

## **USDA-certified Biobased, Low VOC and Biodegradable Paint Stripper and Graffiti Remover**

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### **ABSTRACT**

For many decades, paint strippers have used hazardous solvents such as methylene chloride and N-Methyl-2-pyrrolidone (NMP) to effectively remove paints and coatings. But safety and environmental concerns have introduced an urgent need for environmentally-friendly alternatives. In March 2019, EPA banned the use methylene chloride in all paint removers for consumer use. However, its replacement, NMP, is now also deemed as a substance of very high concern (SVHC) and in jeopardy of being an option for paint stripping by regulatory forces.

The newly developed green paint stripper discussed here is free from methylene chloride and NMP. It achieves an environmentally-friendly profile by utilizing agricultural base stocks and recycled industrial solvents. It meets USDA criteria for biobased paint strippers and graffiti removers, and it complies to the VOC requirements of the California Reduced Emission Regulation for Consumer Products. This low odor and biodegradable paint stripper/graffiti remover effectively removes acrylic, alkyd, and urethane-based coatings, as well as marker ink comparably to petrochemical-based and NMP-containing products. In addition, the product contains corrosion inhibitors to prevent discoloration and flash rust on ferrous metals, aluminium, copper, and brass during and after paint removal.

**Key words:** Green chemistry paint stripper, Graffiti remover, NMP-free, Methylene chloride -free, Low-VOC, Biobased, USDA-biobase certified, Biodegradable, environment-friendly

## INTRODUCTION

For many decades, paint strippers have used hazardous solvents such as methylene chloride and N-Methyl-2-pyrrolidone (NMP) to effectively remove paints and coatings. But safety and environmental concerns have introduced an urgent need for environmentally-friendly alternatives. In March 2019 the U.S. Environmental Protection Agency (EPA) issued a final rule to prohibit the manufacture (including import), processing, and distribution of methylene chloride in all paint removers for consumer use. EPA has taken this action because of the acute fatalities that have resulted from exposure to the chemical.[1]

However, NMP, a popular replacement of methylene chloride, is in jeopardy of being an option for paint stripping by regulatory forces. It is placed on REACH Annex XVII, the restricted substances list in the European Union [2], and on Candidate List of Substances of Very High Concern (SVHC) for authorization at the European Chemical Agency (ECHA) [3].

The newly developed user-friendly and eco-approved paint stripper discussed here, EcoLine® 4320 and 4330 <sup>1</sup>(gel version), is free from methylene chloride and NMP. This low odor, non-flammable paint stripper/graffiti remover is not a regulated material for transportation. It effectively removes acrylic, alkyd, and urethane-based coatings, as well as permanent marker ink, comparably to NMP-containing petrochemical-based products. In addition, the eco-approved stripper contains corrosion inhibitors to prevent discoloration and flash rust on ferrous metals, aluminum, and yellow metals during and after paint removal. Moreover, adhesion of subsequent re-coating to the treated metal is not affected.

The eco-approved paint stripper achieves an environmentally-friendly profile by utilizing agricultural base stocks and recycled industrial solvents. It takes advantage of naturally occurring esters as one of its key solvency components. It is a USDA-certified biobased paint stripper and graffiti remover, and in BioPreferred mandatory federal purchasing program [4]. It is biodegradable, and it complies with the VOC requirements of the California Reduced Emission Regulation for Consumer Products [5].

## EXPERIMENTAL PROCEDURE

### Removal of paint and permanent marking:

Coatings removal was done on carbon steel panels coated with acrylic coating, oil-based alkyd coating, urethane coating with aluminum pigment (sacrificial metal), moisture-cured urethane coating, a 2-coat system (moisture-cured urethane with zinc as primer, and acrylic as top coat), and an epoxy coating, respectively. Ages of coatings were around one year when removal testing was conducted.

Permanent markings removal was done on markings made on carbon steel, and on concrete surfaces with or without epoxy seal, respectively.

Removal efficiency of the eco-approved paint stripper/remover was compared with a NMP-containing petrochemical based remover side by side, A drop of each remover was placed on

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<sup>1</sup> EcoLine® 4320 and 4330 is a trade name of Cortec Corporation, St Paul, Minnesota

the same coating next to each other, and their coating removability was examined by wiping off the affected coating after a given dwell time.

#### **No tarnishing of substrate metal:**

The eco-approved paint stripper/remover was placed on carbon steel, aluminum, and copper for 5 hours, then wiped off. The treated surfaces were examined for signs of tarnish.

#### **Flash rust protection:**

Carbon steel panel was coated with the eco-approved paint stripper, and then wiped off shortly afterwards. An untreated carbon steel was used as a control. Tap water drop was added onto the panels, respectively, and corrosion of the panels was monitored.

Copper panels were treated and tested similarly; 50ppm NaCl solution drop was added onto the surface.

#### **Coatings adhesion to the stripped surface (Re-coatability)**

Coatings adhesion to the stripped surface were tested as follows:

Carbon steel panel A was an untreated control panel. Carbon steel panel B and C were treated with the eco-approved paint stripper, liquid version and gel version, respectively, which were then removed with a paper towel. Carbon steel panel D was treated with the gel version of the remover, then wiped off, and again cleaned with a mineral spirit. All above panels were then coated with a water-based acrylic coating. The coating was allowed to be cured in room temperature for one week. Afterwards, coating adhesion quality among the panels was tested according to ASTM D 3359 [6]. 2 readings were taken on each panel.

#### **USDA Biobased Certification:**

Biobased carbon content was tested according to Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis (ASTM<sup>2</sup> D6866)[7].

Biobased certification was granted by BioPreferred program run by US Department of Agriculture (USDA) [4]

#### **Biodegradability**

Biodegradability of the formulation was calculated from biodegradability data of the ingredients used.

#### **VOC Compliance**

Weight percentage of Volatile organic compounds (VOC) of the formula was calculated from VOC data of the ingredients used.

VOC Compliance to California REGULATION FOR REDUCING EMISSIONS FROM CONSUMER PRODUCTS [5] was considered.

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<sup>2</sup> ASTM International, West Conshohocken, PA

## RESULTS AND DISCUSSIONS

### Removal of Coatings and Permanent Markings




In general, the eco-approved paint stripper performed similarly to a NMP-containing paint stripper on most coating types. Table 1.

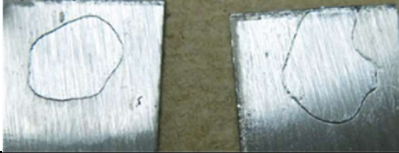




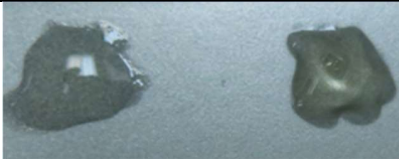
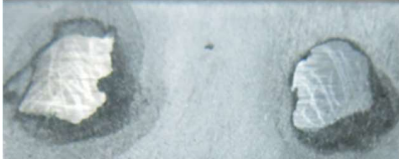
For one-coat surfaces, both strippers removed acrylic (pigmented or clear), alkyd, and 2K aliphatic urethane coatings after 15 minute dwell time; both strippers removed an aromatic moisture-cured urethane after about 30 minute dwell time. For epoxy coating removal, it took longer dwell time for the eco-approved stripper compared to a NMP-containing stripper (8.5 hours versus 6 hours).









For multiple-coated surfaces, such as a system of an aromatic moisture-cured primer plus an acrylic top coat, the eco-approved stripper took slightly longer time, another 15 minutes, to remove the primer than a NMP-containing remover did.




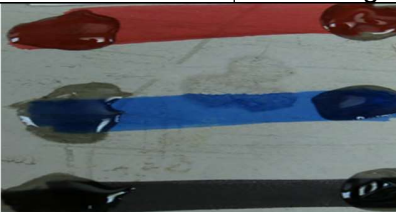

Removal of permanent markers on steel surface was very easy, requiring less than 5 minutes using the eco-approved stripper. On concrete surfaces (untreated or sealed with epoxy) the dwell time needed was around 10 minutes for the eco-approved stripper, similar to that of a NMP-containing stripper.

**Table 1  
Removal Efficiency Comparison**

acrylic coating black pigment		
Remover	Eco-approved	NMP-containing
T=0		
Dwell-15min		
acrylic coating clear		
Remover	Eco-approved	NMP-containing
T=0		

Dwell-15min		
	oil-based alkyd coating	
Remover	Eco-approved	NMP-containing
T=0		
Dwell-15min		
	2K aliphatic urethane with aluminum	
Remover	Eco-approved	NMP-containing
T=0		
Dwell-15min		
	aromatic moisture cure urethane	
Remover	Eco-approved	NMP-containing
T=0		
Dwell-30min		
	2-coating system (Urethane =primer, acrylic =top coat)	
Remover	Eco-approved	NMP-containing

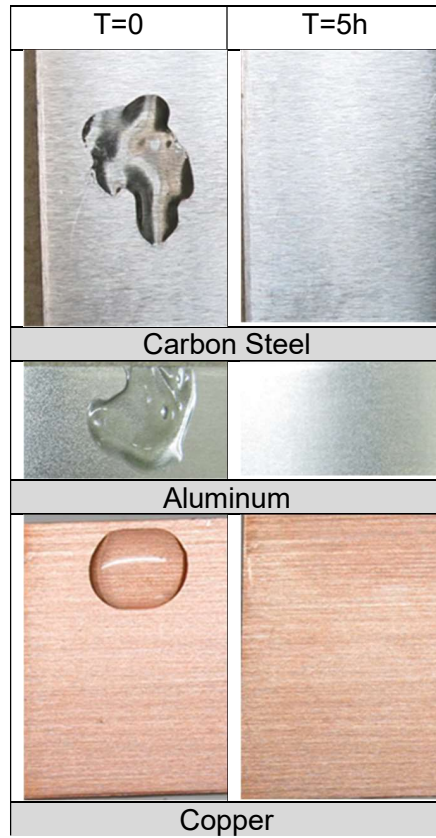
T=0		
Top coat removal: Dwell-30min		
Primer removal: Extra 15min		
Primer removal: Another 15min		
	2K water-based epoxy	
Remover	Eco-approved	NMP- containing
T=0		
Dwell-6h		
Dwell –extra 2.5h		
	Permanent marker ink on steel panel	
Remover	Eco-approved	NMP- containing
T=0		

Dwell-5 min		
	Permanent marker ink on concrete (sealed with epoxy)	
Remover	Eco-approved	NMP-containing
T=0		
Dwell-10 min		
	Permanent marker on concrete (unsealed)	
Remover	Eco-approved	NMP-containing
T=0		
Dwell-10 min		

### Not Causing Tarnish to Metal Substrate

The Eco-approved stripper did not cause carbon steel, aluminum and copper to tarnish after having stayed 5 hours on the surface. Table 2.

**Table 2**  
**Not causing tarnish (5h contact time)**

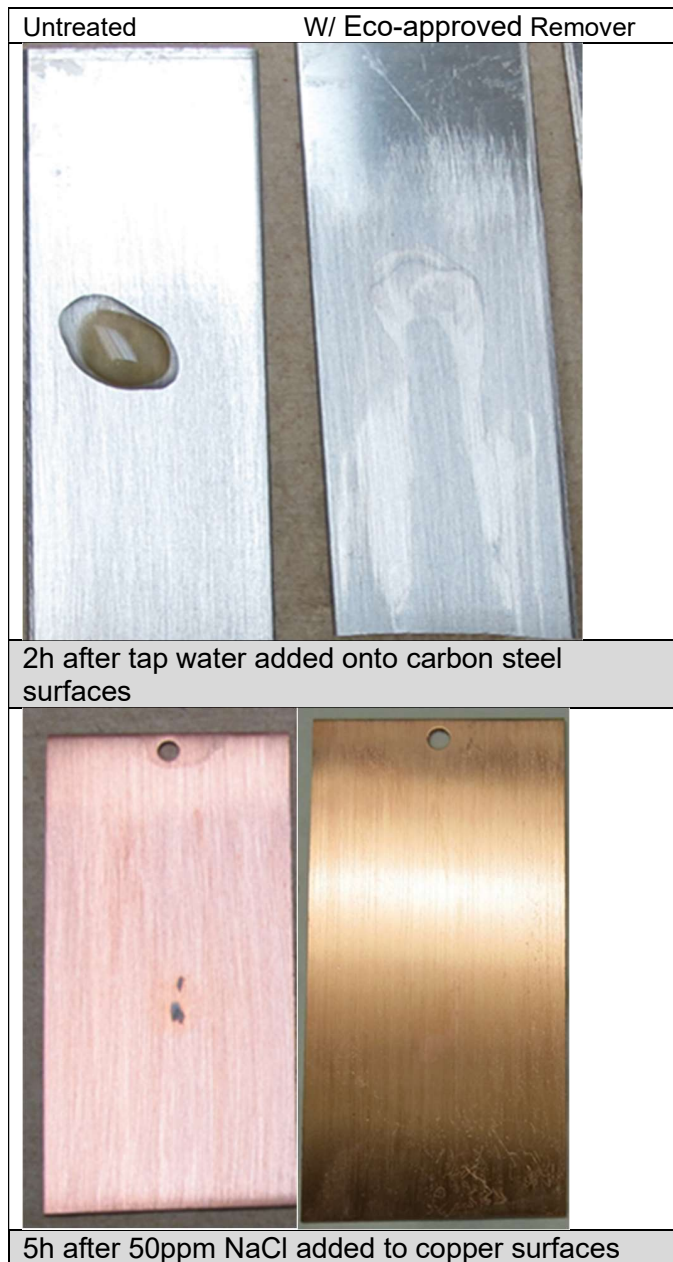


### **Preventing Flash Rust**

Testing showed that the Eco-approved stripper provided flash rust protection to carbon steel, aluminum, and copper. Table 3.



**Table 3**  
**Flash rust prevention**



**Coatings adhesion to the treated surfaces (Re-coatability)**

ATSM D3359 testing showed that coatings adhesion to metal surfaces is not affected when the eco-approved paint stripper is properly cleaned off after its stripping function. The cleaning can be either a complete wipe-off with paper towel, or a wipe-off followed by a mineral spirit cleaning. Table 4.

**Table 4**  
**Coatings adhesion on the treated surfaces (ATSM D3359)**

panel	treatment	Adhesion Rating
A	control	4B and 4B
B	Coated with eco-friendly paint remover (liquid), then wiped off with paper	4B and 4B
C	Coated with eco-friendly paint remover (gel), then wiped off with paper	5B and 5B
D	Coated with eco-friendly paint remover (gel), wiped off with paper; then again cleaned with a mineral spirit	5B and 5B

### **USDA Biobased certification and Sustainability**

The Eco-approved stripper was tested to contain 50% biobased carbons according to ASTM D 6866, surpassing the certification requirements for USDA Biobased paint stripper and graffiti remover categories. The product is accepted into USDA BioPreferred mandatory federal purchasing program.

In addition, the Eco-approved stripper contains about 16% recycled solvents

### **Biodegradability**

98.5% (wt) components in the Eco-approved stripper are biodegradable according to OECD 301 testing.

### **VOC Compliance**

The eco-approved stripper contains about 45% VOC, meeting California consumer product requirement for paint stripper category (less than 50% VOC), and aerosol graffiti category (less than 50% VOC).

## **CONCLUSIONS**

The methylene chloride-free and NMP-free paint stripper is effective on a wide variety of paints. The stripping time is 15 to 30 minutes for alkyds, acrylics and urethanes; and removes permanent marking with ease. The eco-approved paint stripper provides flash rust protection to metal substrate after stripping, and it does not cause staining to copper. The stripped metal can be recoated without ill effect on adhesion. The eco-approved stripper utilizes agricultural base stocks and recycled industrial solvents to achieve an environmentally friendly profile. It is low odor, non-flammable, and classified as non-regulated for transportation.

## **REFERANCES**

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