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% Calcium Sulfonate Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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 1µm 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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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% Calcium Sulfonate
Formulation B
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

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.