

STLE Annual Meeting

Commercial Forum, May 21, 2018

High Performance Water-Based Rust Preventives Reduce VOC

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Volatile Organic Compounds (VOC)

Most high performance rust preventive formulations use a combination of petroleum oil and petroleum derived solvents in combination with rust preventive additives. These solvents are usually 30% to 95% of rust preventive formulations.

Volatile Organic Compounds (VOC)

When these petroleum derived solvents evaporate, they can react with sunlight to form ground level ozone. This is a serious pollution problem in many areas of the world.

Using Water to Replace Petroleum Derived Solvents to Reduce VOC-Caused Pollution

The use of water to replace petroleum solvents almost completely eliminates VOC-caused ozone air pollution.

Until recently, water based rust preventive formulations could not achieve the performance of oil/solvent rust preventive formulations.

KX455 and NA-SUL®450

Two New Highly Effective Water Based Rust Preventives

- KX455 is specifically designed to be added to oil and then emulsified giving exceptional salt fog (ASTM B117) performance.
- NA-SUL 450 is designed to be added to water producing stable emulsions that are highly effective for high humidity rust and corrosion protection.
- Both products effectively protect steel, aluminum and galvanized steel.

KX455 and NA-SUL[®]450

Two New Highly Effective Water Based Rust Preventives

Both new water based rust preventive additives are based on calcium dinonylnaphthalene sulfonate.

KX455 achieves comparable or better rust prevention than most oil/solvent formulations as measured by results in Salt Fog (ASTM B117) testing.

NA-SUL 450 is excellent for corrosion protection in high humidity environments as measured by Humidity Cabinet (ASTM D1748) testing.

Salt Spray (Fog) – ASTM B117

ASTM B117 Salt Fog is a “practice” and not a “method”. Only the chamber conditions are specified and not the test pieces or the criteria for failure.

These conditions are:

- *Collection rate:* 1ml -2ml per hour (salt solution)
- *pH:* 6.5 – 7.2, collected 5% salt solution
- *Temperature:* 35°C

Salt Fog (ASTM B117)

King Industries' criteria for failure:

Rust that extends on the test panel more than 1.5 cm
from the top edge and/or
0.5 cm from either side edge

Salt Spray (Fog) - ASTM B117



Salt Spray (Fog) - ASTM B117



Test Panels

- Steel: 1010 steel alloy with one test surface polished (P) and one test surface matte (M).
- Aluminum: 2024 alloy.
- Galvanized: Hot dip galvanized coated steel.

Solvent based formulations are compared with a water based formulation in Salt Fog (ASTM B117) testing

- KX455 (Calcium dinonylnaphthalene sulfonate)
(water based)
- Commercial Calcium Sulfonate Formulation “A”
(oil/solvent based)
- Commercial Calcium Sulfonate Formulation “B”
(oil/solvent based)

KX455

Salt Fog (ASTM B117) results:

Steel

Salt Spray Results on Steel – 8 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

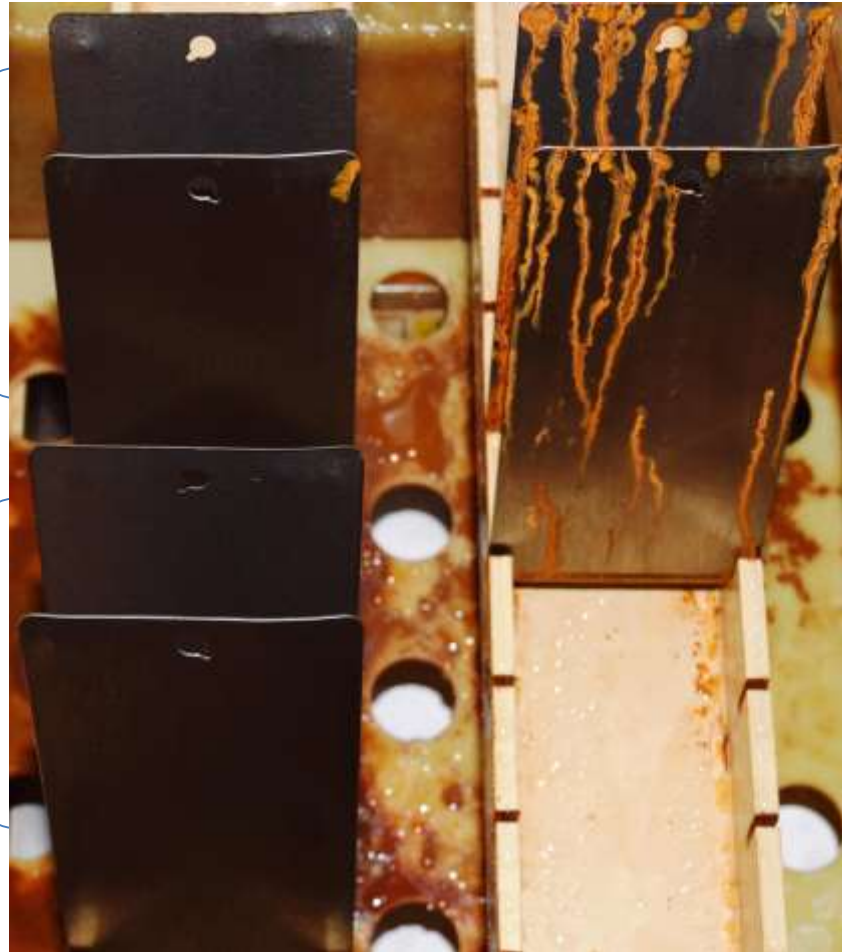
***1010 Steel Panels
Polished (Front)
Matte (Rear)***

Salt Spray Results on Steel

26 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 1010 Steel
Polished (Front), Matte (Rear)*

Salt Spray Results on Steel

72 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 1010 Steel
Polished (Front), Matte (Rear)*

Salt Spray Results on Steel

192 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 1010 Steel
Polished (Front), Matte (Rear)*

Salt Spray Results on Steel

248 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 1010 Steel
Polished (Front), Matte (Rear)*

KX455

Salt Fog (ASTM B117) 480 Hours Exposure

Formulation:
15% KX455
25% ISO VG 32 Group I
Paraffinic Oil
60% Tap Water



KX455

Salt Spray Results on Aluminum

Aluminum is a more active metal than steel, but it corrodes less quickly than expected. This is because it forms a protective oxide layer approximately 1 μ m thick that delays corrosion. This layer dissolves at pH values below 4 or above 8.5 resulting in rapid corrosion.

Corrosion inhibitors that are effective for steel protection are not necessarily effective for aluminum protection.

Salt Spray Results on Aluminum

54 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

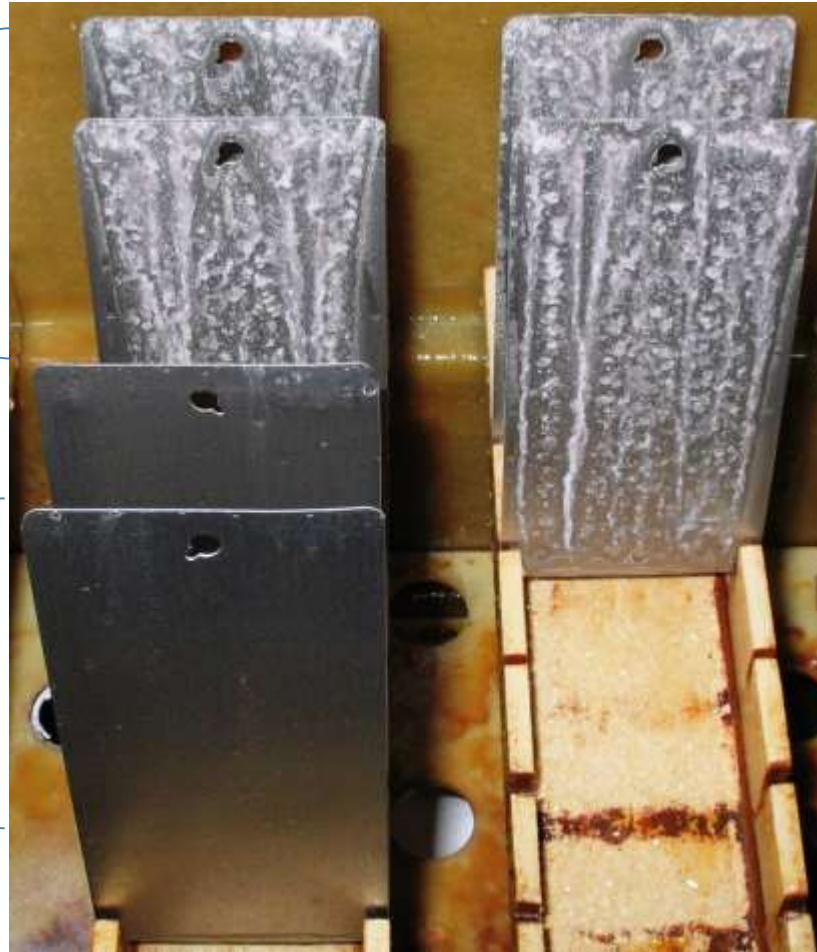
*Test Panels are 2024 Aluminum
Run in Duplicate*

Salt Spray Results on Aluminum

118 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 2024 Aluminum
Run in Duplicate*

Salt Spray Results on Aluminum

190 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 2024 Aluminum
Run in Duplicate*

Salt Spray Results on Aluminum

222 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are 2024 Aluminum
Run in Duplicate*

KX455

Salt Spray Results on Galvanized Steel

Zinc is a more active metal than steel and is more easily corroded. The zinc coating on galvanized steel is designed to corrode before the steel and give protection to the steel. The white corrosion product is often called “white rust”.

Corrosion inhibitors that are effective for steel protection are not necessarily effective for galvanized steel protection.

Salt Spray Results on Galvanized Steel

32 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are Hot Dipped
Galvanized Steel
Run in Duplicate*

Salt Spray Results on Galvanized Steel

48 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are Hot Dipped
Galvanized Steel
Run in Duplicate*

Salt Spray Results on Galvanized Steel

72 Hours Exposure

**10% Calcium Sulfonate
Formulation A
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

**10% KX455
20% ISO VG 32 Group I
Paraffinic Oil
70% City Water**



**10% Calcium Sulfonate
Formulation B
20% ISO VG 32 Group I
Paraffinic Oil
70% Exxsol® D-60 Solvent**

*Test Panels are Hot Dipped
Galvanized Steel
Run in Duplicate*

KX455

Salt Fog (ASTM B117) results:

Cast Iron

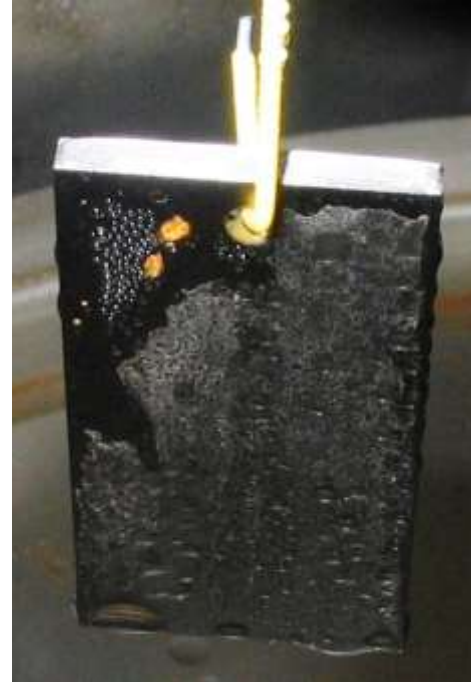
KX455 Cast Iron

720 Hours Exposure Humidity (ASTM D1748)

Front



Back



10% KX455
10% ISO VG 32 Group I Oil
80% Tap Water

KX455 Cast Iron

864 Hours Exposure Humidity (ASTM D1748)

Front



Back



10% KX455
10% ISO VG 32 Group I Oil
80% Tap Water

NA-SUL[®] 450

Humidity Cabinet (ASTM D1748) results

Humidity Cabinet - ASTM D 1748



Humidity Cabinet - ASTM D 1748



NA-SUL[®] 450

Humidity Cabinet (ASTM D1748) results:

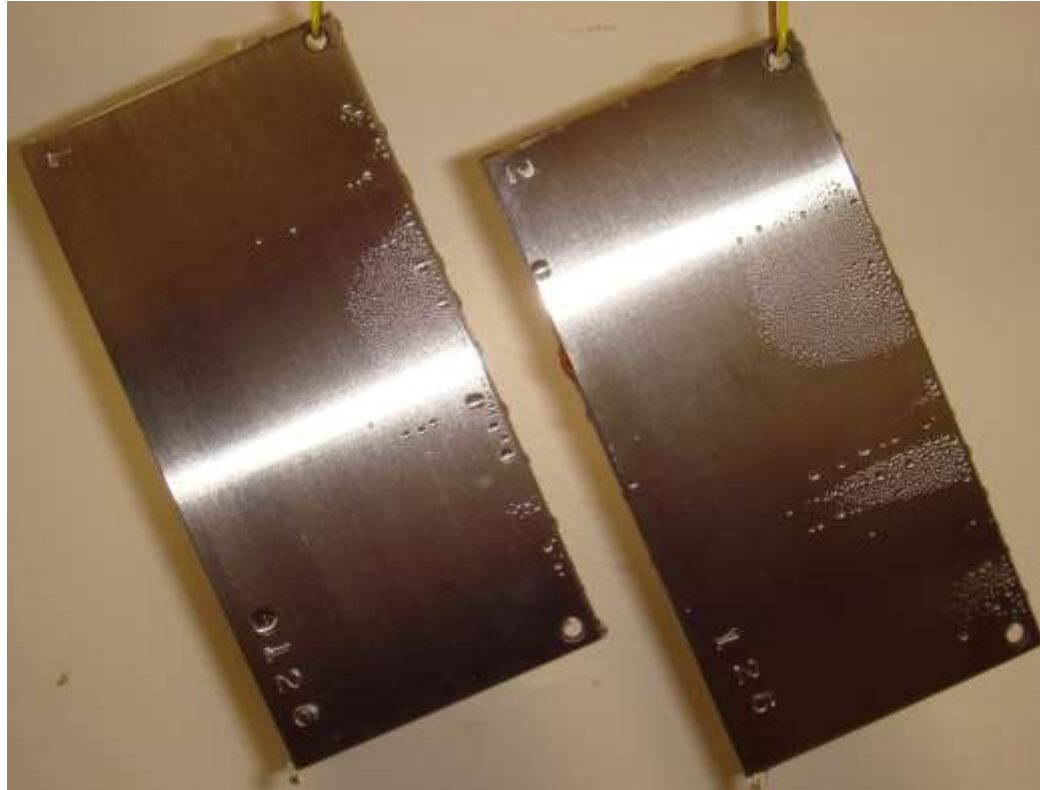
Steel

NA-SUL 450

Humidity Cabinet (ASTM D1748)

440 Hours Exposure

Steel
Test Panels



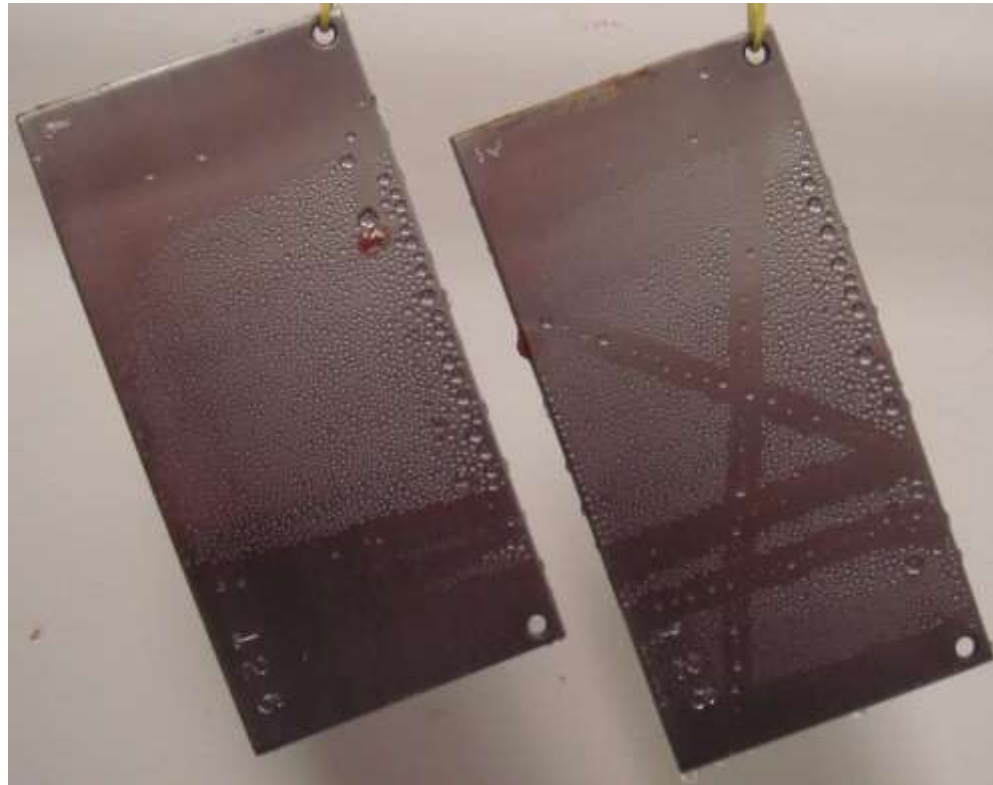
2% NA-SUL 450
98% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

630 Hours Exposure

Steel
Test Panels



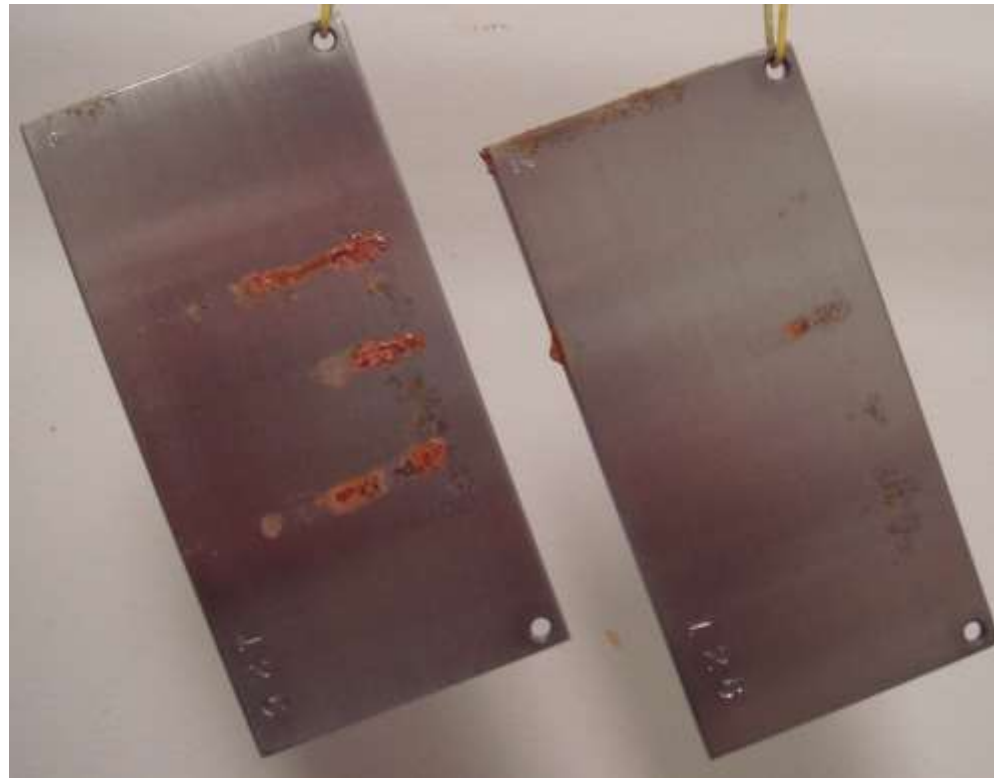
2% NA-SUL 450
98% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

792 Hours Exposure

Steel
Test Panels



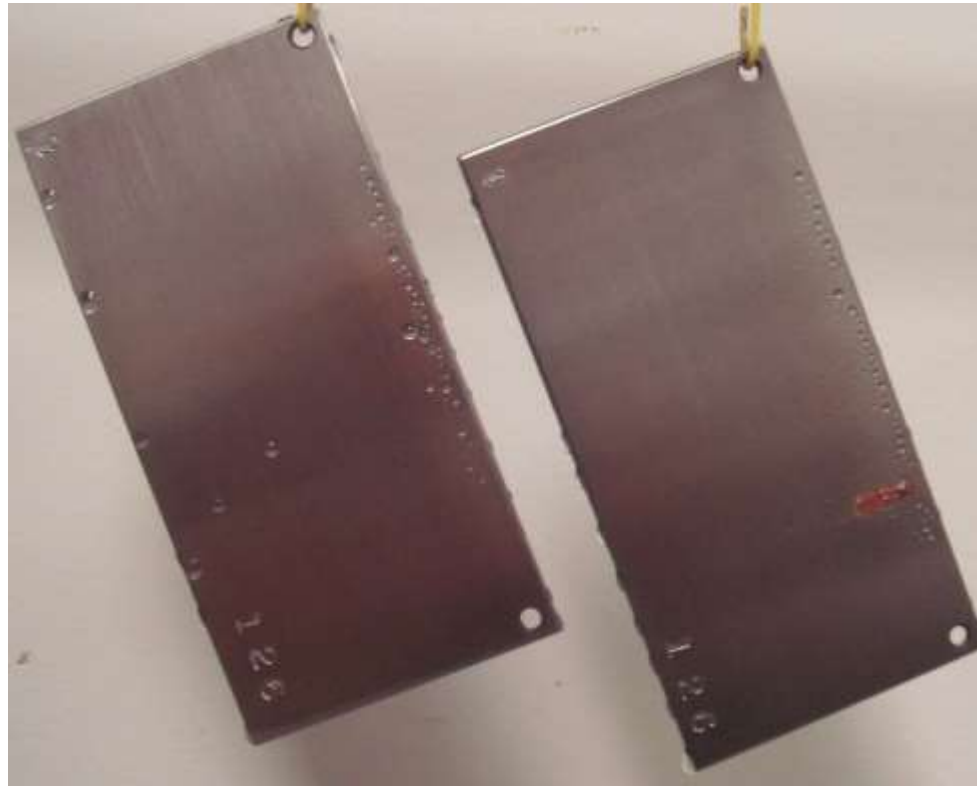
2% NA-SUL 450
98% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

630 Hours Exposure

Steel
Test Panels



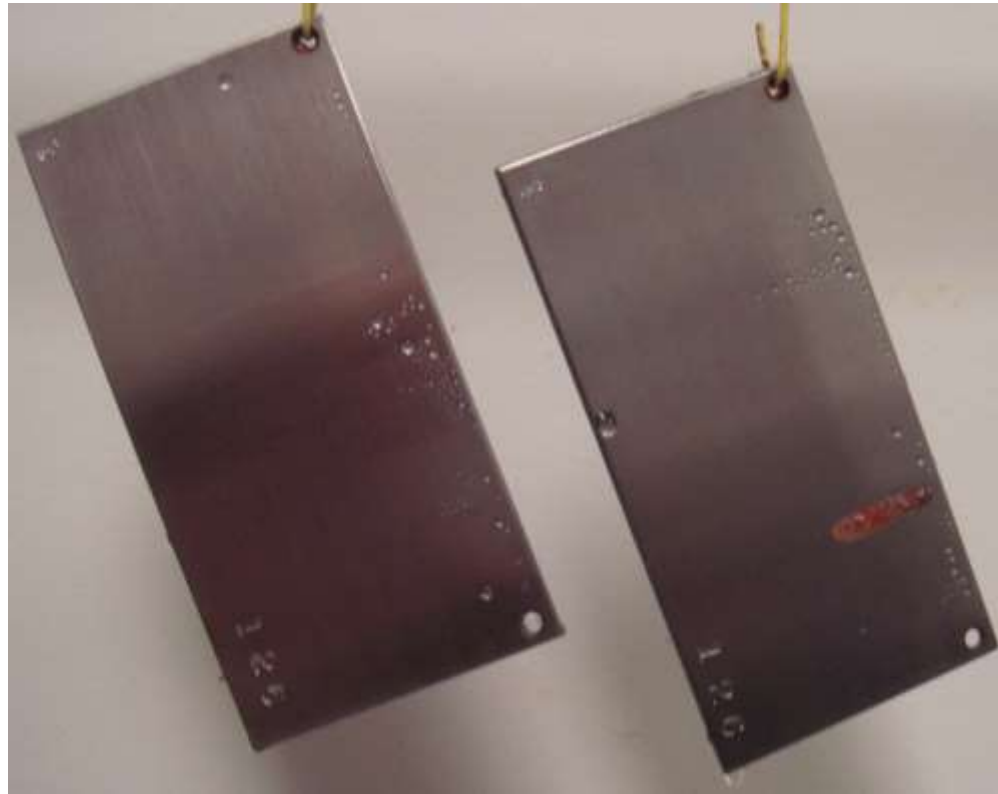
5% NA-SUL 450
95% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

960 Hours Exposure

Steel
Test Panels



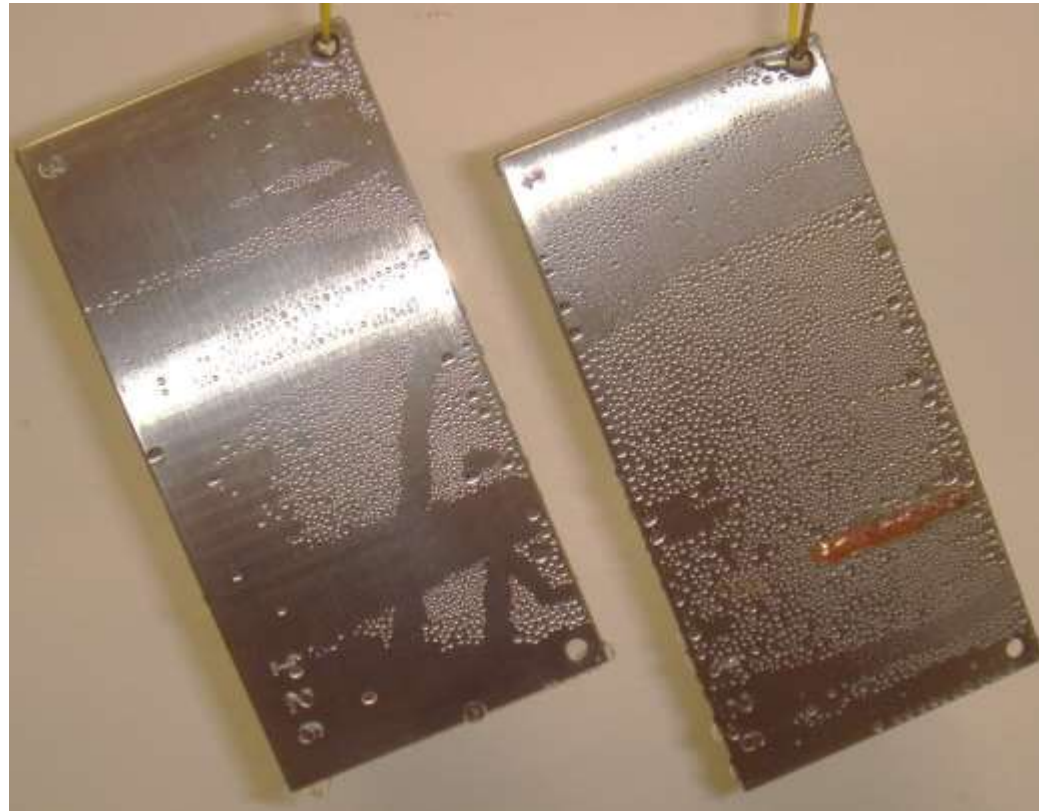
5% NA-SUL 450
95% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

1128 Hours Exposure

Steel
Test Panels



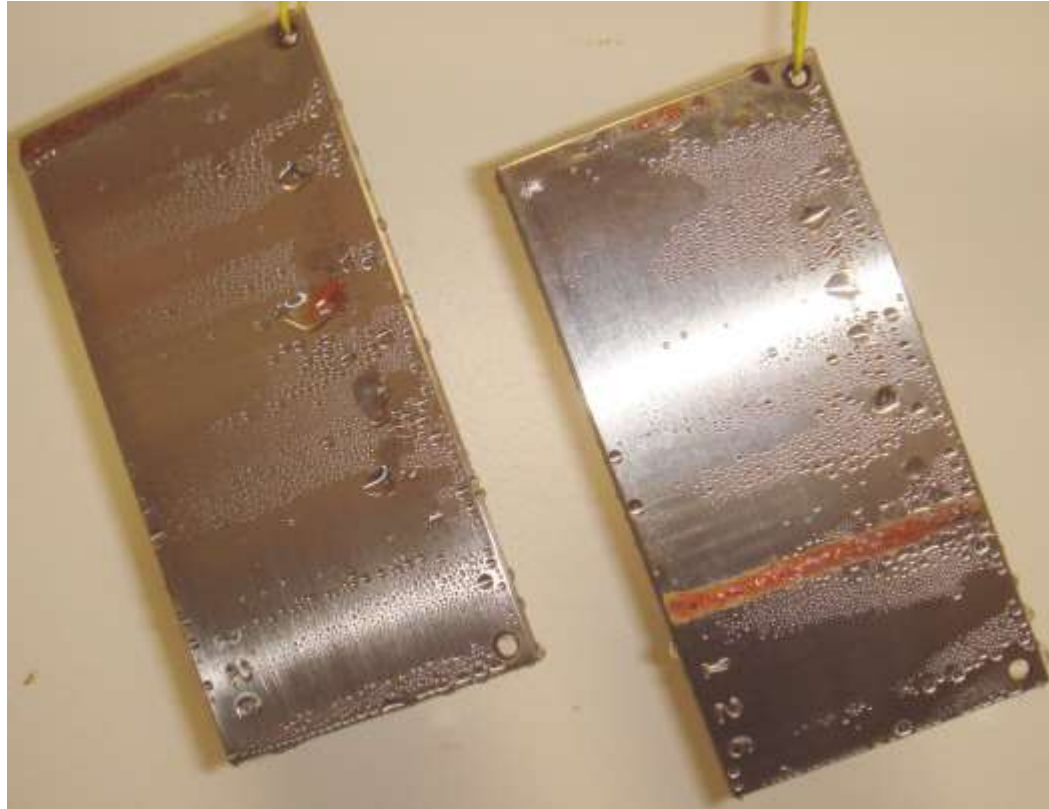
5% NA-SUL 450
95% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

1464 Hours Exposure

Steel
Test Panels



5% NA-SUL 450
95% City Water

NA-SUL[®] 450

Humidity Cabinet (ASTM D1748) results:

Aluminum

NA-SUL 450

Humidity Cabinet (ASTM D1748)

630 Hours Exposure

Aluminum
Test Panels



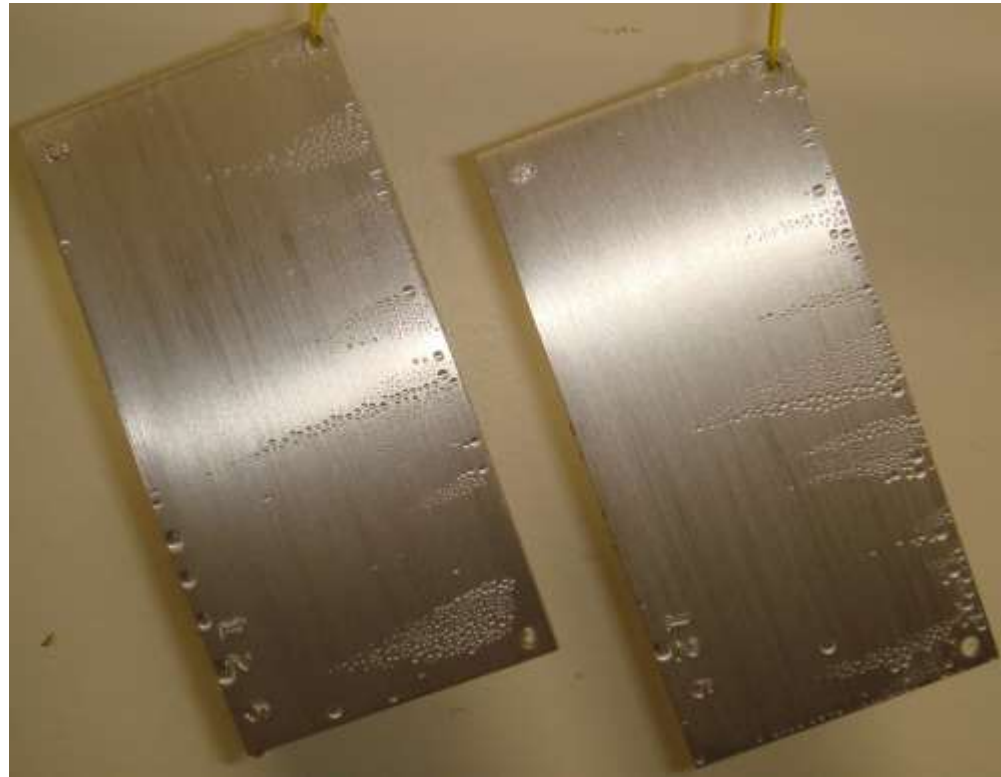
5% NA-SUL 450
95% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

1272 Hours Exposure

Aluminum
Test Panels



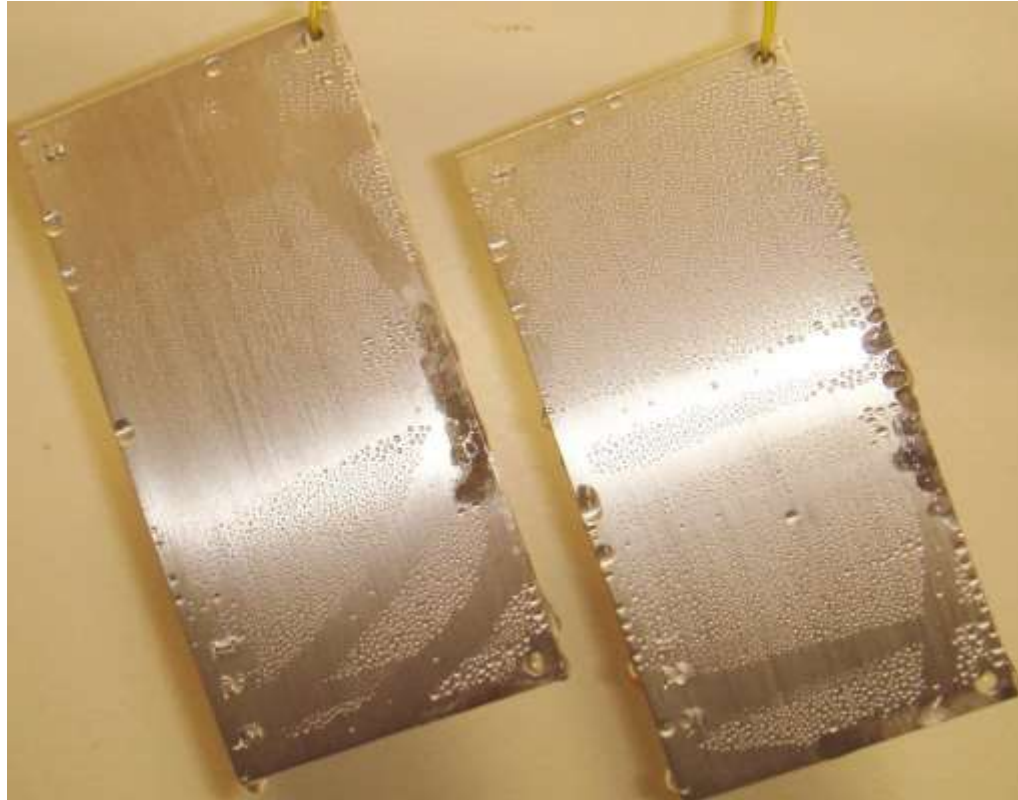
5% NA-SUL 450
95% City Water

NA-SUL 450

Humidity Cabinet (ASTM D1748)

1464 Hours Exposure

Aluminum
Test Panels



5% NA-SUL 450
95% City Water

NA-SUL[®] 450

Humidity Cabinet (ASTM D1748) results:

Galvanized Steel

NA-SUL 450

Humidity Cabinet (ASTM D1748)

268 Hours Exposure

Galvanized
Test Panels



5% NA-SUL 450
95% City Water

Practical Considerations

Oil/Solvent Compared with Water Based Formulations

Oil/Solvent Formulations (Advantages):

- **Faster Drying than water based**
- Can be disposed of by burning
- Manufacturing process requirements are well known
- Less complex formulations are possible

Oil/Solvent Formulations (Disadvantages):

- **High VOC emissions contribute to air pollution**
- Most solvents are flammable (Plant Safety Concerns)
- Workers are exposed to solvent vapors (Worker Safety)

Practical Considerations

Oil/Solvent Compared with Water Based Formulations

Water Based Formulations (Advantages):

- **Very low VOC emissions contribute little to air pollution**
- Formulations are not flammable (Improved Plant Safety)
- Solvent vapors are greatly reduced (Worker Safety)

Water Based Formulations (Disadvantages):

- **Slower drying than solvent formulations**
- Parts must be dry before packaging or stacking
- Fluid must be treated before disposal (Not Burned)
- Formulations are more complex; biocides may be required

Salt Fog (ASTM B117) 168 Hours Exposure

Formulation:
10% KX455
20% Group I, ISO VG 32 Oil
70% water



*Panels were dried for
1.5 Hours at 90°C in an oven*

Conclusions

The use of water based rust and corrosion inhibitors is a very useful way of reducing solvent evaporation that results in ground level ozone air pollution.

Conclusions

New NA-SUL 450 and KX455 from King Industries are highly effective for protection of steel, aluminum and galvanized steel.

Water based KX455 is superior to most commercial rust and corrosion preventive additives designed for oil/solvent systems as measured by salt fog testing.

NA-SUL 450 provides superior corrosion protection in high humidity environments.

Conclusions

Both NA-SUL 450 and KX455 are excellent alternatives to additives designed for oil/solvent formulations giving exceptional performance with a significant reduction in pollution caused by VOC evaporation.

Thank You

Questions?



Questions

If you would like more information about how KX455 or NA-SUL 450 could be used to solve your specific corrosion problem, please stop by the King Industries booth # **308** to discuss these additives in more detail.