



DURABILITY
AND PROTECTION — *with our* —

GREASE ADDITIVES

High Performance Additives & Base Stocks

Product Introductions & Table of Contents

King Industries, Inc. is a leading global developer, manufacturer and marketer of additives and synthetic base stocks for the lubricant and grease industry. For many years, King Industries has been the reliable supplier of the NA-LUBE®, NA-SUL® and K-CORR® product lines. King continually develops high quality additives and base oils to fulfill the industry's needs.

The lubricating grease industry continuously requires higher performance and cost-effective products. The performance of a grease is influenced by many factors, including thickener type, base fluid, base grease manufacturing method and the type and amount of additives used. King Industries offers a broad range of additives that are used in the formulation of greases.

Additionally, King offers the industry's broadest line of synthetic alkylated naphthalene base oils and base oil modifiers under the **NA-LUBE KR** trade name.



Synthetic Base Oils

Base Oil Modifiers

Additives for Grease

Base Oils and Base Oil Modifiers

NA-LUBE KR	page 3	The industry's broadest line of alkylated naphthalene, premium synthetic fluids with outstanding thermal and thermo-oxidative stability.
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Antiwear Additives

NA-LUBE AW	page 4, 8	Ashless antiwear additives based on a variety of phosphorus, sulfur and nitrogen chemistries.
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Extreme Pressure Additives

NA-LUBE EP	page 5	Light colored, low odor sulfurized olefins and fatty acid esters.
NA-LUBE ADTC	page 5	A multifunctional ashless additive offering AW, EP and AO performance.

Antioxidants

NA-LUBE AO	page 5	Primary and secondary antioxidants
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Rust and Corrosion Inhibitors

NA-SUL	page 6, 8	Inhibitors based primarily on proprietary dinonylnaphthalene sulfonate (DNNS) chemistry.
K-CORR	page 7, 8	Non-sulfonate based inhibitors, including K-CORR G grades specifically designed for severe grease rust requirements.

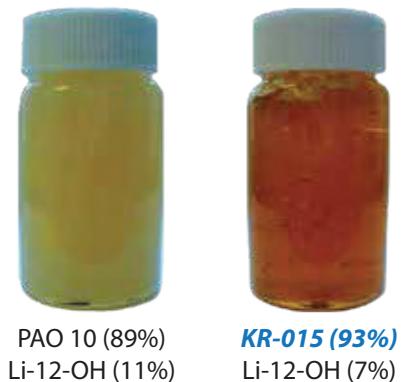
NA-LUBE KR series of alkylated naphthalenes are synthetic fluids with outstanding thermal and thermo-oxidative stability. They exhibit excellent performance properties when used as the sole or co-base oil for grease applications. Alkylation of naphthalene is a core technology of King Industries; thus, we are able to offer customized products designed to meet our customers' demanding application requirements.

Product	Viscosity @ 40°C
KR-015	114 cSt
NSF KR-015FG	114 cSt
KR-019	177 cSt
NSF KR-029FG	177 cSt

NSF = HX-1 Registered for incidental food contact

- Imparts superior thermo-oxidative stability
- Acts as a bridging solvent - reduces opaqueness
- Requires less thickener - improves low temperature properties
- Acts as a highly effective dispersant - produces a smooth grease

NA-LUBE KR-015 Neat Grease Comparison



Neat Base Oil Performance in Lithium 12-OH Grease (NLGI#2)		
Formulation Parameter	89% PAO 10 11% Li-12-OH	93% KR-015 7% Li-12-OH
P (60)	273	288
P (100K)	350	366
% Change	28	27
Oil Separation	4.1%	2.8%
Dropping Point	202°C	200°C
TGA	233°C	304°C

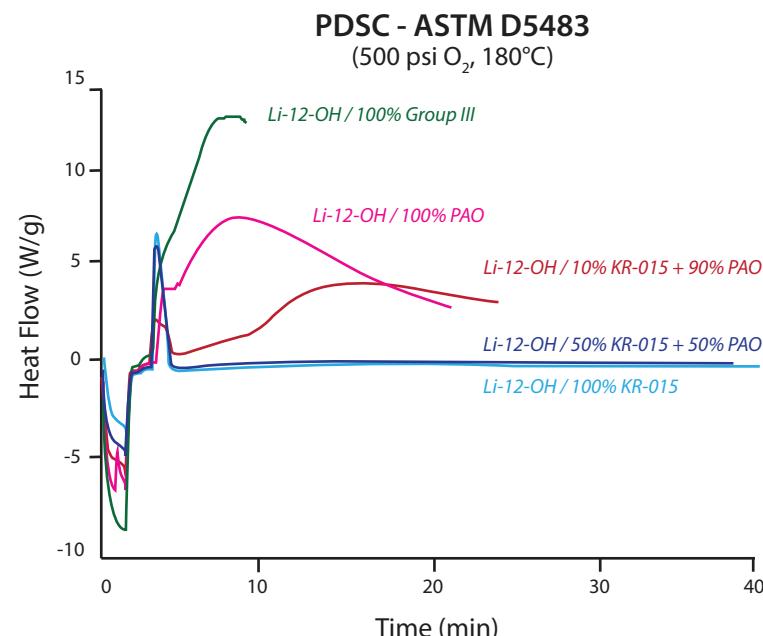
NA-LUBE KR-015 - For Improving Thermo-oxidative Stability

These curves compare five lithium 12-hydroxystearate greases made with different base oils and base oil blends.

Oxidation initiates almost immediately at 180°C for the greases made with Group III and PAO.

A small introduction of alkylated naphthalene NA-LUBE KR-015 into the PAO shows immediate improvement.

50/50 NA-LUBE KR-015 and PAO shows no oxidation after 40 minutes at 180°C under these conditions.



NA-LUBE AW-6000 series of ashless antiwear and extreme pressure additives is based on a variety of phosphorus, sulfur and nitrogen chemistries. If ashless systems are desired, these additives are effective alternatives to metallic phosphates. Typical treat levels are 0.5% to 2.0% by weight.

NA-LUBE	Composition	Content %P %N %S	Advantages/Attributes
AW-6110	Amine salt of aliphatic phosphoric acid esters	8.2 1.8 --	<ul style="list-style-type: none"> Multifunctional additive with excellent anticorrosion and antiwear properties Outstanding FZG performance Light color
AW-6220	Proprietary preparation with amine phosphate	4.5 5.7 --	<ul style="list-style-type: none"> Multifunctional additive with excellent anticorrosion and antiwear properties Yellow metal deactivator functionality Light color
AW-6310	Proprietary preparation of sulfur-phosphorus-nitrogen containing chemistries	4.2 3.0 9.1	<ul style="list-style-type: none"> Multifunctional additive with excellent anticorrosion, AW and EP properties Timken performance booster Excellent thermal stability
AW-6330	Proprietary preparation of sulfur-phosphorus chemistries	4.5 -- 10.0	<ul style="list-style-type: none"> Multifunctional ashless additive Outstanding EP and AW performance Good antioxidation properties Suitable ZnDTP replacement
NSF AW-6400FG	Amine salt of aliphatic phosphoric acid esters	8.3 2.4 --	<ul style="list-style-type: none"> Compliant with FDA CFR 178.3570 up to a treat level of 0.5% by weight Multifunctional additive with excellent anticorrosion, antiwear and EP properties Light color
NSF AW-6509	Triphenyl phosphorothionate	8.9 -- 9.3	<ul style="list-style-type: none"> Compliant with FDA CFR 178.3570 up to a treat level of 0.5% by weight Low coefficient of friction FZG synergy with NA-LUBE AW-6400FG

Performance in Lithium 12-OH (NLGI #2)

NA-LUBE AW-6310 is an ashless multifunctional additive that provides excellent rust protection to greases when tested in the presence of 5% synthetic sea water. In the study below, NA-LUBE AW-6310 is able to provide corrosion-free bearing races, as well as antiwear protection.

Performance Tests	Base Grease	1.5% NA-LUBE AW-6310
EMCOR Rust Test (ASTM D6138, IP 220), 5% SSW	3,3	0,0
Four Ball Wear (ASTM D4172) 1 hour, 75°C, 40 kgf, 1200 rpm, Scar Diameter (mm)	0.72	0.48
Copper Corrosion (ASTM D130, DIN 51 759) 3 hours, 100°C 3 hours, 135°C	1b 1b	1b 1b

NA-LUBE EP-5000 series of extreme pressure additives consists of light-colored, low-odor sulfurized olefins and sulfurized fatty acid esters that provide excellent extreme pressure properties. NA-LUBE EP-5210, an inactive sulfur carrier, and NA-LUBE EP-5415 are ideally suited for greases and work extremely well when combined with other extreme pressure and antiwear additives. Typical treat levels are 3.0% to 5.0% by weight.

NA-LUBE ADTC is an ashless dialkyldithiocarbamate offering extreme pressure, antiwear and antioxidant properties in greases whenever heavy metals are not desired. Because of its chemical structure, NA-LUBE ADTC is ideally suited for formulating antimony-free and low ash containing EP greases. Typical treat levels are 1.0% to 5.0% by weight.

Product	Composition	Total Sulfur	Advantages/Attributes
ADTC	Methylene-bis-dibutylthiocarbamate	30%	<ul style="list-style-type: none"> Multifunctional additive with extreme pressure, antiwear and antioxidant properties Good thermal stability
EP-5210	Sulfurized fatty acid ester	10%	<ul style="list-style-type: none"> Compatible with non-ferrous metals and aluminum alloys Light color, low odor
EP-5415	Sulfurized olefin and triglyceride	15%	<ul style="list-style-type: none"> Light color, low odor, low active sulfur content Environmentally friendly
EP-5665	bis-dimercaptothiodiazole derivative	65%	<ul style="list-style-type: none"> Outstanding performance in heavily loaded grease applications Excellent antiwear and antioxidant properties Compatible with ferrous and non-ferrous metals

NA-LUBE AO series consists of liquid and solid aminic and phenolic antioxidants that are effective stabilizers for a broad range of greases. All products are ashless, non-corrosive and have excellent solubility in petroleum and synthetic base stocks. Typical treat levels are 0.2% to 1.5% by weight.

NA-LUBE	Chemical Basis	Nitrogen	Form	Viscosity @ 100°C
AO-130	Dinonyl diphenylamine	3.5%	Liquid	17 cSt
AO-142	C ₄ /C ₈ diphenylamine	4.5%	Liquid	9 cSt
AO-210	2,6-Di-tert-butylphenol	--	Solid at < 36°C	--
AO-242	Di-tert-butylphenol derivative	--	Liquid	5 cSt
ADTC	Methylene-bis-dibutylthiocarbamate	6.5%	Liquid	15 cSt
AW-6330	Ashless dithiophosphate	--	Liquid	2.8 cSt

NA-SUL rust and corrosion inhibitors are a broad range of high performance additives based upon dinonylnaphthalene sulfonates (DNNS). Many different NA-SUL grades are used in greases depending upon the type of thickener, the base fluid, the level of rust protection desired and the performance requirements other than corrosion protection.

NA-SUL	Description	Attributes
BSN*	Neutral Barium Salt	General purpose, high temperature version available
BSB	Basic Barium Salt	For greases that contain acidic additives
CA-1089	Neutral Calcium Salt	General purpose and high temperature
CA-50	Basic Calcium Salt	For salt-fog protection, excellent for post-tensioning grease
ZS*	Neutral Zinc Salt	General purpose, high temperature version available
420	Sodium Complex	Designed for organo-clay grease - minimal softening
 CA-770FG	Neutral Calcium Salt	NSF HX-1

*BSN-HT and ZS-HT are offered for high temperature conditions



NA-SUL CA-1089 Performance - Lithium 12-OH Grease (NLGI #2) + 0.5% NA-LUBE® AO-142

NA-SUL	Distilled Water			5% Synthetic Sea Water		
	--	0.5% CA-1089	1.0% CA-1089	--	1.0% CA-1089	3.0% CA-1089
Static Rust Test ASTM D1743/D5969	Fail	Pass	Pass	Fail	Pass	Pass
EMCOR Rust Test ASTM D6138, IP 220	3,4	1,2	0,0	4,4	1,1	0,0

K-CORR and **K-CORR G** rust inhibitor systems are specifically designed to provide outstanding rust protection to greases exposed to severe salt water conditions. Test results are available in lithium 12-hydroxystearate, lithium complex, polyurea and calcium sulfonate greases with 5% and 100% synthetic sea water and 3% sodium chloride.

K-CORR	Description	Attributes
1031	Amino Acid Derivative	Rust inhibitor and antiwear synergist
G-1086A	Zinc-Based	For severe salt water conditions
G-1107	Ashless Chemistries	For severe conditions with AW synergy
 NF-200	Ashless YMD	NSF HX-1
SD-1223C	Polyamine	Booster for rust inhibitors, NA-LUBE AO and NA-LUBE AW
NF-410	S-N Chemistry	Copper corrosion inhibitor
G-1340	Proprietary Carboxylate	Medium viscosity zinc naphthenate alternative
G-1350	Proprietary Carboxylate	High viscosity zinc naphthenate alternative
G-1360	Proprietary Carboxylate	Low viscosity zinc naphthenate alternative
G-1370	Proprietary Carboxylate	Medium viscosity zinc naphthenate alternative

Zinc Naphthenate Replacements						
Performance Tests	--	Zinc Naphthenate	K-CORR G-1340	K-CORR G-1350	K-CORR G-1360	K-CORR G-1370
Treat Level	1.5% in Fully Formulated Lithium 12-OH Grease					
EMCOR ASTM D6138 3% NaCl Solution	4,4	1,1	0,0	0,0	1,1	2,2*
Four Ball Wear ASTM D2266 1 hour, 75°C, 40 kgf, 1200 rpm (mm)	0.65	0.50	0.50	0.55	0.50	0.52
PDSC ASTM D5483 Onset Point, 180°C (min)	26	38	45	49	37	48
Grease Water Stability DIN 51 807 Part 1 3 hours, 40°C / 90°C	0/1	0/1	0/1	0/1	0/1	0/1
Water Washout Resistance ASTM D1264 % Loss, 40°C % Loss, 80°C	1.48 0.90	-- --	0.75 0.82	0.60 0.90	1.00 0.97	0.87 1.32

* May perform best in a different Li-12-OH grease

Product Recommendations

NA-SUL® & K-CORR® Recommendations by Grease Type

Grease Type	Product Recommendations
Lithium / Lithium Complex	NA-SUL BSN, NA-SUL CA-1089, NA-SUL ZS, K-CORR G Series
Aluminum Complex	NA-SUL ZS-HT, K-CORR 1031
Calcium / Calcium Complex	NA-SUL CA-1089, NA-SUL CA-50, K-CORR G Series
Polyurea	NA-SUL BSN, NA-SUL CA-1089, K-CORR 1031, K-CORR G-Series
Organo-Clay	NA-SUL 420

NA-SUL®, K-CORR® & NA-LUBE® Recommendations by Special Condition

Special Conditions	Product Recommendations
Acid Neutralization	NA-SUL BSB, NA-SUL CA-50
Ashless Systems	K-CORR 1031, K-CORR G-1107
Elevated Temperatures, Extended Use	NA-SUL ZS-HT, NA-SUL BSN-HT, K-CORR 1031, K-CORR G-1107
Food Grade (for H-1 Greases)	NA-LUBE AW-6400FG, NA-LUBE AO-142, K-CORR NF-200, NA-SUL CA-770FG
Multifunctionality	NA-SUL AW-6310, NA-LUBE ADTC, NA-SUL AW-6330
Salt Spray Protection (ASTM B117)	NA-SUL CA-50, NA-SUL CA/W1935, NA-SUL CA/W1745
Yellow Metal Protection	K-CORR NF-200, K-CORR NF-410
Salt Water Protection (ASTM D5969 or ASTM D6138)	K-CORR G-Series

Technical Service

Our technical service team is ready to assist your development of greases to meet the most demanding applications. This brochure is only a sampling of our products and capabilities. We have a modern grease test laboratory that includes ASTM, DIN and IP equipment. In addition to a series of existing test reports, we are dedicated to individualized projects. The combination of high performance additives, extensive test equipment and our ongoing communication will result in greases to meet your objectives.

Data Disclaimer

Properties presented in this brochure are averages derived from typically twenty production lots. Product properties are subject to normal manufacturing and testing tolerances. Further information can be obtained from the certificates of analysis for each product.

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