

King Industries Lubricant Additives Division

GUIDE TO RUST PREVENTIVES

NA-SUL® and K-CORR®
Rust and Corrosion Inhibitors

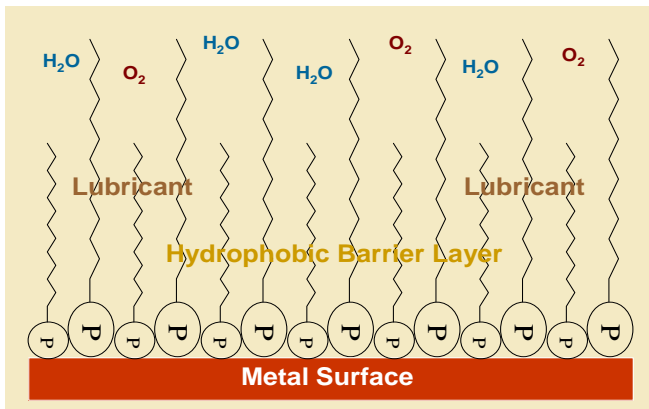


KING GUIDE TO RUST PREVENTIVES

The tremendous cost to society due to rust and corrosion of metals has in the past and continues today to energize research into better corrosion preventives. King Industries has been a leader in new technologies designed to preserve metals for over a half of a century. This product guide has been designed to keep you informed of some of the latest technologies available from King while providing useful information about NA-SUL® rust and corrosion inhibitors, long recognized as the performance standard for unexcelled protection.

For over six decades King Industries's NA-SUL dinonylnaphthalenesulfonates have been used in hundreds of formulations because of their unique abilities as hydrophobic polar compounds to prevent rust and corrosion. Unlike other sulfonates, NA-SUL products are high molecular weight synthetics with a narrow molecular weight distribution that results in:

- Extremely hydrophobic coatings
- Coatings that resist reemulsification repelling water for long time periods
- Batch to batch consistency with high quality



Over the years, using this core technology, King has developed numerous special purpose products by combining other hydrophobic polar compounds creating anti-rust synergy.

Additionally, as markets needs have changed and the quest for more environmentally and health friendly additives has become prevalent, King has kept pace with those trends by:

- Developing a unique line of rust preventive additives for aqueous systems
- Developed additives specifically designed to be used with vegetable based oils
- Developed a 100% ashless non-sulfonate corrosion inhibitor that is >90% biodegradable

Perhaps, just as important as the product advances in rust preventive technology is a company's commitment to provide the technical service and expertise to support those products. That is why King maintains a state of the art, RP technical service lab that in addition to expected North American test equipment has unexpected equipment such as a *Kesternich Cabinet* to fulfill different test requirements from different parts of the world.

Likewise, King technical personnel are ready to assist you in anyway they can with your formulation needs and can be contacted at:



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Rust and Corrosion Preventive Additives

King Industries NA-SUL[®] rust preventive additives are based on salts of dinonylnaphthalenesulfonate (DNNS[®]) with additional polar compounds chosen to provide rust preventive synergy. This results in extremely hydrophobic rust preventive coatings that effectively exclude water and air from reaching the metal surface. The resulting performance advantage allows levels of metal protection that competitive additives cannot achieve and /or reductions in additive use level that result in significant formulation savings. In addition, King Industries offers a line of specialty rust and corrosion inhibitors based on non-sulfonate chemistry under the K-CORR[®] brand.

Additives for Oil and Oil/Solvent Systems

NA-SUL Rust Preventives Concentrates for Oil and Oil/Solvent Systems			
Product	Form	Composition of Active Ingredients	Page
BSN	Liquid	Barium DNNS	3
729	Liquid	Calcium DNNS	3
CA-1082	Liquid	Calcium DNNS/carboxylic acid	3
CA-1089	Liquid	Calcium DNNS/calcium carboxylate	3
CA-1122	Liquid	Calcium DNNS/calcium carboxylate	4
CA-HT3	Liquid	Calcium DNNS/calcium carboxylate	4
CA/W1745	mp~40°C	Calcium DNNS/oxidized petrolatum	4
CA/W1935	mp~40°C	Calcium DNNS/carboxylic acid/oxidized petrolatum	4
CA/W1146	Viscous Liquid	Calcium DNNS/carboxylic acid/oxidized petrolatum	4
Experimental Rust Preventives for Oil and Oil/solvent Systems			
KX 1101	Liquid	Ammonium DNNS/carboxylic acid	5
KX 1177	Viscous Liquid	Calcium DNNS/carboxylic acid/oxidized petrolatum	5
KX 1183	Liquid	Calcium DNNS/Calcium carboxylate	5
K-CORR Rust and Corrosion Inhibitors for Oil and Oil/Solvent Systems			
K-CORR 100	Liquid	Amino Acid Derivative	5
K-CORR NF-200	Liquid	Proprietary Yellow Metal Deactivator	5

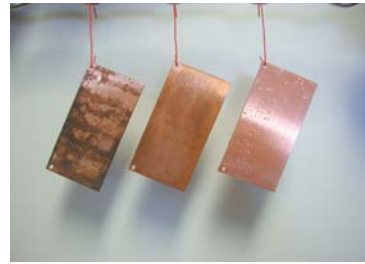
Additives for Aqueous Systems

NA-SUL Rust Preventive Additives for Aqueous Systems			
Product	Solubility	Composition of Active Ingredients	Page
437	Solution	DNNS/alkanolamines/carboxylates	6
1019A	Solution	DNNS/alkanolamines/carboxylates	6
420	Emulsion	Sodium DNNS/alkanolamines / oxidized petrolatum	6
426	Emulsion	Sodium DNNS/alkanolamines/wax	6
451	Emulsion	Sodium DNNS/alkanolamines/polymer	6
Experimental Rust Preventives for Aqueous Systems7			
KX 1028	Emulsion	Sodium DNNS/Sodium carboxylate / oxidized petrolatum	7
KX 1109	Solution	DNNS/alkanolamines/carboxylates/YMD*	7
KX 1165	Oil/Emulsion	Magnesium DNNS/Proprietary emulsifiers	7
CDX 2128		Amino Acid Derivative	7

*Yellow Metal Deactivator

NA-SUL®

Rust Preventive Concentrates for Oil and Oil/Solvent Systems



NA-SUL BSN

Moderate Storage
Indoor/Outdoor
Stacked/Coiled Steel
Non-staining
Water Displacement

**Neutral Barium dinonylnaphthalenesulfonate,
50% active in light naphthenic oil.**

Used for moderate indoor or sheltered outdoor storage of steel pieces. NA-SUL BSN is particularly useful for stacked or coiled steel because of superior non-staining properties. It is well suited for dewatering fluids because of inherent water displacing properties and no tendency to gel from water contamination.

NA-SUL 729

General Purpose
Short Term
Dewatering fluids

**Neutral Calcium dinonylnaphthalenesulfonate,
50% active in light naphthenic oil.**

Used for moderate indoor or short term outdoor sheltered storage of steel pieces. NA-SUL 729 is well suited for general purpose rust preventives as well as dewatering fluids. It is chemically neutral, which makes NA-SUL 729 a good choice where water or alkaline contamination is likely. Known or likely contaminants should always be checked for compatibility with any additive system.

NA-SUL CA-1082

Long Term Storage
Indoor/Outdoor Use
Soluble Oil Type
Metalworking Fluids

**A 67% active complex of Calcium DNNS
and carboxylic acid in light naphthenic oil.**

The synergy of polar materials used in NA-SUL CA-1082 allows for long term metal protection in indoor or outdoor sheltered storage. It has excellent solubility in most conventional diluents, but rust preventive performance is best in naphthenic or Group I paraffinic oils. It does not contain oxidized petrolatum, which improves solubility and reduces odor. NA-SUL CA-1082 does not gel on contamination with water, but can gel if contaminated with highly basic materials such as caustic cleaners. For this reason it is not generally used in dewatering fluid applications. NA-SUL CA-1082 is easy to emulsify due to its acid value so that it may be used in water-based rust preventives or as a rust preventive booster for metalworking fluids.

NA-SUL CA-1089

General Purpose
Long Term Indoor
Dewatering Fluids

**A 50% active complex of calcium DNNS
and calcium carboxylates in light naphthenic oil**

Excellent for general purpose long term indoor storage or short term outdoor sheltered storage of steel pieces. NA-SUL CA-1089 is highly recommended for dewatering fluid applications showing no tendency to gel after exposure to water or alkaline contaminants. Known or likely contaminants should always be checked for compatibility with any additive system.

Proven Performance

A 50% active complex of calcium DNNS and calcium carboxylate in light naphthenic oil

NA-SUL CA-1122 is well suited for long term indoor or outdoor sheltered protection of steel pieces. It is very effective at low treat levels allowing substantial formulation savings. It has excellent solubility and performance in a wide variety of diluents including polyalphaolefin (PAO) and vegetable oils, especially canola or rapeseed oil. It has surprisingly good performance in salt fog testing since it does not contain waxes or oxidized petrolatum. It is not recommended as a dewatering fluid additive because it has a tendency to gel on exposure to large amounts of water. This does not affect its performance after being applied to metal pieces.

NA-SUL CA-1122

**Long Term
Low Treat Levels
Performance in PAO
and Vegetable Oils**

A 55% active complex of calcium DNNS and calcium carboxylate in light naphthenic oil

NA-SUL CA-HT3 is a very good general purpose rust preventive additive for medium term indoor or outdoor sheltered applications. It has excellent solubility in a wide range of oils and diluents. It is not recommended as a dewatering fluid additive because it has a slight tendency to form a gel on heavy contamination with water.

NA-SUL CA-HT3

**General Purpose
Excellent Solubility**

A 100% active additive composed of calcium DNNS and oxidized petrolatum

NA-SUL CA/W1745 is a good general purpose rust preventive for medium duty applications. It does not have a tendency to gel on exposure to water. It is particularly well suited for oil/solvent formulations.

NA-SUL CA-W/1745

General Purpose

A 100% active additive composed of calcium DNNS, oxidized petrolatum and carboxylic acid

NA-SUL CA/W1935 is a good general purpose rust preventive for medium to long term storage of metal parts in indoor or sheltered outdoor environments. It is best used in oil/solvent systems. If used in oil without solvent, solubility must be verified. It is recommended for acid atmosphere applications.

NA-SUL CA-W/1935

**Medium/long Term
Acid Atmosphere**

A 70% active additive composed of calcium DNNS, oxidized petrolatum and carboxylates

NA-SUL CA/W1146 is highly recommended for severe rust preventive requirements. It is especially recommended for marine applications and protection of metal parts during overseas transportation. It is also very effective in acid atmosphere applications. It has improved solubility over other wax containing products. It will form a gel if the formulation is contaminated with water prior to application to parts. Once applied to metal parts, it forms a very hydrophobic protective coating. NA-SUL CA/W1146 is very effective at low levels so that it can significantly save on total formulation costs.

NA-SUL CA-W/1146

**Severe Conditions
Marine Applications
Acid Atmosphere
Low Use Levels**

NEW Experimental Products for Oil and Oil/Solvent Systems

KX 1101

Aluminum Protection

A 67% active complex of Ammonium DNNS and carboxylic acid in light naphthenic oil.

KX1101 provides exceptional protection for aluminum. It is soluble in a wide variety of diluents including mineral oils, polyalphaolefin and vegetable oils. It can easily be emulsified by combining with a suitable alkanolamines. Water emulsions can be made stable at pH levels near 8 that allows KX1101 to be used to protect aluminum without blackening due to high pH.

KX 1177

**Dewatering Fluids
Humid Environments**

An 80% active complex of calcium DNNS, carboxylic acids and oxidized petrolatum

KX1177 is highly recommended for dewatering fluids or other applications where water contamination is likely. It offers good Salt Fog and excellent humidity protection. It has improved solubility over older NA-SUL rust preventive additives based on oxidized petrolatum. KX1177 is highly effective in indoor storage in high humidity environments as well as in outdoor sheltered storage. It can be used at low treat levels for economical total formulations as compared to competitive products.

KX 1183

**Long Term
Indoor/Outdoor
Good Salt Fog
Excellent Humidity
Dewatering Fluids
Tolerates Alkaline
Contamination**

A 75% active complex of calcium DNNS and calcium carboxylate in light naphthenic oil

KX 1183 is a very effective rust preventive that does not contain oxidized petrolatum. This results in excellent solubility in a wide variety of base fluids such as highly refined mineral oils, polyalphaolefins and vegetable oils. The lack of oxidized petrolatum also results in a very mild odor. KX1183 is highly recommended for applications where water contamination is likely such as dewatering fluids. It has very good Salt Fog performance and outstanding humidity performance. It is recommended for moderate to long term indoor and sheltered outdoor storage applications.

K-CORR® Products for Oil and Oil/Solvent Systems

K-CORR 100

**Ashless
Biodegradable >90%**

A 100% active ashless corrosion inhibitor based on amino acid chemistry

K-CORR 100 has an acid value of about 100 and can be used as is or as a rust inhibitor intermediate. It has good thermal and hydrolytic stability along with good water separation. It can be used in oil and with suitable amines or alkanolamines in aqueous systems. It has biodegradability of greater than 90% in the CEC-L-33-A-93 test and over 50% by OECD 301B(modified Sturm) test.

K-CORR NF-200

**High Performance YMD
(Yellow Metal
Deactivator)**

A 100% active ashless yellow metal deactivator

K-CORR NF-200 is a high performance liquid yellow metal deactivator that protects copper and copper alloys from oxidation by forming a protective film on the metal surface. It works at low treat levels, usually 0.03% - 0.07% by weight depending on the formulation. It has excellent solubility in most mineral oil and synthetic base fluids. K-CORR NF-200 is an excellent additive to extend a formulation that is effective on steel to multi-metal corrosion inhibition. K-CORR NF-200 is also effective in greatly reducing or completely eliminating corrosivity of cadmium and zinc.

NA-SUL®

Rust Preventive Concentrates for Aqueous Systems

NA-SUL 437

Water Soluble
Dewatering
Aerosol Can Protection

A water soluble rust preventive based on Triethanolamine DNNS, carboxylic acid and alkanolamines

NA-SUL 437 is a completely water soluble rust preventive especially recommended for short to medium term indoor storage of steel parts. It is recommended to be used at 1% to 5% in water. It is very tolerant of hard water and so can usually be used in local, untreated city water. At 3% or less, the surface, after water evaporation, is dry to the touch. It can be used to protect already wet parts and so can take the place of solvent based dewatering fluids. It is also recommended for internal aerosol can protection by incorporation into water or alcohol based formulations at 0.25% to 1.0%. NA-SUL 437, despite being completely water soluble, will provide extended protection even in 100% humidity environments.

NA-SUL 1019A

Circulating Fluids

Modified version of NA-SUL 437

NA-SUL 1019A is similar to NA-SUL 437 with slightly enhanced iron chip test performance. It is recommended where the aqueous fluid is in contact with the surface to be protected such as in circulating fluid systems.

NA-SUL 420

Emulsifiable With
Moderate Mixing

A water emulsifiable rust preventive based on Sodium DNNS, emulsifiers, alkanolamines and waxes

NA-SUL 420 easily forms emulsions by pouring into water with moderate mixing. It is recommended for short to long term indoor storage. The usual treat levels are 1% to 10% depending on the severity of the requirement. Up to 20% can be used to get moderate Salt Fog performance. At treat levels below 3%, the resulting protective films are dry to the touch. If it is to be applied by spray, antifoam may be required.

NA-SUL 426

Long Term
Excellent Salt Fog

A water emulsifiable rust preventive based on Sodium DNNS, alkanolamines and specialty polymers

NA-SUL 426 is designed for long term indoor and outdoor sheltered storage. It is typically used at 5% to 25% treat levels. At higher usage levels, significant Salt Fog protection can be achieved. It can be dip, brush or spray applied. The resulting films have a tacky feel.

NA-SUL 451

Easily Emulsified
Aluminum Protection

A water emulsifiable rust preventive based on Sodium DNNS, alkanolamines and specialty polymers

NA-SUL 451 is easily emulsified by adding to water with moderate stirring. It produces dry to the touch, detergent removable protective films. It is typically used at treat levels of from 10% to 50%. NA-SUL 451 protects metal parts for extended periods in 100% humidity and will protect in Salt Fog environments at higher treat levels. It is particularly effective in protecting aluminum in high humidity environments. Testing in ASTM D 1748 100% humidity gave complete protection of aluminum for many thousands of hours.

NEW

Experimental Rust Preventive Concentrates for Aqueous Systems

A water emulsifiable rust preventive based on Sodium DNNS, Emulsifiers and waxes

KX1028 is the same composition as NA-SUL 420 but is neutralized with sodium rather than alkanolamines. This results in no appreciable VOC emissions. KX1028 can be used in heated tanks without losing volatile components and destabilizing the emulsion. When applied at temperatures in excess of 60°C, outstanding Salt Fog resistance is obtained. KX1028 is best used where VOC emissions are not permitted or higher temperatures are required for faster drying of parts.

KX 1028

Water Soluble
Dewatering
Aerosol Can Protection

Modified version of NA-SUL 437

A water soluble corrosion inhibitor that adds a yellow metal deactivator to the chemistry of NA-SUL 437 for multi-metal protection.

KX 1109

Yellow Metal
Deactivator

A complex formulation based on Magnesium DNNS

KX1165 has excellent oil solubility in naphthenic and Group I paraffinic oils. The resulting oil solutions self emulsify with gentle stirring when added to water. There is no need to add additional coupling agents. By going through an oil intermediate, the resulting final emulsions are very effective at low activity levels for economical formulation costs. Usually a 30% oil solution of KX1165 is made. This oil solution is then added to water at 5% to 20% that produces emulsions that are 1.5% to 6.0% active. This results in very good humidity and Salt Fog protection. KX1165 is recommended for moderate indoor or outdoor sheltered storage.

KX 1165

Soluble in Naphthenic
and Group I Paraffinic
Oils
Economical Use
Oil Solutions Self-
Emulsify

A 100% active corrosion inhibitor based on amino acid chemistry and alkanolamines

CDX 2128 can be added to existing aqueous formulations as a booster to improve corrosion inhibition or it can be used as a primary corrosion inhibitor. It is typically used at 0.5% - 3.0% treat levels. It finds use in rust preventives, corrosion inhibiting coatings and aqueous cleaning and polishing formulations.

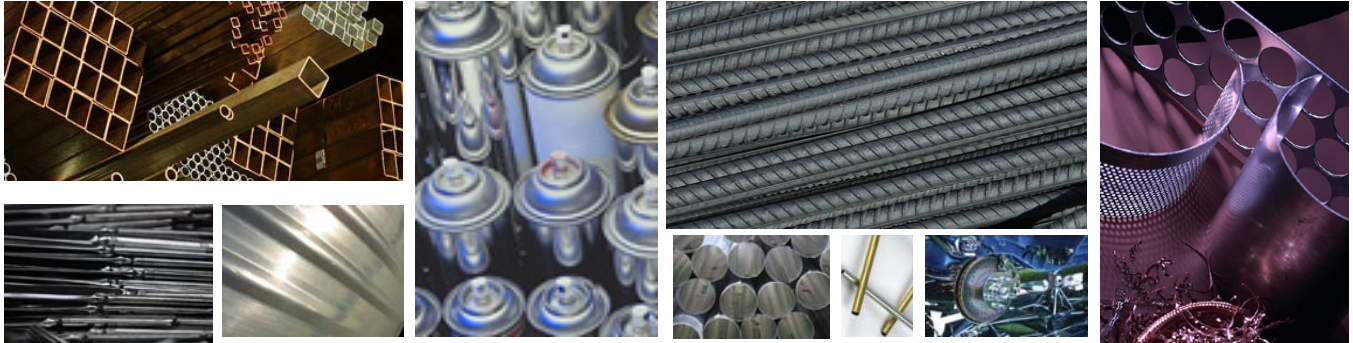
CDX 2128

Protection Booster for
Aqueous Formulations



Selection Guide for Common Rust Preventive Applications

Many NA-SUL® and King Experimental (KX) additives can be used for various rust and corrosion prevention applications. The following brief guide is to help select the best possible additive for some of the more common RP applications but is by no means all inclusive. As always, King's technical staff stands ready to assist you with your specific requirements and can be contacted as shown on the last page - King Contact Page.



Indoor Temporary Storage



Indoor storage conditions range from climate controlled to wide seasonal fluctuations in temperature and humidity. The duration of protection required can range from days to years. The thin protective coatings are generally, but not always, removed prior to use or further processing.

Oil and Oil/Solvent Systems	
Products	Notes
NA-SUL CA-1089	Medium term storage, tolerant of water and alkaline contamination
NA-SUL CA-1082	Medium to long term storage, avoid alkaline contamination
KX 1183	Medium to long term storage, tolerant of water and alkaline contamination

Aqueous Systems	
Products	Notes
NA-SUL 437	Water soluble, thin film dry to touch <3%
NA-SUL 420	Medium term storage, easy to form emulsion, dries quickly, dry to touch at <3%
KX 1165	Form oil soluble intermediate for oily coating and economy

Special Conditions	
Stacked Steel Parts	NA-SUL BSN and CA-1089
High Humidity	NA-SUL CA-1122
Vegetable oil/ester base	NA-SUL CA-1122

Special Conditions	
Stacking Wet Parts	NA-SUL 1019A
Heated Water Applications	KX 1028
Lowest VOC	KX 1028

Sample - Oil and Oil/Solvent Formulation	
5%	NA-SUL CA-1089
10%	Group I - ISO VG 32 Paraffinic Oil
85%	Solvent

Sample - Aqueous Formulation	
3%	NA-SUL 437
97%	City (tap) Water



Dewatering fluids

Dewatering fluids displace water from wet parts to apply a rust preventive coating.

Oil and Oil/Solvent Systems

Products	Notes
NA-SUL CA-1089	Medium term protection
NA-SUL BSN	Superior water displacement
KX 1177	Medium to long term protection

Special Conditions

Galvanized Steel Barium-free	KX-1183 Clean water separation
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Sample - Oil and Oil/Solvent Formulation

5%	NA-SUL CA-1089
95%	Solvent
(Optional 10%)	Oil/ 85% Solvent for increased protection in severe environments

Aqueous Systems

Products	Notes
NA-SUL 437	Water soluble
NA-SUL 1019A	Water soluble

Special Conditions

Stacking Wet Parts	NA-SUL 1019A
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Sample - Aqueous Formulation

3%	NA-SUL 437
97%	City (tap) Water



Part Transportation and Marine Environments

Parts being transported can see many different environments before they reach their destination. They may go from a cold dry environment to a warm humid one or the reverse. They may also be exposed to marine environments requiring salt resistance.

Oil and Oil/Solvent Systems

Products	Notes
NA-SUL CA/W1146	Best Salt Fog resistance, avoid water contamination before applying to parts
NA-SUL CA-1122	Excellent Salt Fog resistance, does not contain wax, avoid water contamination before application to parts
KX 1177	Tolerant of water contamination, use naphthenic, group I paraffinic oils or oil solvent systems

Special Conditions

Water contamination likely, Group II or III or PAO Base Oil	NA-SUL CA-1082 KX-1183
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Sample - Oil and Oil/Solvent Formulation

5 to 10%	NA-SUL CA-1146
10%	ISO VG 32 Paraffinic Oil
80-85%	Solvent

Aqueous Systems

Products	Notes
KX 1028	Excellent Salt Fog resistance especially if applied from heated emulsion system, very low VOC
NA-SUL 426	Good Salt Fog resistance, tacky coating

Special Conditions

Protection of Galvanized Steel	NA-SUL 426
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Sample - Aqueous Formulation

10-20%	KX 1028
80-90%	City (tap) Water (For maximum salt fog results apply by spray or dip from emulsion heated above 55°C)

Outdoor Sheltered Storage



Conditions for outdoor sheltered storage are extremely varied both seasonally and regionally. The most common factor is alternating dry and wet conditions due to condensation, rain or humidity changes.

Oil and Oil/Solvent Systems	
Products	Notes
NA-SUL CA-1122	Avoid contamination with water before application
KX 1183	Tolerant of water or alkaline contamination, excellent solubility
NA-SUL 1089	Tolerant of water or alkaline contamination, excellent solubility, not recommended for coastal or marine environments

Special Conditions	
Galvanized Steel	KX 1183
Aluminum	KX 1101 or KX 1183

Sample - Oil and Oil/Solvent Formulation	
5-10%	NA-SUL CA -1122
10-20%	Group I - ISO VG 32 Paraffinic Oil
70-85%	Solvent

Aqueous Systems	
Products	Notes
KX 1165	For best economy first dissolve in Naphthenic or Paraffinic Group I Oil

Sample - Aqueous Formulation	
KX-1165	Make a 30% solution in naphthenic or Group I paraffinic oil and then an emulsion of 10% to 20% for a final activity of 3% to 6%. Easy to form emulsions, tolerant of relatively hard (mineral containing) water



Contact - Technical Assistance

We can offer significant individualized assistance for optimizing your formulation using our extensive experience and wide range of testing capabilities. Our customers find this service increasingly important due to rapidly changing base fluids, world wide governmental regulations and lack of in-house laboratory time and personnel.

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