Krytox® Performance Lubricants

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Krytox
Oxygen Compatibility

Krytox grease and oil Lubrication use in Oxygen systems

Krytox greases and oils have been used in liquid and gaseous oxygen systems for many years because of the inherent safety of the products. These products do not react with oxygen and are not flammable so they are the safest materials for use as lubricants in any type of oxygen system. Because they are also excellent lubricants, they can increase the life of the equipment they lubricate while improving safety. In addition to being non-reactive towards oxygen, they are also safe for use with other oxidizing chemicals such as chlorine and do not have adverse safety issues so the people using it are also protected.

There are Krytox grease and oil grades to meet every lubricating requirement that oxygen and compressed gas users have. Because of the range of temperatures and speeds of bearings and the types of equipment needing lubrication from valves to pumps to motors to gearboxes there is not one single product that can do everything.

Knowledge of Krytox products and their place in the oxygen industry is relatively well known by major manufacturers and users but many downstream users are unfamiliar with it and sometimes use other products. There are many individual users who are aware of the safety and performance of Krytox but there are others who use hydrocarbon, PAO or phosphate ester based lubricants and risk fires and explosions. They do this because of misinformation or fear of change.

NASA and the aerospace industry have used Krytox as their lubricant of choice for oxygen systems since the 1960's. However, there are only a few aerospace grades of grease and oil that are commonly used in these high tech applications. There is a much wider range of oils and greases and additives available to solve problems now than anytime in the past.

Because some of these common military / aerospace greases have been improperly used in some applications, many users have heard of poor performance by oxygen compatible lubricants. While the lubricants were safe for use in oxygen, too high of a base oil viscosity or grease consistency or the lack of grease additives needed for the application caused bearing failure to occur.

Application Information

All pumps and valves can be lubricated with Krytox. Some of the many pump models that have been lubricated include Cryostar, Cryomec, Estritio, Cosmodyne, APD. We recommend the use of an anticorrosion additive in greases in pump bearings. Product series to use would include the 283 series greases, GPL 22X series greases and XP 2AX series greases. XP 1AX series oils can be used where oil lubrication is needed. NRT 8990 was formulated specifically for pump bearing lubrication.

For valves we recommend the use of greases and oils with no additives. Products would include the 143 series oils, the GPL 10X series oils, the 240 series greases and the 20X series greases. Any of the NRT products can be used.

Vacuum pump used in oxygen service have used the Krytox VPF 1500 series oils for many years. NRT 8805 is a newer product for this application.

Lubrication of oxygen systems requires the same lubrication fundamentals that any other lubrication application needs. The viscosity of the lubricant must be adequate to carry the load and the additives in the grease must be capable of preventing wear and rusting. In addition, the grease must be safe for use in oxygen.

There are several things about oxygen systems that make them unique and require some additional attention. Many of the systems handle liquid oxygen, which is at a temperature of –180°C. This cold temperature will travel through the equipment, making the bearing or seal much colder than normal on startup. Because of this, a lubricant of lower viscosity and with a softer consistency is often needed to allow startup. This will keep the bearing from skidding and causing wear. The temperature cycling and freezing of the equipment will cause ice to form and this increased moisture can cause rusting and premature failure if anti-rust additives are not present in the grease.

In addition, the bearings should not be overfilled with grease as this makes them stiffer and harder to turn which can caused increased wear. Also, many of the pumps used in oxygen service are run for short periods with many start-stop cycles. We have found that use of Krytox grades such as NRT 8990, GPL 223 grade 1, 283 AA grade 1, or XP2A3 grade 1 seems to work well. Use of a fill of 35% with relubrication every 6 months and possibly longer for pumps that do not run all of the time is recommended.

As with all applications, the equipment should be cleaned of all hydrocarbon lubricants and preservatives.

Product Approvals

Krytox Products have passed many different oxygen tests and have been used for many years. Some of the more recent approvals for some of the products are listed below along with some of the older information.

BAM in Germany has tested many of the Krytox products in recent years and Krytox is listed in "Liste Der nichtmetallischen Materials, die von der (BAM) zum Eisatz in

Anlageteilen Fur Sauerstoff als geeignet befunden worden sind." (List of non-metal materials, which have been reported as suited for putting in equipment for oxygen by the BAM).

NRT products have been certified for oxygen service by BAM in 2008 with the following ratings: **NRT 8908** = 350 bar, **NRT 8950** = 180 bar, **NRT 8805** = 130 bar, **NRT 8990** = 80 bar, **NRT 8906A** = 80 bar, **NRT 8900** = 70 bar, **NRT 8904** = 70 bar, **NRT 8906** = 70 bar, **NRT PLSS** = 60 bar. (all at 60°C)

In 1998,
Krytox 1625 oil was tested and achieved a rating of 130 bar at 60°C.
Krytox 16256 oil was tested and achieved as rating of 110 bar at 60°C.

In 1995,
Krytox 143 AZ oil was tested and achieved a rating of 120 bar at 60°C.

In 1994,
Krytox GPL 226 grease was tested and had an ignition temperature of 467° C at a pressure of 250 bar of oxygen. In addition, it achieved the following ratings:

110 bar up to 60° C.
100 bar up to 150° C.
80 bar up to 200° C.
40 bar up to 250° C.

In 1990, **Krytox 1514** oil had an ignition temperature of 449°C and 1525 oil had an ignition temperature of 448° C.

In 1975, the results for **143AC oil** were 120 bar at 60°C and **240AC grease** was 110 bar at 60° C.

Krytox **240 AZ, 240 AB, 240 AC** have been used for many years in military and aerospace applications and meet the oxygen compatibility requirements of MIL- PRF-27617.

The **BOC** Technical Center in New Jersey tested **GPL 225** and **240AC** greases in 1997 using the BS 3N 100 spontaneous ignition test and LOX impact test. Both greases passed and exhibited an SIT greater than 400° C and passed the LOX impact test at impact energy 122 joules. On the basis of British standards guidelines, the greases are considered suitable for GOX at pressures up to 34.6 Mpa, provided that the maximum working temperature is 90° C and / or in LOX up to 4 Mpa. (test # 97021, #97022, #97016, #97017)

Air Liquide Centre de Technologie et d'Expertises, in France in 1999 tested **GPL 226** grease using ISO 11114-3 and EN 1797-1 standards (report #99/JPS 08) – No autoignition up to 500° C at 121 bar pressure and a second batch of **GPL 226** by EN 1797-1 (report # 99/JPS 253) – passed an impact test with 20 impacts at 100 joules.
Krytox 1506 oil (report # 99/JPS 09) and **Krytox 1525 oil** (report # 99/JPS 010) were tested according to ISO 11114-3 and EN 1797-1 standards. **Krytox 283AC** grease (report #

99/JPS 07) was tested using ISO 11114-3 and EN 1797-1 standards.) – No autoignition up to 500° C at 121 bar pressure

Air Liquide Electronics Chemicals & Services in Texas issued a new specification, number ALC4200110, for Krytox **GPL 225** grease in 1999.

BOC gases Australia is using Krytox products in pumps motors and valves and as a thread sealant in many applications. They have received a recommendation to use a variety of Krytox oils and greases based on the temperature of the application. Oils include Krytox **GPL 100, GPL 103, GPL 104, 143AZ, 143 AB, VPF 1506 and VPF 1525**. Greases for cold applications include Krytox **283AA** (NLGI grade 1 penetration) **or Krytox GPL 223** (NLGI grade 1 penetration). For higher temperatures and loads they use **Krytox 283AA** grease, **Krytox 223 grease, Krytox 283AC greases or Krytox GPL 226 grease**. They also recommend Krytox **240AB or 240AC** for thread sealing.

In 1995, **NASA** , Materials Science Division, Failure Analysis and Physical Testing Branch Kennedy Space Center, Florida, (REPORT 95-2T0006) retested **Krytox 240 AC grease** against the following standards**:**

NHB 8060.1C, Tests 13A, 13B, and 15
ASTM G72
NASA-JSC-SP-R-0022A
White Sands Test Facility Report 95-28814

Results:

The standard NHB 8060.1C Tests 13A and 13B were used to evaluate the Krytox **240AC** compatibility with liquid and gaseous oxygen, respectively.

The nitrogen tetroxide, hydrazine, monomethylhydrazine, and gaseous ammonia compatibilities were determined using NHB 8060.1C, Test 15.

The autoignition temperature was determined using ASTM G 72 and the outgassing characteristics were determined using NASA-JSC-SP-R-0022A.

The Krytox **240AC** exhibited no reactions in 20 drops in liquid oxygen at the 98 J (72 ft-lbs) energy level or in gaseous oxygen at 68.9 MPa (10,000 psia) and impacted at the 98 J (72 ft-lbs) energy level.

The Krytox **240AC** exhibited no reactivity with nitrogen tetroxide, hydrazine, monomethylhydrazine, or ammonia.

The autoignition temperature was determined to be 431°C, which satisfactorily agrees with previous test data. Outgassing characteristics were found to be very similar to data previously determined.

In 1994, **GENERAL DYNAMICS**, Space Systems Division performed Liquid Oxygen impact sensitivity tests on two samples of **Krytox GPL 206 grease**. The tests were run at an energy level of 11 Kg-m according to MSFC 106B.

There were zero detonations for 20 drop tests on each sample. Both samples conform to the requirements of the specification.

IN 1987, **South Bank Polytechnic**, London England, performed high pressure bomb tests on Krytox **GPL105 oil and GPL205 grease**. Tests were performed at 200 bar (2960PSI) oxygen pressure with no ignitions. Autoignition did not occur up to 500° C.

In 1987, **BOC** in England, tested **GPL 105 oil and GPL 205 grease** in LOX and GOX and had no ignition at 122 joules of energy and tested up to 400° C with no autoignition. They rated the products up to 345 bar at a temperature of 90°C in oxygen.

The following data has been in the Krytox literature for many years.

Oxygen compatibility of Krytox Lubricants

Test Type	Temperature, °C (°F)	Oxygen Pressure, Mpa (psi)	Impact Energy, Joules (ft-lb)	Test Result
Ignition in gaseous oxygen (a)	400 (752)	13 (1,886)		No ignition
Pressure drop in gaseous oxygen bomb (b)	99 (210)	0.7 (100)		No pressure drop after 600 hr
Mechanical impact in liquid oxygen	Ambient		98 (72)	No reaction in 20 trials (c,d,e)
Mechanical impact in liquid oxygen	Ambient		122 (90)	No reaction in 10 trials (a)
Mechanical impact in liquid oxygen	Ambient		736 (543)	No reaction in multiple trials (f)

a British Specification 3N100
b American Society for Testing and Materials, D-942
c Marshall Space Flight Center Specification 106B
d National Aeronautics and Space Administration Handbook, 8060.1B, Test 13, Part 1
e American Society for Testing and Materials, D-2512
f West German Federal Institute for Materials Testing (BAM), 8104-411

If you have any questions, please contact me on (302) 695-8338, by fax on 302-695-8860 or on E-mail at gregory.a.bell@usa.dupont.com.

Respectfully Submitted,

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