SHERWIN-WILLIAMS HIGH PERFORMANCE FLOORING NMP CHEMICAL RESISTANCE TESTING RESULTS

CONTEXT:

During a 2020 visit to one of the first U.S. EV battery manufacturing facility construction sites, our Construction Solutions team obtained a sample of the OEM's battery slurry to understand the effects of NMP on our flooring systems. Collaborating closely with the OEM and our R&D team, we determined a formulation that would provide lasting results in this harsh environment. Due to confidentiality, the composition of the battery slurry was undisclosed. To ensure durability, our team tested the flooring system against the most extreme case using a 100% NMP solution.

- The results on pages 1-3 document our testing for the OEM's battery slurry formulation (with an undisclosed percentage of NMP).
- The results on page 4 document our testing for the most extreme case, 100% NMP, as a control to ensure the flooring system would not be compromised with any level of NMP used in the EV battery manufacturing environment.

LOCATION:

EV Battery Cell Manufacturing Plant in Ohio

ON-SITE TESTING:

Jan. 5, 12 and 19, 2023, by Vikki Young, R&D Group Leader - Flooring

SHERWIN-WILLIAMS HIGH PERFORMANCE FLOORING:

HTS System:

- 5 mils MPE Epoxy Primer
- 20 mils MPE Epoxy Build Coat
- 3 mils HPS Urethane Topcoat
- 3 mils HTS Urethane Topcoat

TEST METHOD:

ASTM D1308 Standard Test Method for Chemical Exposure on Coating Systems

EXECUTIVE SUMMARY

The purpose of the visit to the owner's facility was to set up on-site beta testing of ASTM D1308 with a mockup of the Sherwin-Williams HTS System on the concrete floor.

Two chemical materials used to process the owner facility's battery cells were part of the beta test. Exposure to on-site chemicals was evaluated after seven and 14 days.

The composition of the two processing materials is confidential and hasn't been disclosed to Sherwin-Williams. Both materials, insulation and slurry contain NMP. Owner facility suggested as follows:

- Insulation is 60-90% NMP; creamy, whitish color.
- Slurry is closer to 50% NMP; contains carbon black, graphite.

Seven and 14-day exposure were rated as follows:

- Good, (Limited Adverse Effect) – Slight change in satin appearance to slightly matted finish. No loss of pencil hardness for seven days. 14-day, one decrease in pencil hardness (6H to 5H).

BACKGROUND

Oct. 2022:

Previous chemical resistance testing was performed onsite at owner facility on Oct. 2022. The HTS System was applied with one topcoat instead of a combination of two topcoats as defined above four and 24-hour exposure to the NMP materials were rated "Very Good" and "Good" with barely noticeable change in appearance, and no change or less than one change in pencil hardness.

Seven day and 14-day had a rating of "Fair" due slight softening and blisters in the coating.

Blisters formed due to the chemicals migrating through microscopic pores and/or larger pores in the topcoat. Construction debris and dirt settled

into the coating while curing. Some were rolled into the coating during application creating microscopic pores. In some areas, sparks from onsite grinding of steel also burned through and melted the topcoat providing channels and craters. These created spots where the chemicals could potentially migrate through and attack the primer underneath. The chemical attack then creates larger blisters.

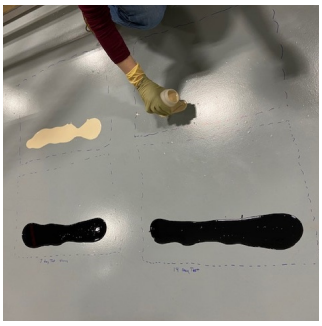
Based on the results of the first mockup, we decided to do an additional mockup with two topcoats, HPS followed by HTS and repeat ASTM D1308 at seven and 14-day exposure.

ASTM D1308 CHEMICAL RESISTANCE FOR HTS SYSTEM WITH TWO TOPCOATS

Jan. 5, 2023: Application of Insulation and Slurry
On-site visit included inspecting the second mockup of HTS System and two topcoats for surface defects. Debris particles from construction had landed in the coating, and one area had burn marks from grinding sparks. Burn marks are 1/16-1/2 inch in diameter and form small craters with brown outline. Microscope attached to a cell phone revealed that sparks burned through the topcoat to primer or through coating to concrete. Sections of the floor with the least number of debris were used for testing.

ASTM D1308 COVERED SPOT TEST EXPOSURE

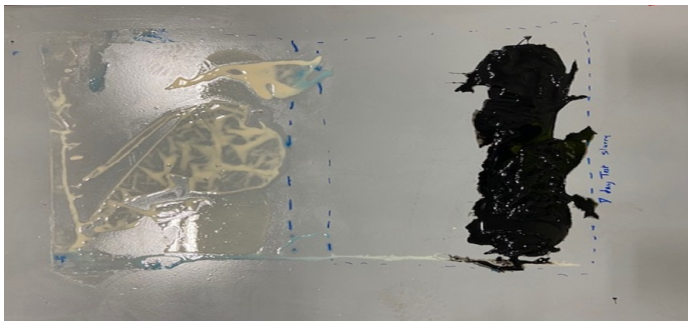
Simulates spills that migrate underneath a drum, pallet, or when objects are set on top of spill, and evaporation of solvent (NMP) in the materials is prevented.
Both the insulation and slurry were applied to the floor and covered with both foil and plastic, then sealed with tape to prevent evaporation.



Pouring, covering and sealing of the insulation and slurry

Jan. 12, 2023: Evaluation of Seven Day Exposure
Both chemicals were removed with a dry cloth, and coating was cleaned with detergent and rinsed with water.

HTS System rated “Good” after seven day exposure to both Insulation and Slurry. Slight change in satin appearance to slightly matted finish. Pencil Hardness 6H, no change, same as unexposed coating.



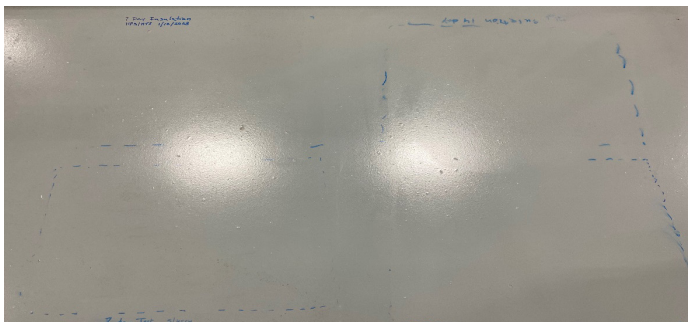
Insulation and slurry once foil and plastic removed

Visual results of flooring system once insulation and slurry wiped away

Jan. 19, 2023: Evaluation of 14-day Exposure

Both chemicals were removed with a dry cloth, coating was cleaned with detergent and rinsed with water.

HTS System rated "Good" after 14-day exposure to both Insulation and Slurry. Slight change in satin appearance to slightly matte finish. Pencil Hardness 6H to 5H.



RATING KEY

E-Excellent (No Adverse Effect)

G-Good (Limited Adverse Effect) – (ex. staining/color change/slightly lower gloss/1 pencil change in hardness acceptable.

F-Fair (Moderate Adverse Effect) – (ex. slight softening/ two pencil change in pencil hardness-some recovery)

P-Poor (Unsatisfactory) – (ex. severe softening, deterioration, swelling, curling, no recovery)

TEST EVALUATION

Discoloration, evaluated by visual interpretation.

Degree of softening and recovery were evaluated by change in Pencil Hardness ASTM D3363.

TESTING PHASE TWO: 100% NEAT NMP TEST

CONTEXT:

Given the unknown chemical composition of the NMP slurry provided by the EV Battery Plant Owner, our R&D team rigorously tested the HTS flooring system by conducting immersion tests on panels coated with our flooring system in 100% NMP. The following lab data showcases the performance results from that test.

SYSTEM TESTED

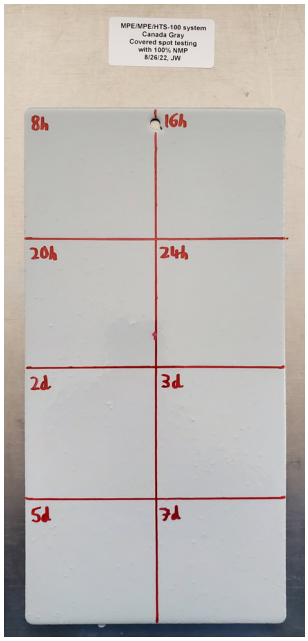
- Resuprime™ MVB @ 22 mils
- Resuflor™ MPE @ 5 mils + 20 mils
- Resutile™ HPS 100 Clear @ 3 mils
- Resutile™ HTS 100 Canada Gray Topcoat @ 3 mils.

SYSTEM	14-DAY EXPOSURE TO NEAT-NMP (CURED AT 70°F/10% RH FOR TWO WEEKS)
Use combination of **Resutile HPS Clear** with **Topcoat of HTS Canada Gray**. Must have **HPS Clear** underneath **HTS Canada Gray** for maximum resistance to neat-NMP.	No change in hardness, slight color change (lighter), no other issues

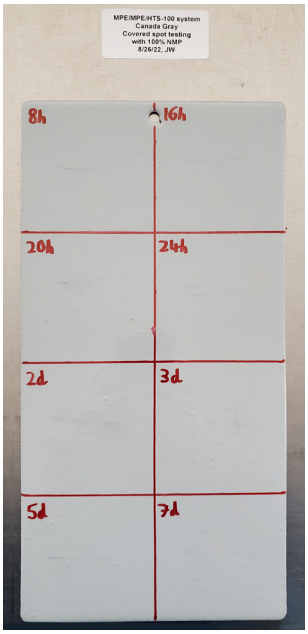
COVERED SPOT TESTING – 100% NMP

Pre-test and post-test panel after subjected to 100% NMP

Results: Little to no change reported. Panels look nearly identical.



Pre-Test



Post-Test

THE SHERWIN-WILLIAMS DIFFERENCE

Sherwin-Williams Protective & Marine delivers world-class industry subject matter expertise, unparalleled technical and specification service, and unmatched regional commercial team support to our customers around the globe.

United States & Canada
sherwin-williams.com/protective
swprotective@sherwin.com

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