Krytox™ XP
Performance Lubricants

With Soluble Additives

Product Information

Krytox™ lubricant XP products are formulated using patented soluble additives. Typical perfluoropolyether (PFPE) greases use solid additives for anti-rust, anti-wear, or extreme pressure performance. These components are mixed into the grease and held in place by the grease thickener. In the past, there were no additives available for the oil, because of the inertness of the oil and insolubility of available additives.

The Krytox™ lubricant XP line offers greases and oils—with a soluble additive in the oil. The soluble additive won't be washed away or left behind with the grease thickener. These patented additives enhance the performance of Krytox™ PFPE greases and oils, giving them improved performance properties. Bearings run quieter and wear less, because there are no solid additives to make noise. Lower wear will extend bearing and component life. The anti-corrosion protection of the additive will reduce rusting, and allow longer grease and bearing life. The extreme pressure properties of the additive protect bearings under high loads.

Krytox™ lubricant XP products are high-quality, ultrahigh-performance, anti-friction and anti-rust lubricants. Formulated with synthetic PFPE fluids, soluble additives, and the most efficient polytetrafluoroethylene (PTFE) thickeners available, these lubricants exceed the performance requirements of most demanding applications.

Krytox™ lubricant XP products will hold up under tremendous load conditions, preventing metal-to-metal contact and, thereby, reducing wear. The long-term anti-rust properties repel moisture, providing extra protection against corrosion of metal parts and bearing surfaces. They also exhibit excellent resistance to water washout when used in wet environments.

While Krytox™ oils are inert and non-reactive to all elastomers, plastics, and metals, the soluble additives in

Typical Properties of Krytox™ XP Lubricants							
Oil	XP 1A1	XP 1A2	XP 1A3	XP 1A4	XP 1A5	XP 1A6	XP 1A7
Grease	XP 2A1	XP 2A2	XP 2A3	XP 2A4	XP 2A5	XP 2A6	XP 2A7
ISO Grade of Base Oil	7	15	32	68	150	220	460
Estimated Useful Temperature Range, °C (°F)	<–70–104 (<–94–220)	–63–132 (–81–270)	–60–154 (–76–310)	–51–179 (–60–355)	–36–182 (–33–360)	–36–182 (–33–360)	–30–182 (–22–360)
Oil Viscosity, cSt 20 °C (68 °F) 40 °C (104 °F) 100 °C (212 °F)	 16 8 2	 36 15 3	 80 30 5	 180 60 9	 550 160 18	 810 240 25	 1600 440 42
Oil Viscosity Index	—	59	121	124	134	134	155
Base Oil Pour Point, °C (°F)	<–70 (<–94)	–63 (–81)	–60 (–76)	–51 (–60)	–36 (–33)	–36 (–33)	–30 (–22)
Food Contact Approval	None	None	None	None	NSF H-1 for XP 1A5 only	None	None

Chemours™

Krytox™ lubricant XP products are new and have not been tested with all materials. It is possible that some reactivity and damage could occur to some materials. Initial testing has shown no problems with Teflon™ fluoropolymer, Kalrez® perfluoroelastomer parts, Viton™ fluoroelastomer, nitrile, and silicone rubbers. There is some reactivity of the additive with copper, but less so with brass. These additives have not been tested at all temperatures, and degradation of performance could occur at elevated temperatures over a long period of time.

Performance

Wear testing of the additive was done using standard laboratory tests to demonstrate improved performance.

Four Ball Wear tests on oil with the additive compared to oil with no additive were run according to ASTM D4172 at 1,200 rpm, 20 kg load, 107 °C (224 °F) starting temperature, and 1 hr duration. The wear scar was measured using a microscope. This method tests the wear prevention properties of the oils.

Test Oil	Wear Scar Size, mm
Krytox™ GPL 105	0.44
Krytox™ XP 1A5	0.29

Krytox™ XP 1A5 oil showed a reduction of 34% in wear over the same viscosity oil with no additive.

Four Ball Wear tests on grease with the additive compared to grease with a typical solid additive were run according to ASTM D2266 at 1,200 rpm, 20 kg load, 107 °C (224 °F) starting temperature, and 1 hr duration. The wear scar was measured using a microscope. This method tests the wear prevention properties of the greases.

Test Grease	Wear Scar Size, mm
Krytox™ GPL 225	0.42
Krytox™ XP 2A5	0.34

Krytox™ XP 2A5 grease showed a reduction of 19% in wear over a current grease with the same viscosity oil and with additives to reduce wear and corrosion.

Four Ball EP tests were run on grease and oil according to ASTM D2783 for oil and ASTM D2596 for grease. This method tests the extreme pressure properties of the oil or additive and its ability to carry heavy loads.

Product	Load Wear Index, No Additive	Load Wear Index with Krytox™ XP Additive	% Improvement
Oil	Krytox™ GPL 103 = 40.9	Krytox™ XP 1A3 = 53.3	30
Grease	Krytox™ GPL 206 = 127.8	Krytox™ XP 2A6 = 143.6	12.4

Water washout of grease from a bearing was tested by ASTM D1264 at 79 °C (175 °F).

Test Grease	Grease Removed
Krytox™ XP 2A5	0.25%

Pin and Vee Block tests were conducted according to ASTM D3233. The test is a load to failure test that uses progressive loading on Vee blocks that squeeze a shaft rotating at 290 rpm. The test terminates when the shaft seizes and breaks a shear pin or the machine reaches its top loading of 3,000 lb on the load pressure gauge. The test pieces are submerged in oil. This method tests the extreme pressure properties of the oil or additive. These tests were run starting at room temperature.

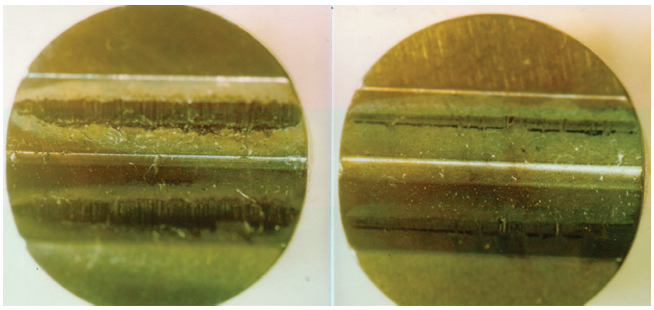
Test Oil	Maximum Load Reached, lb	Final Torque, in·lb
Krytox™ GPL 105	3,000	96
Krytox™ XP 1A5	3,000	51

Krytox™ XP 1A5 oil showed a reduction of 47% in torque over the same viscosity oil with no additive.

Block on Ring tests were run per ASTM D2714. The test runs at 72 rpm, with a 100 lb normal load for 5,000 cycles. The test is a line contact configuration. The size of the wear scar on the test block is measured. The specimen assembly is partially immersed in the lubricant sample during the test. This method tests the wear prevention properties of the oil.

Test Oil	Wear Scar Size, mm
Krytox™ GPL 105	0.80
Krytox™ XP 1A5	0.70

Krytox™ XP 1A5 oil showed a reduction of 12% in wear over the same viscosity oil with no additive.



Pin and Vee Block Coupons (Large wear scar on left is from oil with no additives; the smaller scar on the right shows the effect of Krytox™ XP additives.)

Bearing Noise

Solid particles in grease cause bearing noise, and very large particles can lead to early failure of the bearing. Small bearings and electrical motor bearings are commonly plagued by noise. Krytox™ lubricant XP products with soluble additives minimize noise. Various greases were tested to show the effects of particles on noise level in bearings. Any readings above 25 on the low or high band is considered unacceptable for electric motor quality. Any amplitude greater than one grid on the oscilloscope is also unacceptable for electric motor quality.

Test Grease	Low Band	High Band	Oscilloscope
Competitive Grease (Large particle additives)	60	95+	Off scale (8+ grids)
Krytox™ Grease (Small particle additives)	17.5	43	3.3 grids
Krytox™ Grease (No solid additives)	20	19.3	1/4 grid

Anti-Corrosion Protection

Performance of the soluble additives in the Krytox™ lubricant XP line is superior to additives that are commonly used for anti-corrosion protection in PFPE grease.

The corrosion prevention performance of oil with the soluble additive was tested against a PFPE oil with no additives using a modified version of ASTM D665. Cylindrical C-1018 steel coupons were cleaned and coated with oil. They were allowed to drip for 1 hr, and then placed into a water bath that was stirred and held at 80 °C (176 °F). They were examined at routine intervals for corrosion. The water for the test is a modified hard water that contains salts and minerals to simulate water normally found in industrial applications, and is somewhat corrosive and similar in action to saltwater.

Test Oil	Time to Initial Corrosion	Final Corrosion Rating at 24 hr
Krytox™ GPL 105	Less than 1 hr	Severe rusting
Krytox™ XP 1A5	None	No rusting visible

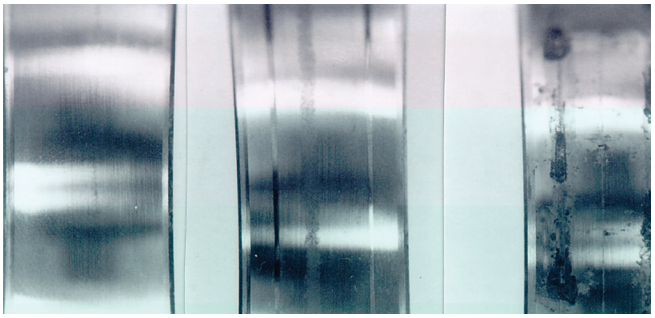
An additional test was run with corrosion coupons in 80 °C (176 °F) agitated hard water for five weeks with no rusting visible.

Bearing corrosion prevention performance of grease with the soluble additive was tested against a PFPE grease with no additives and against a PFPE grease with standard anti-corrosion additives using the IP-220 (EMCOR) test method. This method uses a double row self-aligning bearing that is packed with grease. It is a dynamic test that runs partially submerged in water for 8 hr, sits for 16 hr, runs again for 8 hr, sits for 16 hr, runs again for 8 hr, and then allowed to sit for an additional 108 hr, which gives a test time of one week. At this time, the bearing is disassembled, and the outer race is examined for rusting. The outer race is rated from 0–5 on a standard rating scale, with 0 having no corrosion and 5 having more than 10% of the surface covered with corrosion. The water for the test is a modified hard water that contains salts and minerals to simulate water that normally would be found in industrial applications and similar in corrosion action to saltwater.

Test Grease	Final Corrosion Rating
Krytox™ GPL 205 (No additives)	5 (More than 10%)
Krytox™ GPL 225 (Standard anti-rust additive)	3 (1–5%)
Krytox™ XP 2A5	0 (No corrosion)

Corrosion prevention was also tested by ASTM B117, salt spray test. A polished steel test panel that was coated with a 4 mil coating of Krytox™ XP 2A5 grease and exposed to a 5% salt solution at 95 °C (203 °F) for 100 hr passed with no corrosion forming.

Grease corrosion prevention was also tested by ASTM D1743. This test uses greased tapered roller bearings that are rotated to spread the grease, and then are dipped in water and stored in a 100% relative humidity environment for two days. The Krytox™ XP 2A5 grease passed with no rusting.



The bearing race on the left clearly shows there is no corrosion when Krytox™ XP additive is present, the bearing in the center shows traces of rust with standard additives, and the bearing on the right shows heavy rusting with no additives.

Corrosion-Oxidation Stability Test

Krytox™ lubricant XP oils have been tested in the Corrosion-Oxidation Stability test as per Federal Test Method 791C, 5308.7. This method tests the ability of oils to resist oxidation and their tendency to corrode various metals. Metal specimens are suspended in oil at elevated temperature, and air is blown through the mix. After completion, the oil is tested to determine the extent of degradation, and the metal coupons are examined for corrosion.

Results on Krytox™ XP 1A5 oil after 168 hr at 122 °C (250 °F)

Evaporation loss	1.0%
Increase in viscosity	1.7%

Change in weight of metals, mg/cm²

Copper	-0.59
Copper alloy 932	-0.22
Cadmium	-0.01
Aluminum	0.00
Steel	0.00
Magnesium	+0.01

Elastomer Compatibility

Elastomer compatibility screening was conducted on Krytox™ lubricant XP products. Additional testing is being performed to fully characterize if materials are affected by additives in Krytox™ XP products. The table below lists the percentage of swelling after 168 or 672 hr of exposure.

Mylar® polyester film and Teflon™ fluoropolymer have been tested with no damage, and additional elastomers are currently being tested for compatibility with the additives. Kalrez® perfluoroelastomer parts show the same swell that happens with pure Krytox™ at high temperatures. Caution should be used with unlisted materials until compatibility testing is completed.

Elastomer/ Plastic	Test Temperature	Krytox™ GPL 105 Oil	Krytox™ XP 1A5 Oil
Viton™, 672 hr	100 °C (212 °F) 175 °C (347 °F)	0.06 −2.94	0.82 8.18
Silicone, 168 hr	100 °C (212 °F)	−1.24	−4.58
Neoprene, 168 hr	100 °C (212 °F)		−2.18
EPR, 168 hr	100 °C (212 °F)		−0.70
Nitrile, 672 hr	100 °C (212 °F) 175 °C (347 °F)	−2.24 −2.92	−1.55 −3.06

Storage and Shelf Life

Krytox™ XP series lubricants can develop an odor and a slight amber/pinkish color over time. The Krytox™ XP series has a three-year shelf life and recommended maximum operating temperature of 182 °C (360 °F). Testing has shown that these products retain their anti-rust and anti-wear properties, and perform well past the end of the recommended three-year shelf life. Keep product sealed and store in a cool, dry place.

For product information, industry applications, technical assistance, or global distributor contacts, visit krytox.com or within the U.S. and Canada, call 1-844-773-CHEM/2436 or outside of the U.S., call 1-302-773-1000.

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