BAM
Bundesanstalt für Materialforschung und -prüfung

Report

on Testing Nonmetallic Material for Reactivity with Oxygen

Reference Number	2-463/2012 E
Copy	1st Copy of 2 Copies
Customer	Rich. Klinger Dichtungstechnik GmbH & Co KG Am Kanal 8 - 10 2352 Gumpoldskirchen Österreich
Order Date	February 2, 2012
Reference	Order-No.: Eb
Receipt of Order	February 10, 2012
Test Samples	Klingersil® C-4430 plus gasket material for use in flanged connections in piping, valves and fittings or other components for gaseous oxygen service. BAM-Order-No.: 2.1/50 977
Receipt of Samples	February 8, 2012
Test Date	May 4, 2012 to October 23, 2012
Test Location	BAM - Working Group "Safe Handling of Oxygen"; building 41, room 073
Test Procedure or Requirement According to	DIN EN 1797: 2002-02 „Cryogenic Vessels - Gas/Material Compatibility" ISO 21010: 2004-07 „Cryogenic Vessels - Gas/Material Compatibility" Annex of technical bulletin M 034-1 (BGI 617-1) "List of nonmetallic materials compatible with oxygen by BAM Federal Institute for Material Research and Testing.", by Berufsgenossenschaft Rohstoffe und chemische Industrie, Edition: September 2011; Technical rule BGR 500 „Betreiben von Arbeitsmitteln" part 2, chapter 2.32 „Betreiben von Sauerstoffanlagen", paragraph 3.17 „Lubricants and sealing materials", Edition: April 2008.

All pressures of this report are excess pressures.
This test report consists of page 1 to 3 and annex 1 to 2.

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In case a German version of the test report is available, exclusively the German version is binding.

TEST REPORT

1 Documents and Test Samples

The following documents and samples were submitted to BAM:

1 Test Application
1 Material Data Sheet
10 Disks Klingersil® C-4430 plus
Diameter: 140 mm; Thickness: 2 mm
One side "red-brown" the other one "white"

2 Test Methods

A determination of the autogenous ignition temperature (AIT) and an investigation of the aging resistance in high pressure were not necessary as the material is not designed for use at temperatures greater than 60 °C.

A flange test were carried out at 60 °C and 100 bar for evaluation the compatibility of the material for use as a gasket material in flanged connections in piping, valves and fittings or other components for gaseous oxygen service.

The compatibility of the material with liquid oxygen was tested by its reactivity with liquid oxygen on mechanical impact.

3 Results

3.1 Flange Test

The test method is described in annex 1.

Results:

Number of Tests	Oxygen Pressure [bar]	Temperature [°C]	Notes
1	60	100	Only those parts of the gasket burn that project into the pipe. The flange connection remains gas-tight.
2	60	100	Same behavior as in test no.1
3	60	100	Same behavior as in test no.1
4	60	100	Same behavior as in test no.1
5	60	100	Same behavior as in test no.1

It was observed, that in five tests at 100 bar and 60 °C the five was neither transmitted to the steel nor to the gasket between the flanges. Only those parts of the gasket was burned, that project into the pipe.

3.2 Reactivity with Liquid Oxygen on Mechanical Impact

The test method is described in annex 2.

Results:

Test No.	Drop Heights [m]	Impact Energy [Nm]	Reaction
1	0.67	500	ignition on 1. impact
2	0.17	125	ignition on 1. impact

Already in the first test, at drop heights of 0.67 m and 0.17 m of the falling weight (impact energy 500 Nm and 125 Nm) a severe reaction of the test sample with liquid oxygen occurred.

4 Summary and Evaluation

On basis of the test result of the flange testing, there are no objections with regard to technical safety to use the gasket material Klingersil® C-4430 plus in flange connections made of copper, copper alloys or steel at following conditions:

Maximum Temperature	Maximum Oxygen Pressure
60 °C	100 bar

This applies to flat faced flanges, male/female flanges, and flanges with tongue and groove.

According to the BAM-Standard "Testing for Reactivity with Liquid Oxygen on Mechanical Impact", described in annex 2, the gasket material Klingersil® C-4430 plus is not suitable for liquid oxygen service.

5 Comments

The test results refer exclusively to the batch of the tested material.

Products on the market that contain a reference to BAM testing shall be marked accordingly. It shall be evident that only a sample of a batch has been tested and evaluated for oxygen compatibility. The reference shall not produce a presumption of conformity that monitoring of the production on a regular basis is being performed by BAM.

It shall be clear that the product may only be used for gaseous oxygen service. The maximum safe oxygen pressure of the product and its maximum use temperature as well as other restrictions in use shall be given.

BAM Federal Institute for Materials Research and Testing
12200 Berlin, March 27, 2013

Division 2.1
"Gases, Gas Plants"

on behalf of

Dipl.-Ing. P. Hartwig
Study Director "Safe Handling of Oxygen"

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2nd Copy: BAM – Division 2.1 "Gases, Gas Plants"

Annex 1

Testing of Gaskets for Flanges in Oxygen Steel Pipings

The test apparatus mainly consists of two DN 65 PN 160 steel pipes, each approximately 2 m in length, with corresponding standard flanges welded to each pipe.

Both pipes are sealed using the gasket to be tested. In case of a gasket disk its inner diameter is chosen in such a way that it projects into the pipe. If a gasket tape is under test, both ends of the tape are allowed to project into the pipe. The test apparatus is then pressurized with oxygen up to the desired test pressure. The flange is heated by heating sleeves to the test temperature, at least 50 K lower than the ignition temperature of the gasket. An electrical filament ignites that part of the gasket projecting into the pipe. If the gasket is electrically conductive, such as spiral seals or graphite foils, a nonconductive primer capsule of organic material (PTFE, rubber) is used which acts on the seal.

The gasket's behavior after ignition is important for its evaluation. If the seal burns with such a hot flame that the fire is transmitted to the steel of the flange (in most case the test apparatus is destroyed), the seal is considered unsuitable from the beginning. If only those parts of the seal burn that project into the pipe and the fire is not transmitted to the flanges and if the seal does not burn between the flanges there are no objections with regard to technical safety to use the seal under the conditions tested. Such a positive result is to confirm in four additional tests. If, however, the flanged connection becomes un-tight during a test, e. g., because of softening or burning of the seal, the test has to be continued at a lower temperature and oxygen pressure until a positive test result is reached in five tests, as mentioned above.

Annex 2

Testing for Reactivity with Liquid Oxygen on Mechanical Impact

Approximately 0.5 g of the liquid or divided sample is placed into a sample cup (height = 10 mm; diameter = 30 mm), made of 0.01 mm copper foil. Liquid oxygen is poured into the cup over the sample which is then exposed to the mechanical impact of a plummet (mass = 76.5 kg). The drop height of the plummet can be varied. A steel anvil with a chrome/nickel steel plate supports the sample cup. The anvil, having a mass eight times of the plummet, is supported by four damping elements mounted on the steel frame of the test apparatus that rests on a concrete base.

A reaction of the sample with liquid oxygen is usually indicated by a flame and a more or less strong noise of an explosion. The impact energy, at which no reaction occurs, is determined in varying the drop height of the plummet. This result shall be confirmed in a series of ten consecutive tests under the same conditions. The tests are finished, if reactions can be observed at impact energies of 125 Nm or less (equivalent to a drop height of the plummet of 0.17 m or less). In this case, with regard to technical safety, the material is not suitable for liquid oxygen service.