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Report

on Testing a Gasket Material for Reactivity with Oxygen

Reference Number II-2124/2006 E

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1 Application

Customer Richard Klinger GmbH & Co. KG
Am Kanal 8 - 10
2352 GUMPOLDSKIRCHEN
ÖSTERREICH

Order Date July 26, 2006

Receipt of Order July 31, 2006

Test Samples Gasket KLINGER top-chem 2005 for use in flanged connections in gaseous oxygen piping at 100 bar and temperatures up to 200 °C and for liquid oxygen service.
BAM-Order No. II.1/ 48 614

Receipt of Samples July 13,2006

Test Date August 9,2006 to September 26, 2006

Test Location BAM - Working Group "Safe Handling of Oxygen"; building no. 41, room no. 073

Test Procedure According to DIN EN 1797: 2002-02
„Cryogenic Vessels - Gas/Material Comptibility"
Annex of pamphlet M 034-1 (BGI 617-1)
„Liste der nichtmetallischen Materialien die von der Bundesanstalt für Materialforschung und –prüfung (BAM) zum Einsatz in Anlageteilen für Sauerstoff als geeignet befunden worden sind."
to pamphlet M 034 „Sauerstoff" (BGI 617)
Berufsgenossenschaft der chemischen Industrie
Edition: October 2005;
according chapter 3.17 „Gleitmittel und Dichtwerkstoffe"
to rule BGR 500 „Betreiben von Arbeitsmitteln" part 2, chapter 2.32 „Betreiben von Sauerstoffanlagen",
Edition: March 2006

TESTREPORT

All pressures of the report are excess pressures.
This test report consists of page 1 to 5 and annex 1 to 4.

2 Documents and Test Samples

The following documents and samples were submitted to BAM:

1 test application
10 disks of KLINGER top-chem 2005
diameter 140 mm; thickness 2 mm
with imprint: KLINGER top-chem 2005
colour: auburn

3 Test Methods and Results

3.1 Autogenous Ignition Temperature (AIT)

The test method is described in annex 1.

Results:

Test No.	Oxygen pressure p_a [bar]	Oxygen pressure p_e [bar]	AIT [°C]
1	40	103	478
2	40	103	479
3	40	104	484
4	40	104	481
5	40	104	483

In five tests with an oxygen pressure of p_a = 40 bar, an AIT of 481 °C was determined with a standard deviation of ± 3 °C. The oxygen pressure p_e at ignition is approximately 104 bar.

3.2 Artificial Aging

The test method is described in annex 2.

Results:

Time [h]	Temperature [°C]	Oxygen Pressure [bar]	Mass change [%]
100	225	100	0

After aging of KLINGER top-chem 2005 at 100 bar oxygen pressure and 225 °C, the material was apparently unchanged. The mass of the test sample did not change.

3.2.1 AIT after Artificial Aging

The test method is described in annex 1.

Results:

Number of tests	Oxygen pressure p_a [bar]	Oxygen pressure p_e [bar]	AIT [°C]
1	40	104	484
2	40	104	483
3	40	103	481
4	40	103	487
5	40	105	484

In five tests with an oxygen pressure of p_a = 40 bar, an AIT of 484 °C was determined with a standard deviation of ± 2 °C. The oxygen pressure p_e at ignition is approximately 104 bar. This shows, that the AIT of the aged sample is unchanged compared to the AIT of the non-aged sample within the precision of measurement.

3.4 Flange Test

The test method is described in annex 3.

Results:

Number of tests	Oxygen pressure [bar]	Temperature [°C]	Notes
1	100	200	Only those parts of the gasket burn that project into the pipe.
2	100	200	same behavior as in test no. 1
3	100	200	same behavior as in test no. 1
4	100	200	same behavior as in test no. 1
5	100	200	same behavior as in test no. 1

At 100 bar oxygen pressure and 200 °C only those parts of the gasket burn that project into the pipe; the fire is neither transmitted to the steel nor does the gasket burn between the flanges. The flange remained gas-tight. Thereupon, the test was repeated four times at 100 bar and 200 °C. The same result was obtained as before.

3.5 Reactivity with Liquid Oxygen on Mechanical Impact

The test method is described in annex 4.

Results:

Test No.	Drop heights [m]	Impact energy [Nm]	Reaction
1	1,00	750	ignition on 1. impact
2	0,83	625	no reaction
3	0,83	625	no reaction

Test No.	Drop heights [m]	Impact energy [Nm]	Reaction
4	0,83	625	ignition on 3. impact
5	0,50	375	no reaction
6	0,50	375	no reaction
7	0,50	375	no reaction
8	0,50	375	no reaction
9	0,50	375	no reaction
10	0,50	375	no reaction
11	0,50	375	no reaction
12	0,50	375	no reaction
13	0,50	375	no reaction
14	0,50	375	no reaction

No reaction of the material KLINGER top-chem 2005 with liquid oxygen could be detected at drop heights of 0,50 m (Impact energy 375 Nm), in ten separate tests.

4 Evaluation

Generally, in evaluating nonmetallic materials for oxygen service, a safety margin of 100 °C between AIT and maximum operating temperature is being considered for safety reasons.

The tests have shown that the autogenous ignition temperature of the gasket material KLINGER top-chem 2005 is (481 ± 3) °C at 104 bar oxygen pressure. The standard deviation is ± 3 °C.

At a temperature of 200 °C and an oxygen pressure of 100 bar, the material proved to be sufficient aging resistant. The mass of the test sample did not change.

On basis of those test results and the results of the flange testing, there are no objections with regard to technical safety to use the gasket KLINGER top-chem 2005 in flange connections made of copper, copper alloys or steel at following conditions:

Maximum Oxygen Pressure	Maximum Temperature
up to 100 bar	up to 200 °C

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

According to the BAM-Standards "Testing for Reactivity with Liquid Oxygen on Mechanical Impact", described in annex 4, there are no objections with regard to technical safety to use the gasket KLINGER top-chem 2005 in components and apparatuses for liquid oxygen. In this case, a limitation to a particular pressure range is not necessary as compression of liquid oxygen causes no significant changes in concentration and therefore has no considerable influence on the reactivity of the gasket material.

5 Comments

This report expires at once, if the composition of the tested material is changed. This report expires on October 31, 2016, at the latest. A prolongation beyond this date is possible, if the manufacturer confirms in writing that the material has not changed since this evaluation.

Products that have been tested by us, and which are on the market, shall be marked according to our evaluation in the BAM test report. A label on a product saying that a BAM test has been performed and (or) citing our reference number, only, is not tolerable. The use of the product and its safe operating conditions must also be given.

It shall be clear that the product may be used for gaseous oxygen service and liquid 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.

Federal Institute for Materials Research and Testing (BAM)
12200 Berlin, October 26, 2006

Division II.1
"Gases, Gas Plants"

Dr. Chr. Binder
Head of Working Group

Working Group
"Safe Handling of Oxygen"

Dipl.-Ing. P. Hartwig
Engineer in Charge

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