DuPont™ Krytox® XP Lubricants with Soluble Additives

PRODUCT INFORMATION

DuPont™ Krytox® XP lubricants are formulated using patented soluble additives. Typical perfluoropolyether (PFPE) greases use solid additives for antirust, antiwear, 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® XP lubricant 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 anticorrosion 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.

Typical Properties

Oil	**XP 1A0**	**XP 1A1**	**XP 1A2**	**XP 1A3**	**XP 1A4**	**XP 1A5**	**XP 1A6**	**XP 1A7**
Grease	**XP 2A0**	**XP 2A1**	**XP 2A2**	**XP 2A3**	**XP 2A4**	**XP 2A5**	**XP 2A6**	**XP 2A7**
ISO Grade of Base Oil	5	7	15	32	68	150	220	460
Estimated Useful Temperature Range, °C (°F)	<–70 to 66 (<–94 to 150)	<–70 to104 (<–94 to 220)	–63 to 132 (–81 to 270)	–60 to 154 (–76 to 310)	–51 to 179 (–60 to 355)	–36 to 204 (–33 to 400)	–36 to 260 (–33 to 500)	–30 to 288 (–22 to 550)
Oil Viscosity, cSt								
20 °C (68 °F)	7	16	36	80	180	550	810	1600
40 °C (104 °F)	4	8	15	30	60	160	240	440
100 °C (212 °F)	—	2	3	5	9	18	25	42
Oil Viscosity Index	—	—	59	121	124	134	134	155
Base Oil Pour Point, °C (°F)	<–70 (<–94)	<–70 (<–94)	–63 (–81)	–60 (–76)	–51 (–60)	–36 (–33)	–36 (–33)	–30 (–22)

Krytox® XP lubricants are high-quality, ultra-high-performance antifriction and antirust lubricants. Formulated with synthetic perfluoropolyether fluids, soluble additives, and the most efficient polytetrafluoroethylene thickeners available, these lubricants exceed the performance requirements of most demanding applications.

XP lubricants will hold up under tremendous load conditions, preventing metal-to-metal contact and thereby reducing wear. The long-term antirust 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.

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While DuPont™ Krytox® oils are inert and nonreactive to all elastomers, plastics, and metals, the soluble additives in the XP lubricants 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 DuPont™ Teflon®, DuPont™ Kalrez®, DuPont™ Viton®, 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 the improved performance.

4 Ball Wear tests on oil with the additive compared to oil with no additive were run according to ASTM D4172 at 1200 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)
GPL 105	0.44
XP 1A5	0.29

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

4 Ball Wear tests on grease with the additive compared to grease with a typical solid additive were run according to ASTM D2266 at 1200 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)
GPL 225	0.42
XP 2A5	0.34

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.

4 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.

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

Test Grease	Grease Removed
XP 2A5	0.25%

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

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 3000 psi 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
GPL 105	3000	96
XP 1A5	3000	51

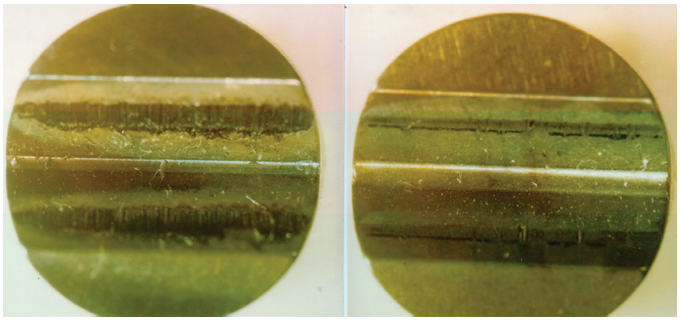
XP 1A5 oil showed a reduction of 47% in torque over the same viscosity oil with no additive.

Block on Ring tests were run per ASTM D2714. The test runs at 72 rpm, with a 100 lb normal load for 5000 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)
GPL 105	0.80
XP 1A5	0.70

XP 1A5 oil showed a reduction of 12% in wear over the same viscosity oil with no additives present.

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 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. The 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

Anticorrosion Protection

Performance of the soluble additives in the XP line is superior to additives that are commonly used for anticorrosion 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 were 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 that normally would be 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
GPL 105	Less than1 hr	Severe rusting
XP 1A5	None	No rusting visible

An additional test was run with corrosion coupons in 80 °C (176 °F) agitated hard water for 5 weeks with no rusting visible.

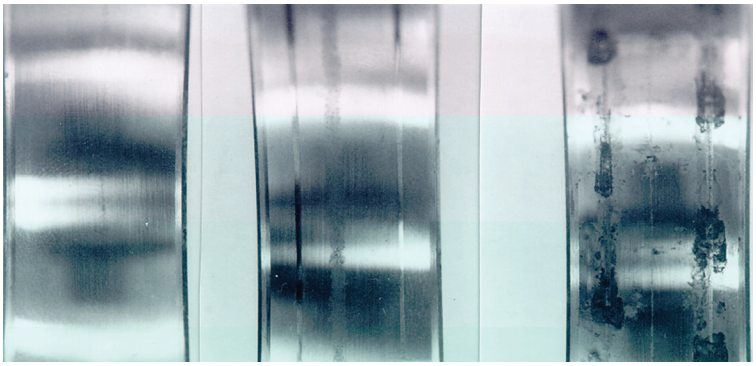
Bearing corrosion prevention performance of grease with the soluble additive was tested against a PFPE grease with no additives and against a PFPE grease with standard anticorrosion additives using the IP-220 (EMCOR) test method. This method uses a double row self-aligning bearing that is packed with grease. It is a dynamic test that runs partially submerged in water for 8 hr, sits for 16 hr, is run again for 8 hr, sits for 16 hr, is run again for 8 hr, and is 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
GPL 205 (No additives)	5 (More than 10%)
GPL 225 (Standard antirust additive)	3 (1–5%)
XP 2A5	0 (No corrosion)

Corrosion prevention was also tested by ASTM D117, salt spray test. A polished steel test panel that was coated with a 4 mil coating of XP 2A5 grease and exposed to a 5% salt solution at 203 °C (95 °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 2 days. The XP 2A6 grease passed with no rusting.

The bearing race on the left clearly shows there is no corrosion when the 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

The 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 XP 1A5 oil after 168 hr at 122 °C (250 °F):

Evaporation loss	1%
Increase in viscosity	1.7%

Change in weight of metals, mg/cm^2:

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

Elastomer Compatibility

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

DuPont™ Mylar® and DuPont™ Teflon® have been tested with no damage, and additional elastomers are currently being tested for compatibility with the additives. DuPont™ Kalrez® shows 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	GPL 105 Oil	XP 1A5 Oil
DuPont™ Viton®	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	100 °C (212 °F) 175 °C (347 °F)	–2.24 –2.92	–1.55 –3.06

DuPont Performance Lubricants

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For more information or for technical assistance, please call 1-800-424-7502 or contact us at krytox@usa.dupont.com.

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