



AEROSPACE INFORMATION REPORT

AIR4071™**REV. A**

Issued 1997-10
Revised 2010-11
Reaffirmed 2020-07

Superseding AIR4071

Lubricants for Oxygen Use

RATIONALE

AIR4071A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Scope

This SAE Aerospace Information Report (AIR) describes two classes of lubricants which, when properly applied, can be used in oxygen systems and components.

1.2 Product Classification

Lubricants covered by this document are classified as follows:

Class I Fluids and greases

Class II Solids and dry films

1.3 Field of Application

Molecular oxygen is an aggressive oxidizer, which will support and highly intensify combustion, which is why contact with conventional lubricants must be avoided. Only special sliding agents, tested under standardized conditions / materials and approved by certified Agencies, can safely handle their jobs in valves, fittings or systems that carry oxygen.

The major requirement established is that lubricants must be primarily non-reactive, in all expected use conditions, to gaseous oxygen (GOX) and – if applied – to liquid oxygen (LOX). The emphasis on oxygen compatibility confines the choice of the components making up the formulation to non-reactive fluids, thickeners, powders and binders. These are typified by the fully fluorinated fluids - polyperfluoroalkylethers and polytetrafluoroethylene (PTFE), fluorinated ethylenepropylene (FEP) and by saturated hydrogen-free chlorofluorocarbons.

1.3.1 In selecting lubricants for oxygen systems, not only oxygen compatibility has to be considered but also their toxicity property. A toxic or just skin irritating chemical, even if it is oxygen compatible, should not be used in oxygen systems.

1.3.2 Oxygen compatible lubricants are safer in oxygen systems only in the sense that the energy required to initiate a reaction is higher than that of conventional materials. Under appropriate conditions, all such materials are combustible in oxygen.

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- 1.3.3 Prior to application of any lubricant, all components which come in contact with oxygen must be cleaned for oxygen service and thoroughly dried.
- 1.3.4 Fluids and greases will not function as lubricants at LOX temperatures -183 °C (-297 °F). Only solid or dry film lubricants can be used at these temperatures. To ensure maximum safety, contact the application engineers of the manufacturer.
- 1.3.5 Fluoro and chloro-organic compounds are capable of reacting with aluminum and magnesium, even in the absence of oxygen, when the metals are subjected to conditions of high shear or galling, as is the case with pipe threads.
- 1.3.6 Bonded solid lubricants do not provide corrosion resistance. The metal substrate must be protected or be a corrosion-resistant material prior to the application of the solid film.
- 1.3.7 Before use, check the product information leaflet, the data sheet and the materials safety data sheet to check the compatibility between the lubricant and the metal piping and any possible surrounding fluids.
- 1.3.8 If the lubricant should be used in connecting fittings/hose couplings (pipes, valves etc.), inform about the sealing effects. Read the data sheet and decide whether the lubricant meets your requirements.
- 1.3.9 If the lubricant should be used in connecting fittings in contact with other sealing materials (NBR, EPDM, FPM or PTFE), inform about the compatibility with those materials.

2. REFERENCES

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP1176 Oxygen System and Component Cleaning and Packaging

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM G 72 Standard Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High Pressure Oxygen-Enriched Environment

2.3 U.S. Government Publications

Available from Document Automation and Production Services (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, [http://assist.daps.dla.mil/quicksearch/..](http://assist.daps.dla.mil/quicksearch/)

MIL-PRF-27617 Grease, Aircraft and Instrument, Fuel and Oxidizer Resistant

MIL-PRF-81329 Lubricant, Solid Film, Extreme Environment, NATO Code Number S-1737, Metric

SAE AMS-M-7866 Molybdenum Disulfide Technical, Lubrication Guide

A-A-58092 Tape, Anti-Seize, Polytetrafluoroethylene

NAEG Misc. 92-0354 Compatibility of Materials with Oxygen

NATO AEP-15C Lubricants for use in Oxygen Systems with Oxygen Rich Environments

NATO STANAG No. 3976

2.4 Other Publications

Solid Lubrication Technology - Mahlon E. Cambell Midwest Research Institute, Kansas City, Missouri

Du Pont Technical Bulletin G-6 Krytox® Fluorinated Greases

Du Pont Technical Bulletin L-6 Krytox® 143 Fluorinated Oils

Burman-Castrol, Inc. Technical Bulletin Perfluorinated Greases

Klüber Lubrication, Technical Information, www.klueber.com

CRC – Handbook of Lubrication and Tribology, E. Richard Booser, 1994

3. TECHNICAL REQUIREMENTS

3.1 Selection of Lubricants

Lubricants, when needed, must be carefully selected for safe operation of equipment in oxygen enriched environments. Lubricants should be selected through qualification tests. The qualification tests should be more severe than the conditions expected in actual use. Use only lubricants which have been qualified and batch/lot tested for oxygen service and use them sparingly.

NOTE: The limits of temperature, pressure and pressure rise rate for their intended application must be specified and observed.

The use of Class I lubricants (fluids and greases) that see direct oxygen service at pressures in excess of 500 psig (= 35 bar) is not recommended. Age controlled lubricants must not be used after their shelf life has expired.

Check the manufacturers certification, like ISO 9000ff, ISO 14001, ISO 21469 or OHSAS 18001. These types of quality-certificate stand for steady good products.

3.2 Description of Lubricants

3.2.1 Fluids and Greases

3.2.1.1 Specification MIL-PRF-27617 covers five types of grease. Separation of types is based primarily on the operating temperature of each. The definition of types is as follows:

Type I-54 to 149 °C (-65 to 300 °F)
Type II-40 to 204 °C (-40 to 400 °F)
Type III-34 to 204 °C (-30 to 400 °F)
Type IV-73 to 204 °C (-100 to 400 °F)
Type V-73 to 232 °C (-100 to 450 °F)

Manufacturer's designations for the various types are as noted in Military Qualified Products List, QPL-27617.

NOTE: Check the latest issue of the above document to ensure current listing of qualified suppliers.

3.2.1.1.1 Krytox® (E.I. du Pont Co.) 240 series fluorinated greases are straight greases without additives. They are insoluble in all common solvents including aliphatic hydrocarbons, aromatic hydrocarbons, alcohols, ketones, chlorinated hydrocarbons and water. One solvent which will gradually cause disintegration of the grease structure is trichlorotrifluoroethane. In general, Krytox® 240 greases are not dissolved by highly chlorinated solvents but show some solubility in highly fluorinated liquids. These greases are suggested for use as lubricants for "O" rings, valves and other fittings used in gaseous oxygen systems.

- 3.2.1.1.2 Fomblin Y-VAC-3 (Montedison, USA, Inc.) is a perfluorinated polyether fluid, chemically similar to Krytox®. This grease meets the type III requirement of MIL-PRF 27617.
- 3.2.1.1.3 Tribolube (Aerospace Lubricants, Inc.) is a perfluorinated ether base fluid meeting MIL-PRF-27617 requirements for Type I, II, and Type III greases. They can be used at temperatures ranging from -42.7 to 204.4 °C (-45 to 400 °F).
- 3.2.1.1.4 Braycote® (Burmah-Castrol Inc.) perfluorinated polyether greases are based upon perfluoroalkylether base oils and blended with tetrafluoroethylene thickeners.
- 3.2.1.1.5 Fluoroether (William F. Nye, Inc.) Fluoroether greases are based on fluorinated oils gelled with fluorocarbon polymers.
- 3.2.1.1.6 CHRISTO-LUBE® (Lubrication Technology Inc.) MCG 111 is a fluorinated polyether grease meeting MIL-PRF-27617 requirements for type I, II, and type III.
- 3.2.1.1.7 Krytox® (E.I. du Pont Co.) 143 oils are perfluorinated alkyl polyethers. Depolymerization of the oil starts at about 288 °C (550 °F) when certain metal oxides are present, and the decomposition products are highly toxic. The oils are of a low order of toxicity at room temperature and are not significantly irritating to the skin or eyes.
- 3.2.1.2 Other Lubricants than mentioned in MIL Spec
- 3.2.1.2.1 Oxigenoex FF250 (Klüber Lubrication), fluorinated polyether oil, PTFE, silicate. The oil is of a low order of toxicity and is not significantly irritating to the skin or eyes.
- 3.2.1.2.2 Oxigenoex FF450 (Klüber Lubrication), fluorinated polyether oil
- 3.2.1.2.3 Oxigenoex S4 (Klüber Lubrication), methyl silicone oil, PTFE, silicate. The oil is of a low order of toxicity and is not significantly irritating to the skin or eyes.
- 3.2.1.2.4 Barrierta L55/3 OX (Klüber Lubrication), PFPE, PTFE
- 3.2.1.2.5 Gleitmo 595 (Fuchs Lubritech GmbH), white paste for high pressure and LOX, perfluorinated alkyl-polyether
- 3.2.2 Solids and Dry Films
- 3.2.2.1 A solid lubricant can be defined as a material that provides lubrication to two relatively moving surfaces under dry conditions. The most generally used solid lubricants are graphite, molybdenum disulfide, and polytetrafluoroethylene.
- MIL-L-81329 covers one grade of a solid film lubricant for use at temperatures ranging from -185 to 400 °C (-301 to 752 °F).
- 3.2.2.2 Molyube N: Molyube N is an inorganic, molybdenum disulfide, dry film lubricant. It is a LOX insensitive coating. All surfaces should be thoroughly degreased before applying the coating which can be air-dried or baked. This lubricant meets all the requirements of MIL-M-7866.
- 3.2.2.3 Molyube Spray: Molyube spray contains molybdenum disulfide powder meeting the specification of MIL-M-7866.
- 3.2.2.4 Molybdenum Disulfide: It has been found that molybdenum disulfide oxidizes to molybdenum trioxide, which acts as an abrasive at 150 °C (302 °F) in oxygen and 398.9 °C (750 °F) in air. This oxide reduces the ability of the solid lubricant to protect the moving surfaces.