearly flat and fillet the edge of the film to create a tab that can be pulled. For surfaces that the gel adheres to well, such as concrete, 12" – 24" strips can be cut in the film resulting in less force being required to peel the film.

- Let DeconGel dry for 24 hours

Dry time will vary depending on humidity, temperature, air flow and thickness of the DeconGel. This can take from as little time as an hour for thin coats in a dry environment with plenty of airflow, to overnight or longer if thicker coats are applied in humid environments. Dry times exceeding 24 hours may sometimes be required for good peel performance on bare concrete, wood and other highly porous substrates and substrates with deep cracks or grooves. However, 18-24 hours is often sufficient dry time on good quality concrete. It is recommended that users test a small area to determine drying time prior to applying DeconGel for an entire job. Supplemental heat or air circulation will accelerate DeconGel's drying time for any job.

- Peel DeconGel off the surface by starting from one of the edges



When dry, the product locks the contaminants into a polymer matrix. The film containing the encapsulated contamination can then be peeled. DeconGel peels from most non-porous and porous hard surfaces if the dried film is thick enough. If the film is difficult to peel, add another coat, let dry, and peel. In most cases the DeconGel will come off in a single sheet but for odd shaped surfaces you may be required to score DeconGel in order to peel it off.

- Dispose of the dried DeconGel in accordance with the local, state and Federal disposal regulations of the contaminant/substance you are removing. DeconGel itself has no special disposal restrictions.

For questions about DeconGel or to place an order, visit our website at www.decongel.com or contact us at:

KT Chemicals, Inc.
1002 N Central Expy Suite 499
Richardson, TX 75080
(855) 932-2228
info@kt-chemicals.com