Making Massachusetts a safer place to live and work

Outstanding Bath Refinishing Sees Success with Safer Stripping Product

"Paint strippers must work fast for us to meet customer requirements. The new paint stripper works close enough to methylene chloride strippers to meet this requirement, and also provides a safer environment for our workers."

Ed Valente, Co-owner, Outstanding Bath Refinishing

Overview

Methylene chloride is a widely used, effective solvent ingredient for paint stripping during bathtub refinishing. It is, however, extremely hazardous to workers. When used as a stripping agent in poorly ventilated spaces, methylene chloride vapors can build to high levels, causing direct harm to the central nervous system and potentially leading to asphyxiation. In the U.S., 17 workers died between 2000 and 2015 while using methylene chloride paint stripping products to refinish bathtubs.[1]

The use of methylene chloride in paint stripping formulations has been increasingly restricted by government agencies in Europe and the United States. In 2014, the Massachusetts Toxics Use Reduction (TURA) program designated methylene chloride as a higher hazard substance (lowering the threshold for reporting from 10,000 to 1,000 pounds per year), in an effort to elevate companies' focus on reducing or eliminating its use. In addition, OSHA has numerous requirements for employers whose employees are potentially exposed to methylene chloride.

Outstanding Bath Refinishing, located in Milford, Massachusetts, has been providing bathtub restoration services since 2001. The company's practice had been to use a methylene chloride-based paint stripper (e.g., Rust-Oleum® Aircraft Remover, which contains 75% - 100% methylene chloride) to remove coatings during bathtub restorations. The company used approximately 400 to 800 gallons (an average of 600 gallons) of paint stripping product per year. Due to increasing restrictions on the use of methylene chloride-based products, and concern for the health and safety of company employees, Outstanding Bath Refinishing applied for a grant from the Small Business Grant program at the Toxics Use Reduction Institute (TURI). TURI awarded the company a grant and provided lab assistance to successfully identify and evaluate the use of a safer, non-methylene chloride-based product for their bathtub refinishing services.

Environmental Health and Safety Evaluation

TURI used the GreenScreen® for Safer Chemicals, developed by Clean Production Action, as a screening tool to compare the chemical hazards of various paint stripping product ingredients. This method evaluates a range of human health, environmental toxicity and fate, and physical hazard endpoints for each chemical. Upon completion of a GreenScreen assessment, the chemical receives one of four possible Benchmark scores:

- Benchmark 1: Chemical of High Concern – Avoid
- Benchmark 2: Use but Search for Safer Substitutes
- Benchmark 3: Use but Still Opportunity for Improvement
- Benchmark 4: Prefer – Safer Chemical

Methylene chloride received a Benchmark 1 score "Chemical of High Concern – Avoid" largely because of the following human health hazards:

- Methylene chloride is highly volatile, and because the primary route of worker exposure is inhalation this increases the risk of workers experiencing health effects.
- Methylene chloride can cause acute and chronic effects on the central nervous system. The inhalation of methylene chloride can result in short-term effects such as asphyxiation, dizziness, clumsiness, headache, nausea, and numbness of fingers and toes, and long-term effects such as loss of concentration, memory loss, and personality changes.[2]
- Further, methylene chloride is classified as "reasonably anticipated to be a human carcinogen" by the U.S. National Toxicology Program.[3]

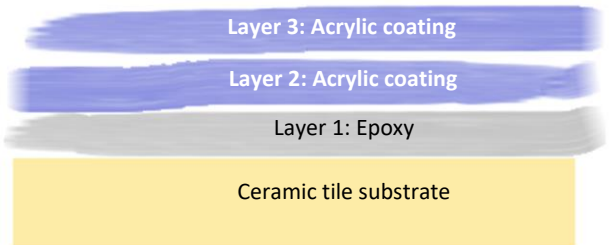
TURI's research objective as part of this grant project work was to ensure that all the ingredients used in the various non-methylene chloride products tested (see Table 1 for details) are safer than methylene chloride. Therefore, paint stripping products that use Benchmark 1 ingredients were considered unacceptable.

Performance Testing

Bathtub refinishers encounter a wide variety of coatings on bathtubs. These coatings range from those used by homeowners using do-it-yourself painting kits that are easy and fast to remove, to professional bathtub coating applications using high-quality coatings that are time-consuming and difficult to remove.

Performance testing of various paint stripping products was conducted in the TURI laboratory first, and then in the field. High-quality professional bathtub coatings were used as the most challenging circumstance. Ceramic tiles provided by Outstanding Bath Refinishing, measuring 4.25 inches wide by 4.25 inches long, were used as the substrate material. The company prepared the tiles by sanding them lightly and then spraying them with three high-quality coatings to simulate the most challenging use situation. The coating consisted of three layers (manufactured by Standard Paints Inc.):

1) Epoxy SG Part A White and Epoxy Activator Part B clear
2) EP – Acrylic Gloss White
3) EP – Acrylic Clear



Layers of the bathtub ceramic tile test panels.

Several commercially available paint strippers (see Table 1) were evaluated for their effectiveness to remove the professional bathtub coating on the ceramic tiles. The paint strippers selected for testing represent the various common solvents used in paint stripping products such as methylene chloride, methanol, acetone, dibasic esters, methyl acetate, and benzyl alcohol. The paint strippers were applied to the surface of the coated ceramic tiles for a predetermined 10-minute dwell time. The paint stripper was then removed and the coating was scraped with a plastic spatula. After scraping, the test area was examined to determine the percentage of the test area in which all three layers of the coating were removed. If less than 90% of the coating was removed, the paint stripper was reapplied for another 10-minute dwell time followed by subsequent scraping and visual inspections. This process was repeated until 90% of the coating was removed. If 90% removal was not achieved within a full 60 minutes of dwell time, the increments for dwell time were increased to 60 minutes, with a maximum of 8 hours of dwell time tested.

Table 1 shows the laboratory-based performance testing results for the bathtub ceramic tiles. The results are sorted from fastest to slowest time to achieve 90% removal. The full report with performance testing results can be downloaded at turi.org/coatingremovalreport.

Table 1: *Bathtub Ceramic Tile Extended Dwell Time Test Results*

Supplier	Product Name	Benchmark 1 Solvents	Other Solvents	Dwell Time Required to Remove 90% of the Coating
WM Barr	Klean Strip Premium*	Methylene chloride, methanol	Polyoxy 1,2 ethanediyl	10 – 20 minutes
Savogran	Superstrip*	Methylene chloride, methanol, toluene	None	10 – 20 minutes
DS Super Remover	Professional Grade	None	Methyl acetate, 1,3 dioxolane, formic acid	20 – 30 minutes
Savogran	Strypeeze*	Methylene chloride, methanol, toluene, Stoddard solvent	Acetone	20 – 30 minutes
WM Barr	Strip X*	Methylene chloride, methanol, toluene, xylene, ethylbenzene	Acetone, ethanol, isopropyl alcohol	20 – 30 minutes
DS Super Remover	New Generation	None	Methyl acetate, DMSO, 1,3 dioxolane	30 – 40 minutes
Savogran	Super Strip (with no Methylene Chloride)	Methanol	Dimethyl carbonate, 1,3 dioxolane	30 – 40 minutes
Sunnyside	2 Minute Remover (with no Methylene Chloride)	Methanol	Dimethyl carbonate, 1,3 dioxolane, acetone, hydrotreated distillates	30 – 40 minutes
WM Barr	Aircraft Remover (with no Methylene Chloride)	None	Tetrahydrofuran, acetone, ammonia, petroleum distillates	30 – 40 minutes
WM Barr	Kwik Strip	Xylene, ethylbenzene	DMSO, dimethyl carbonate	50 – 60 minutes
Dumond	Smart Strip	None	Water, benzyl alcohol	5 – 6 hours
EZ Strip	EZ Strip Paint and Varnish Stripper	None	Dibasic esters, triethyl phosphate	Greater than 8 hours
Packaging Services	Crown STRP Max	Naphthalene	2-butoxyethanol, unidentified solvent naphtha (H351 "Suspected of Causing Cancer"), acetic acid, benzyl alcohol, proprietary solvent blend	Greater than 8 hours
WM Barr	Citristrip no NMP	None	Benzyl alcohol, 2-(2-butoxyethoxy) ethanol	Greater than 8 hours

* Product contains methylene chloride.

As shown, the methylene chloride-based products removed 90% of the coatings between 10 and 30 minutes. The only paint stripper that demonstrated performance similar to the methylene chloride-based paint strippers and did not contain other Benchmark 1 chemicals (such as toluene, methanol, and naphthalene) was the Super Remover Professional Grade product. All of the safer alternative products (no Benchmark 1 chemicals) contained at least one Benchmark 2 chemical.

Based on the lab performance test results, Outstanding Bath Refinishing conducted extensive field testing of the Super Remover Professional Grade product on job sites over a period of several months. The refinishers used the identical process for bathtub restoration for the field trials as had been used with the methylene chloride-based paint stripper. Specifically, the stripping process included scoring the bathtub surface with a utility knife, applying the stripper to the entire bathtub surface area, allowing the stripper to remain on the surface for an initial 10-minute dwell time, and then periodically checking the coating to see when it had softened enough for scraping and removal.

In addition, most bathtubs are located in small area bathrooms with limited ventilation. Consequently, Outstanding Bath Refinishing technicians use chemical cartridge air purifying respirators and protective gloves to prevent inhalation and dermal exposure respectively when applying any solvent based stripping product – with or without methylene chloride.

Table 2 summarizes the results of the field tests.

Table 2: *Bathtub Coating Field Tests*

Type of Bathtub Coating	Approximate Percentage of Bathtub Refinishing Projects	Previous Results with Methylene chloride-based Product	Results with Super Remover Professional Grade
Homeowners that used do-it-yourself painting kits that are fast and easiest to remove.	30%	Softened the coating for removal in less than 10 minutes.	Softened the coating for removal in less than 10 minutes.
Professional bathtub coating applications that used ***low*** quality coatings that are moderately difficult to remove.	50%	Softened the coating for removal in approximately 10 – 20 minutes.	Softened the coating for removal in approximately 15 – 25 minutes.
Professional bathtub coating applications that used ***high*** quality coatings that are time consuming and most difficult to remove.	20%	Softened the coating in some bathtub areas in 30 minutes, and other bathtub areas needed to be sanded.	Softened the coating in some bathtub areas in 30 minutes, and other bathtub areas needed to be sanded.

The field-testing results indicate that the alternative paint stripper provided comparable results to methylene chloride strippers for do-it-yourself and high-quality coatings, and somewhat slower performance for the low-quality coatings.

Economic Evaluation

Outstanding Bath Refinishing's initial cost for methylene chloride-based strippers was approximately $40 per gallon when buying single gallons from a local retailer. However, in 2018, Outstanding Bath Refinishing began to purchase 100 gallons at a time of the methylene chloride-based stripper directly from the paint stripper manufacturer (Rust-Oleum). This change reduced their cost (including shipping) to approximately $19 per gallon, or (based on 600 gallons/year usage) $11,400 per year.

After observing acceptable performance in the field, Outstanding Bath Refinishing switched to the methylene chloride-free product (Super Remover Professional Grade) and began purchasing 110 gallons at a time directly from the paint stripper manufacturer (Super Remover) for approximately $23 per gallon (including shipping). The cost of the new product (also based on 600 gallons/year) is $13,800 per year.

Although Outstanding Bath's costs rose by $4 per gallon or $2,400 per year, there are potential cost savings for employers that need to comply with OSHA requirements for the use of methylene chloride (e.g., monitoring and air sampling, work practice controls, medical surveillance, worker training).

Results

Field testing of the non-methylene chloride-based paint stripper demonstrated that Outstanding Bath Refinishing could justify eliminating its use of methylene chloride in their bathtub refinishing operations. No changes to their bathtub restoration process were necessary when switching to the replacement product. Although the cost of the replacement product is slightly higher than the methylene chloride-based product, it provides a much safer working environment for the bathtub refinishing workers and eliminates any costs that may be required to comply with OSHA requirements for methylene chloride.

Supplemental Information: Environmental, Health, and Safety Analysis of Alternatives

GreenScreen for Safer Chemicals, developed by Clean Production Action, is a comparative chemical hazard assessment method. In this method, several human health, environmental toxicity, fate, and physical hazard endpoints are evaluated for each chemical. The GreenScreen method was used to evaluate the various stripping products for this project. The method and the screening results are detailed in this supplemental section.

"Group I Human Health endpoints reflect priorities that are consistent with national and international governmental regulations, and cover hazards that can lead to chronic or life-threatening effects or adverse impacts that are potentially induced at low doses and transferred between generations. Group II and II★ Human Health endpoints reflect hazards that are also important for understanding and classifying chemicals. Typically, Group II hazards may be mitigated. Group II and II★ are differentiated from one another in the Benchmarking system because Group II endpoints have 4 hazard levels (i.e., vH, H, M and L) while Group II★ endpoints have 3 hazard levels (i.e., H, M and L) and are evaluated based on repeated exposure. Environmental Toxicity and Fate endpoints include Acute and Chronic Aquatic Toxicity, Persistence and Bioaccumulation potential … Physical hazard endpoints include Flammability and Reactivity and are based on Globally Harmonized System (GHS) criteria."[4] Table S1 shows the hazard endpoints used in the GreenScreen for Safer Chemicals methodology.

Table S1: *GreenScreen Hazard Endpoints*

Hazard Grouping	Hazard Endpoint (Abbreviation)
Human Health Group I	Carcinogenicity (C) Mutagenicity and Genotoxicity (M) Reproductive Toxicity (R) Developmental Toxicity, including Neurodevelopmental Toxicity (D) Endocrine Activity (E)
Human Health Group II	Acute MammalianToxicity (AT) Systemic Toxicity & Organ Effects (ST-single) Neurotoxicity (N-single) Skin Irritation (IrS) Eye Irritation (IrE)
Human Health Group II★	Systemic Toxicity & Organ Effects, Repeated Exposure sub-endpoint (ST-repeated) Neurotoxicity – Repeated Exposure sub-endpoint (N-repeated) Skin Sensitization (SnS) Respiratory Sensitization (SnR)
Environmental Toxicity & Fate	Acute Aquatic Toxicity (AA) Chronic Aquatic Toxicity (CA) Persistence (P) Bioaccumulation (B)
Physical Hazards	Reactivity (Rx) Flammability (F)

The GreenScreen assessments are conducted in the following 6 steps:[4]

Step 1 – Identify Chemical to Assess
Chemicals used in coating removal product formulations were assessed.

Step 2 – Research
Assessing chemicals is accomplished by examining comprehensive toxicological data, checking GreenScreen Specified Lists, and using estimated data from suitable analogs or modeled data where measured data are lacking for the parent chemical.

Step 3 – Classify Hazards

Step 3a – Classify hazard level for each hazard endpoint.
The GreenScreen Chemical Hazard Criteria are used to classify the hazard level for the parent chemical as High (H), Moderate (M), Low (L) or in some cases very High (vH) or very Low (vL) for each hazard endpoint. The color scheme shown in Figure S1 was used to indicate the hazard score assigned for each hazard endpoint.

Hazard Score	
Very High	vH
High	H
Moderate	M
Low	L
Very Low	vL
Data Gap	DG

Figure S1: Hazard Scores

Step 3b – Determine level of confidence (high or low) for each hazard level assigned.
The level of confidence is determined by data source(s), data quality, and expert judgment considering the strength of evidence.

Step 3c – Assign a data gap (DG) to each hazard endpoint with insufficient information.
When assessing chemicals, it is ideal to use a complete set of publicly available data covering all hazard endpoints. In reality, most chemicals have insufficient data to assess and classify all of the hazard endpoints.

Step 3d – Document hazard levels.
It is essential to provide detailed documentation of the supporting data and rationale for all hazard levels in an assessment report.

Step 3e – Fill in the Hazard Summary Table.
Fill in the designated hazard level for each hazard endpoint in the respective box of the Hazard Summary Table.

Step 4 – Identify Environmental Transformation Product(s)
The GreenScreen Benchmark score for a chemical includes the evaluation of the chemical itself (i.e. parent chemical) and any feasible and relevant environmental transformation product(s) of the parent chemical.

Step 5 – Assess Environmental Transformation Product(s)
Assess each feasible and relevant environmental transformation product identified in Step 4 above using the GreenScreen List Translator at a minimum. The GreenScreen List Translator™ is an automated tool that provides an abbreviated version of GreenScreen for Safer Chemicals. A GreenScreen List Translator score of "LT-1" means the hazard classifications for a given chemical meet one or more of the GreenScreen Benchmark-1 criteria and this information is based on authoritative lists; if a full GreenScreen assessment were conducted, the chemical would most likely be a Benchmark-1 chemical.[5]

Step 6 – Assign a GreenScreen Benchmark™ Score
First, assign a preliminary Benchmark score by comparing the completed Hazard Summary Table for the chemical to the Benchmark Criteria. Next, perform a data gap analysis. Consider feasible and relevant environmental transformation products to assign a final Benchmark score. The color-coded Benchmark scores are shown on page 1.

The results for each hazard endpoint from the GreenScreen hazard assessments for methylene chloride and the solvents (methyl acetate, formic acid, and 1,3 dioxolane) used in the Super Remover Professional Grade product are included in Table S2.

Table S2: *GreenScreen Hazard Assessment Results*

Chemical	Benchmark	Group I Human					Group II & II Human									Ecotox		Fate		Physical	
		C	M	R	D	E	AT	ST		N		SnS	SnR	IrS	IrE	AA	CA	P	B	RX	F
								single	repeated	single	repeated										
Methylene chloride	1	**H**	**NE**	**DG**	**DG**	**M**	*M*	*vH*	**H**	*vH*	*vH*	**L**	**DG**	**H**	**H**	**M**	*L*	*vH*	**vL**	**L**	**L**
1,3-dioxolane	2	*L*	**L**	*M*	*M*	DG	*L*	**M**	**M**	**M**	**L**	**L**	*L*	*M*	*H*	**L**	*L*	*M*	**vL**	*L*	**H**
Formic acid	2	**L**	**L**	**L**	*L*	DG	**H**	**vH**	*H*	vH	DG	**L**	DG	vH	vH	**M**	**M**	**vL**	**vL**	**L**	**M**
Methyl acetate	2	**L**	**L**	*L*	*M*	*M*	**L**	**M**	*M*	**M**	*M*	**L**	*L*	**L**	**H**	**L**	**L**	**vL**	**vL**	**L**	**H**

Abbreviations:

C = Carcinogenicity
M = Mutagenicity
R = Reproductive Toxicity
D = Developmental Toxicity
E = Endocrine Activity

AT = Acute Toxicity
ST = Systemic Organ Toxicity
N = Neurotoxicity
SnS = Skin Sensitization
SnR = Respiratory Sensitization
IrS = Skin Irritation
IrE = Eye Irritation

AA = Aquatic Toxicity
CA = Chronic Aquatic Toxicity
P = Persistence
B = Bioaccumulation
RX = Reactivity
F = Flammability

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (VL)) in *italics* reflect estimated modeled values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II Human Health endpoints in that they have four hazard scores (i.e., vH, H, M and L) instead of three (i.e., H, M and L), and are based on single exposures instead of repeated exposures. DG indicates insufficient data for assigning hazard level. NE indicates no determination was made (conflicting data).

References

1. OSHA FatalFacts, No. 13 – 2016, Lethal Exposure to Methylene Chloride during Bathtub Refinishing. Accessed at: https://www.osha.gov/Publications/OSHA3883.pdf
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4. CPA (Clean Production Action). (2018). GreenScreen for Safer Chemicals hazard assessment guidance V1.4. January 2018.
5. CPA (Clean Production Action). (2019). "GreenScreen List Translator™: A list-based hazard screening approach." Accessed December 9, 2019 at https://www.greenscreenchemicals.org/learn/greenscreen-list-translator

The Toxics Use Reduction Institute (TURI) at UMass Lowell *provides the resources and tools to help Massachusetts companies and communities make the Commonwealth a safer place to live and work. TURI awards grants to businesses, community organizations, and researchers to discover new opportunities to reduce the use of toxic chemicals and to demonstrate technologies to peers. For more information, visit http://www.turi.org or contact Joy Onasch (joy@turi.org, 978-934-4343).*