TITLE: Surface Decontamination of Zinc Compounds (Elemental Zinc Powder (Zn), Zinc Oxide (ZnO), and Zinc Acetate ($Zn(O_2CCH_3)_2$) by DeconGel™

ABSTRACT

Surface decontamination efficacy determination of DeconGel™ on stainless steel, carbon steel, and concrete surfaces contaminated with zinc compounds (elemental zinc powder (Zn), zinc oxide (ZnO), and zinc acetate ($Zn(O_2CCH_3)_2$)) was performed with ICP-OES (Inductively Coupled Plasma-Optical Emission Spectroscopy) according to Environmental Protection Agency (EPA) SW-846 Methods: 3005A (sampling) and 6010C (analysis).

HAZARDOUS MATERIALS RELEVANCE

Zinc compounds are common industrial compounds and are used as anti-corrosive agents and in the semi conductors and batteries Industries. Zinc compounds are irritants if inhaled and may cause flu-like symptoms known as "metal fume fever". Zinc powder, zinc oxide, and zinc acetate were chosen as representative zinc compound for evaluating DeconGel's efficacy; DeconGel is expected to have similar efficacy towards the wide range of zinc compounds.

HIGHLIGHTS

- Acceptable to excellent surface decontamination was achieved by applying DeconGel onto surfaces contaminated with zinc compounds resulting in encapsulation of contaminants by DeconGel's active components. Decontamination efficacies of DeconGel ranged from greater than 86.5% (on concrete) to greater than 66.9% (on carbon steel) to greater than 77.3% (on stainless steel) as determined by residual swipe analysis
- Optimized experimental and analytical methods were successfully developed following standardized EPA sampling and analysis methods as guidelines for determination of inorganic compounds in aqueous samples. When necessary, experimental methods were customized to afford complete dissolution of inorganic contaminants, and to ensure accurate decontamination efficacy determination of DeconGel.
- Due to the corrosive nature of zinc powder, DeconGel surface decontamination was not found to be exceptional on steel (carbon and stainless steel) surfaces due to zinc powder's ability to react with these surfaces, forming a fixed residue that was not able to be completely removed by DeconGel. Nevertheless, DeconGel showed acceptable decontamination efficacy of loose zinc powder contamination from such surfaces.

RESULTS

Tables 1 through 3 show the decontamination efficacies of DeconGel on stainless steel, carbon steel, and concrete surfaces contaminated with elemental zinc powder (Zn), zinc oxide (ZnO), and zinc acetate ($Zn(O_2CCH_3)_2$) as determined by the residual swipe testing method.

Table 1. Decontamination efficacy of DeconGel on stainless steel, carbon steel, and concrete surfaces contaminated with zinc powder (Zn) as determined by residual swipe testing.

Swipe Testing (ppm)		**Formulation**
		DeconGel
Stainless Steel*	Control	330.6 ± 14.4
	Residual	74.9 ± 17.7
	Decon. Efficacy (%)	**77.3 ± 6.4**
Carbon Steel*	Control	327.2 ± 7.0
	Residual	108.4 ± 8.0
	Decon. Efficacy (%)	**66.9 ± 2.9**
Concrete	Control	292.1 ± 16.1
	Residual	39.3 ± 13.8
	Decon. Efficacy (%)	**86.5 ± 7.7**

21880x dilution factor for samples and controls

* Zinc powder is corrosive and reacted with all the surfaces evaluated, resulting in a fixed residue on the contaminated surface that could not be completely removed by DeconGel.

Table 2. Decontamination efficacy of DeconGeon stainless steel, carbon steel, and concrete surfaces contaminated with zinc oxide (ZnO) as determined by residual swipe testing.

Swipe Testing (ppm)		**Formulation**
		DeconGel
Stainless Steel	Control	553.4 ± 33.2
	Residual	0.086 ± 0.075
	Decon. Efficacy (%)	**100.0 ± 0.2**
Carbon Steel	Control	578.8 ± 14.3
	Residual	0.204 ± 0.104
	Decon. Efficacy (%)	**100.0 ± 0.4**
Concrete	Control	543.2 ± 22.4
	Residual	8.52 ± 7.23
	Decon. Efficacy (%)	**98.4 ± 0.2**

21880x dilution factor for samples and controls

Table 3. Decontamination efficacy of DeconGel on stainless steel, carbon steel, and concrete surfaces contaminated with zinc acetate ($Zn(O_2CCH_3)_2$) as determined by residual swipe testing.

Swipe Testing (ppm)		**Formulation**
		DeconGel
Stainless Steel	Control	468.9 ± 25.3
	Residual	8.58 ± 1.38
	Decon. Efficacy (%)	**98.2 ± 6.0**
Carbon Steel	Control	474.4 ± 17.5
	Residual	7.71 ± 0.14
	Decon. Efficacy (%)	**98.4 ± 3.9**
Concrete	Control	477.1 ± 19.6
	Residual	11.4 ± 5.8
	Decon. Efficacy (%)	**97.6 ± 4.4**

21880x dilution factor for samples and controls

NOTES

- ASTM method E1728-03 (a standardized swipe testing method used for the sampling of inorganic contaminants) was the integral method used to accurately evaluate DeconGel's decontamination efficacy. GhostWipe™ (Environmental Express; Mt. Pleasant, SC) swipes (pre-wetted with DI H_2O) were utilized in this swipe testing method.
- Standardized EPA SW-846 Sampling Method 3005A "Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy" was followed as a guideline to prepare all samples and controls. Because potassium ferricyanide reacts violently with acid releasing poisonous cyanide gas, all samples were digested solely in DI H2O (≥ 17 M-Ohm). To reduce the viscosity of samples, a 1:00 dilution in water took place on all samples and controls after ample soaking and vigorous shaking to incorporate any contaminant contained within swipes and to ensure full dissolution of the gel. All samples, controls, and standards were prepared using the same dissolution solution and experimental conditions to ensure both correct instrument calibration and accurate analytical results.
- To ensure accurate determination of DeconGel decontamination efficacy, calibration standards of the analyte of interest were prepared using either a sufficiently pure analyte or an appropriate ICP-MS Standard (Ricca Chemical Company; Arlington, TX); the respective standards were diluted to a known concentration (ppm) using the same digestion method as that used for samples and controls. Instrument blank controls were DI H_2O (≥17 M-Ohm).
- ICP-OES instrumentation is a sensitive and accurate analytical tool for qualitative and quantitative determination of a large number of inorganic compounds. Standardized EPA SW-846 Analytical Method 6010C "Inductively Coupled Plasma-Atomic Emission Spectrometry" was followed as a guideline to prepare all samples and controls.

CALCULATIONS

Decontamination Efficacy (Swipe Testing) =

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

MATERIALS AND METHODS

Sample Method

In a typical procedure, 0.05 g of contaminant was evenly applied on 1) stainless steel (commercial grade, surface area: 56.3 cm^2), 2) carbon steel (commercial grade, surface area: 100 cm^2), or 3) concrete (industrial grade, surface area: 56.3 cm^2) coupons. Approximately 6.0 g of DeconGel was poured onto the contaminated surface and let to dry for 24-48 hours. Dried DeconGel samples were peeled off the contaminated surface, and the surface was swipe tested (ASTM method E1728-03) using a GhostWipe™ swipe (Environmental Express; Mt. Pleasant, SC). Swipe samples were suspended in 100 mL aqueous acidic solution (20% HCl, 15% HNO_3, 65% deionized (DI) H_2O) for 24 hours and were then analyzed via ICP-OES (see below).

Control Methods

For swipe control samples, a respective amount of contaminant was evenly applied on 1) stainless steel (surface area: 56.3 cm^2), 2) carbon steel (commercial grade, surface area: 100 cm^2), or 3) concrete (industrial grade, surface area: 56.3 cm^2) coupons, and the surface was swipe tested (ASTM method 1728-03) using a GhostWipe™ swipe (Environmental Express; Mt. Pleasant, SC). Swipe samples were suspended in 100 mL aqueous acidic solution (20% HCl, 15% HNO_3, 65% DI H_2O) for 24 hours and analyzed via ICP-OES (see below).

Reagents and Standards

Zinc metal, Zn, finest powder grade (CAS# 7440-66-6, Fisher Scientific; Fair Lawn, NJ) was used as received.

Zinc oxide, ZnO (CAS# 1314-13-2, Fisher Scientific; Fair Lawn, NJ) was used as received.

Zinc acetate, $Zn(O_2CCH_3)_2$ (CAS# 5970-45-6, Fisher Scientific; Fair Lawn, NJ) was used as received.

A 1000 ppm calibration standard of each contaminant was prepared using the zinc and zinc compounds in freshly prepared aqueous acidic solution (20% HCl, 15% HNO_3, 65% DI H_2O). DI H_2O ($\geq$ 17 M-Ohm) was used as the blank sample.

Analytical Instrumentation

A Thermo ICP-OES instrument model radial iCap 6300 was used to determine zinc concentration (ppm) of all samples and controls using a freshly prepared 1000 ppm calibration standard.

Analyte (zinc) analyzed at 213.8 nm

Pump Speed: 0.5 mL/min

APPLICATION INSTRUCTIONS FOR END-USERS

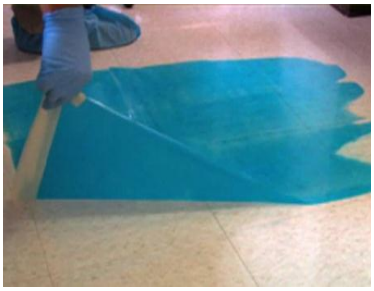
Use product directly as is from container. DO NOT DILUTE. Masking or painters tape can be applied along one edge of the area that is to be decontaminated to aid creating a peeled edge to grip for peeling the dried film. Apply DeconGel using a paint brush, a trowel, a handheld sprayer, or an industrial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

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