

# Ashless Additives

*Corrosion and Wear Protection*

*For Lubricants, Greases & Rust Preventives*

**King Industries, Inc.** offers a wide variety of multifunctional ashless antiwear additives, rust and corrosion inhibitors, and yellow metal deactivators. The term ashless is generally used to indicate that the product does not contain any metals. For applications where it is necessary or desirable to limit or eliminate metals or ash formation, metal-containing additives are excluded from consideration.

Below is a summary of the products further described in this brochure.



# Ashless Rust & Corrosion Inhibitors

		Chemistry		Functions			
		RI	AW	EP	YMD	AO	HX-1
<b>For Industrial Lubricants &amp; Functional Fluids</b>							
<b>K-CORR 1031</b>	Amide carboxylate	●	●				
<b>K-CORR SA-300</b>	Carboxylic acid ester	●					
<b>KX1311</b>	Proprietary amide	●					
<b>NA-LUBE AW-6110</b>	Amine phosphate	●	●				
<b>NA-LUBE AW-6310</b>	Sulfur-phosphorus package	●	●	●	●		
<b>NA-LUBE AW-6330</b>	Dithiophosphate	●	●			●	
<b>NA-LUBE AW-6400FG</b>	Amine phosphate	●	●				●
<b>NA-LUBE AW-6509</b>	Triphenyl phosphorothionate		●	●			●
<b>NA-LUBE ADTC</b>	Ashless dithiocarbamate		●	●		●	●
<b>K-CORR NF-200L</b>	Triazole derivative				●		●
<b>K-CORR NF-410</b>	DMTD derivative		●	●		●	●
<b>For Rust Preventives</b>							
<b>NA-SUL 437</b>	Amine sulfonate/carboxylate	●					
<b>NA-SUL EDS</b>	Amine sulfonate	●					
<b>NA-SUL 1101</b>	Ammonium sulfonate/carboxylate	●					
<b>K-CORR 1031</b>	Amide carboxylate	●					
<b>K-CORR SA-300</b>	Carboxylic acid ester	●					
<b>NA-SUL 1019A</b>	Sulfonate/carboxylate	●					
<b>For Grease</b>							
<b>K-CORR G-1107</b>	Proprietary blend	●	●				
<b>NA-LUBE AW-6310</b>	Sulfur-phosphorus package	●	●	●	●		

Almost all industrial lubricants need to protect against rust and will be formulated with a rust inhibitor. Most of the rust inhibitors herein are effective at low levels and will pass the typical requirements of ASTM D665B at 0.1% or less. The product selection generally depends upon the base fluid and the performance of the additive in the system, including antiwear, demulsibility, filterability, oxidation stability and the effect on specific tests like FZG and RPVOT.



**KX1311** is an ashless rust inhibitor with relatively low acid value. KX1311 is recommended for R&O, circulating, compressor, paper machine, gear, and hydraulic oils.

- Low acid value (~60 mg KOH/g)
- Improves solubility in highly refined and low polarity base oils
- Good thermal and hydrolytic stability
- Good demulsification properties
- No detrimental effect on AFNOR filterability, dry or wet
- Suitable for formulating HF-0 type hydraulic fluids
- Imidazoline-free

**Rust Preventive Test ASTM D665**

ISO VG 46 Group II



0.35% K-CORR NF-410  
0.06% **KX1311**

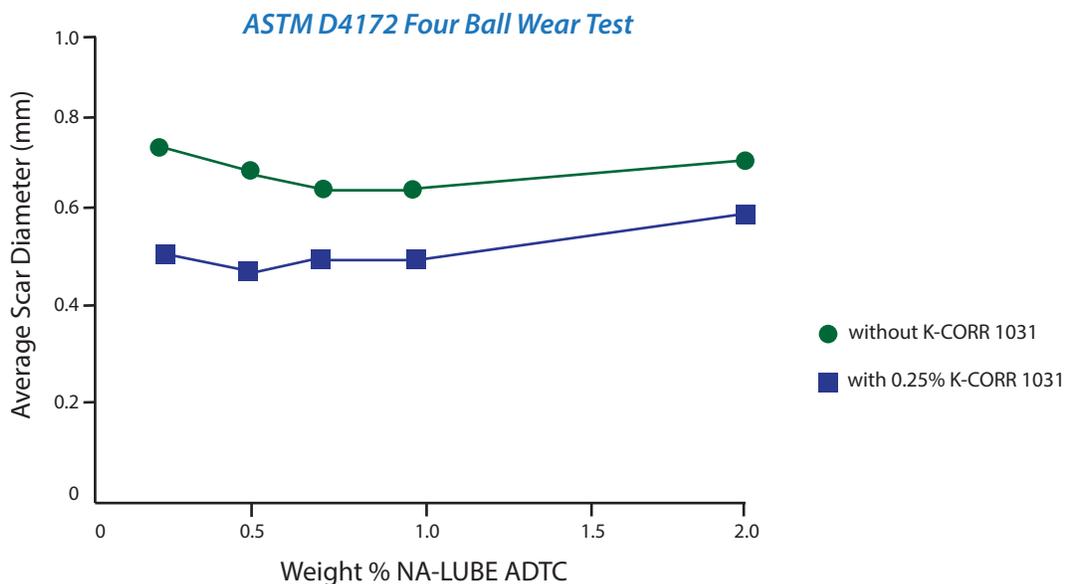


0.35% K-CORR NF-410  
0.06% Competitive RP

**K-CORR® 1031** is well suited for the formulation of premium industrial lubricants and functional fluids, including ashless HF-0 hydraulic fluids. It has a moderate acid value of 90 mg KOH/g.

- Improves solubility in highly refined and low polarity base oils
- Good thermal and hydrolytic stability
- No detrimental influence on FZG performance
- Synergistic AW performance with selected EP chemistries

The graph below shows antiwear synergy using 0.25% **K-CORR 1031** in combination with various treat levels of **NA-LUBE ADTC** in an ISO VG 32 paraffinic oil.



**K-CORR® SA-300** is an excellent general purpose ashless rust inhibitor with an acid value of 180 mg KOH/g.

-  Acidic-type inhibitor for industrial and automotive lubricants
-  Excellent demulsification properties
-  Good thermal and hydrolytic stability
-  Improves solubility in highly refined and low polarity base oils
-  Good humidity protection for light duty rust preventive fluids



**NA-LUBE® AW Series**

The **NA-LUBE AW Series** of ashless antiwear additives will generally all pass the standard rust requirements, per ASTM D665B, at the levels effective for the wear performance requirements. All provide excellent demulsibility and solubility in low polarity base oils.

NA-LUBE	Composition	Content			Advantages/Attributes
		%P	%N	%S	
<b>AW-6110</b>	Amine salt of aliphatic phosphoric acid esters	8.2	1.8	--	<ul style="list-style-type: none"> <li>• Multifunctional additive with excellent anticorrosion and antiwear properties</li> <li>• Outstanding FZG performance</li> <li>• Light color</li> </ul>
<b>AW-6310</b>	Proprietary preparation of sulfur-phosphorus-nitrogen containing chemistries	4.2	3.0	9.1	<ul style="list-style-type: none"> <li>• Multifunctional additive with excellent anticorrosion, AW, EP, and YMD properties</li> <li>• Timken performance booster</li> <li>• Excellent thermal stability</li> </ul>
<b>AW-6330</b>	Proprietary preparation of sulfur-phosphorus chemistries	4.5	--	10.0	<ul style="list-style-type: none"> <li>• Multifunctional ashless additive</li> <li>• Outstanding EP and AW performance</li> <li>• Good antioxidation properties</li> <li>• Suitable ZnDTP replacement</li> </ul>
 <b>AW-6400FG</b>	Amine salt of aliphatic phosphoric acid esters	8.3	2.4	--	<ul style="list-style-type: none"> <li>• Compliant with FDA CFR 178.3570 up to a treat level of 0.5% by weight</li> <li>• Multifunctional additive with excellent anticorrosion, AW and EP properties</li> <li>• Light color</li> </ul>
 <b>AW-6509</b>	Triphenyl phosphorothionate	8.9	--	9.3	<ul style="list-style-type: none"> <li>• Compliant with FDA CFR 178.3570 up to a treat level of 0.5% by weight</li> <li>• Synergistic with RI and EP additives</li> <li>• Excellent antiwear performance</li> </ul>

**K-CORR NF-200L** is a premium ashless liquid yellow metal deactivator for industrial and automotive lubricants, greases, and rust preventive fluids. It complies with FDA 21 CFR 178.3570 and is NSF HX-1 registered. It is used in all types of lubricants and greases where copper and copper-alloy machine parts need to be protected from corrosion.

**K-CORR NF-410** is a multifunctional additive that provides extreme pressure properties in addition to yellow metal protection. It can be used with K-CORR NF-200L to achieve higher levels of non-ferrous metal protection.

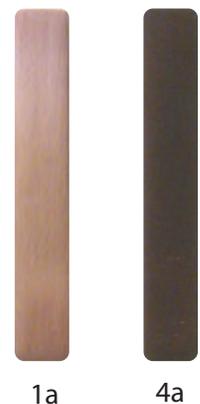
-  Excellent thermal and hydrolytic stability
-  Excellent demulsification properties
-  Outstanding solubility in mineral oils and synthetic base stocks
-  Good compatibility with other additives
-  Low viscosity

K-CORR	Composition	Description
<b>NSF NF-200L</b>	Triazole derivative	Premium ashless liquid yellow metal deactivator for industrial and automotive lubricants, greases, and rust preventive fluids. HX-1 registered.
<b>NF-410</b>	DMTD derivative	Premium ashless liquid multifunctional additive providing extreme pressure properties and yellow metal protection by scavenging active sulfur.

The table below shows the ability of **K-CORR NF-200L** to protect copper against the corrosive effects of active sulfur. The incorporation of active sulfur into an ISO VG 32 oil results in severe corrosion of the copper strips in the ASTM D130 test. Addition of a low treat level of **K-CORR NF-200L** offsets the detrimental effects of the active sulfur.

Base Oil	0.05% NF-200L		0.05% NF-200L	
	-- ISO VG 32 + 50 ppm Sulfur	-- ISO VG 32 + 50 ppm Sulfur	-- ISO VG 32 + 100 ppm Sulfur	-- ISO VG 32 + 100 ppm Sulfur
<b>Copper Corrosion (ASTM D130)</b>				
3 hours, 100°C	3a	1a	4a	1b
3 hours, 135°C	4a	1b	4c	1b

Copper Corrosion  
ASTM D130



The majority of rust preventives utilize metal salts as the hydrophobic ingredients protecting the surface. However, there are applications where the temporary RP coating is required to not contain metals or needs to be removed without leaving an ash. Selection of the ashless inhibitor is dependent upon a number of considerations, including the nature of the substrate to be protected and the conditions of exposure.

### Humidity Cabinet Performance (ASTM D1748)

1010 Steel - 0.1 - 0.3mm film thickness

	Product in ISO VG 32 Group I Oil	Average hours to failure		Comments
		2.0%	5.0%	
Synthetic Additive in Mineral Oil	NA-SUL EDS	250	250	Light duty performance at 2%.
	K-CORR SA-300	500	700	Improved light duty performance.
	NA-SUL 1101	600	600	Excellent performance at higher treat.
	K-CORR 1031	700	1500	Best performance at lower treat.

	Product in Water	Average hours to failure		Comments
		2.0%	5.0%	
Synthetic Additive in Water	NA-SUL 437	100	225	Excellent solubility for hard water, stability and tolerance
	K-CORR 1019A	300	500	Water soluble, passes iron chip test at 2%

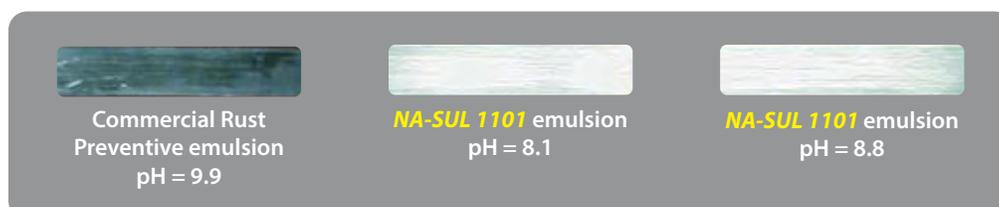
Additionally, **NA-SUL 1101** performs exceptionally well to prevent the corrosion of aluminum and galvanized steel. Salt fog performance results on aluminum are shown below.

### NA-SUL 1101 - Aluminum Performance

Aluminum test pieces submerged for 16 hours at 85°C

	Non-Aqueous	Aqueous	
	10% NA-SUL 1101 90% Group I ISO VG 32 Oil	10% NA-SUL 1101 2% Diethylethanolamine 88% Tap Water	10% NA-SUL 1101 2.5% Diethylethanolamine 87.5% Tap Water
Emulsion pH	NA	8.1	8.8
Salt Fog (ASTM B117) Average Hours to Failure	120	600	600

### Emulsions of NA-SUL 1101 as Corrosion Inhibitor for Aluminum



The rust requirements for greases vary more significantly than for fluid lubricants because of the influence of the grease thickener. Higher treat levels are required because inhibitors cannot easily flow through the grease to the metal surface. Requirements are even more severe when contaminant water contains salt. In that case, high performance additives are required.

As anti-rust requirements have increased, specific additives have been developed. **K-CORR G-1107** is an ashless rust inhibitor designed to provide protection against severe conditions in most grease types. Shown below are results for a lithium complex grease.



#### **K-CORR G-1107 Performance in Lithium Complex Grease (NLGI #2)**

<b>K-CORR G</b>	<b>5% Synthetic Sea Water</b>		<b>100% Synthetic Sea Water</b>		
	--	<b>1.0% G-1107</b>	--	<b>3.0% G-1107</b>	<b>5.0% G-1107</b>
<b>Static Rust Test</b> ASTM D5969	Fail	Pass	Fail	Pass	Pass
<b>EMCOR Rust Test</b> ASTM D6138, IP 220	3,3	0,0	4,4	2,2	0,0

The rust inhibitors shown for industrial lubricants on pages 3-4 will pass the distilled water rust test requirements at 0.5% - 1.0% treat levels in most greases. Notably **NA-LUBE AW-6310** is an excellent multifunctional additive for grease. Shown below are results in a lithium 12-hydroxystearate grease.

#### **NA-LUBE AW-6310 Performance in Lithium 12-OH Grease**

	--	<b>1.5% AW-6310</b>
<b>EMCOR Rust Test (ASTM D6138)</b> 5% Synthetic sea water	3,3	0,0
<b>Four Ball Wear (ASTM D2266)</b> 1 hour, 75°C, 40 kgf, 1200 rpm Scar diameter (mm)	0.72	0.48

Notes:

### Contact Information

[www.kingindustries.com](http://www.kingindustries.com)

**Global Headquarters  
Tech. Service, R&D, and Sales**  
King Industries, Inc.  
1 Science Road  
Norwalk, CT 06852, USA  
Phone: 1-203-866-5551

**European Tech. Sales Office**  
King Industries, International  
Science Park 402  
1098 XH Amsterdam  
The Netherlands  
Phone: 31 20 723 1970

**China Sales Office**  
Dalian Mingruida Technical Consulting Co., Ltd.  
Building 51, 20 Shuxiang Street  
Dalian, China  
Phone: 86 15941108485



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