Report

on Testing a Gasket Material for Reactivity with Oxygen

Bundesanstalt für Materialforschung und -prüfung

Reference Number	2-1963/2014 I E
Copy	1. Copy of 2 Copies
Customer	Triangle Fluid Controls 399 College Street E. Belleville, ON K8N 5S7 Canada
Order Date	July 18, 2014
Receipt of Order	August 12, 2014
Test Samples	Durlon® 9002, for use as a gasket material for gaseous oxygen service at temperatures up to 260 °C and 52 bar as well as for liquid oxygen service; BAM Order-No.: 2.1/52 244
Receipt of Samples	July 28, 2014
Test Date	August 21, 2014 to November 14, 2014
Test Location	BAM - Working Group "Safe Handling of Oxygen"; building no. 41, room no. 073 and no. 120
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 pamphlet 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: March 2014 TRGS 407 Technical Rules for Hazardous Substances "Tätigkeiten mit Gasen - Gefährdungsbeurteilung" chapter 3 "Informationsermittlung und Gefährdungsbeurteilung" and chapter 4 "Schutzmaßnahmen bei Tätigkeiten mit Gasen" Edition: June 2013

TEST REPORT

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

1 Documents and Test Samples

The following documents and samples were submitted to BAM:

1 Test Application
1 Material Data Sheet
(1 page, revision 2013-3)
1 Safety Data Sheet
(4 pages, date of issue: December 18, 2012)
15 Disks Durlon® 9002
Outer-Ø: 111 mm; Thickness: 3 mm
Color: Light blue

2 Test Methods

To evaluate the compatibility of Durlon® 9002, for use as a gasket material for gaseous oxygen service at temperatures up to 260 °C and 52 bar, a determination of the autogenous ignition temperature (AIT), an investigation of the aging resistance in high pressure oxygen and a flange test were carried out.

The compatibility of Durlon® 9002, with liquid oxygen was tested by its reactivity with liquid oxygen on mechanical impact.

3 Results

3.1 Autogenous Ignition Temperature (AIT)

As the maximum operating pressure of Durlon 9002, for use as a gasket material in 52 bar, the test was performed at a final oxygen pressure or approximately 52 bar. The test method is described in annex 1.

Results:

Test No.	Initial Oxygen Pressure p_I [bar]	Final Oxygen Pressure p_F [bar]	AIT [°C]
1	21	54	466
2	21	54	465
3	21	53	455
4	21	53	454
5	21	53	453

In five tests with an initial oxygen pressure of p_I = 21 bar, an AIT of 459 °C was determined with a standard deviation of ± 6 °C. The oxygen pressure p_F at ignition is approximately 53 bar.

3.2 Artificial Aging

In general, the aging test is carried out at the maximum operating pressure and at an elevated temperature, which is 25 °C above the maximum operating temperature. In this case, the aging test was carried out at 52 bar and at 285 °C. The test method is described in annex 2.

Results:

Time [h]	Temperature [°C]	Oxygen Pressure [bar]	Mass Change [%]
100	285	52	± 0

After aging of the test sample at 285 °C and 52 bar oxygen pressure, the test sample 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:

Test No.	Initial Oxygen Pressure p_I [bar]	Final Oxygen Pressure p_F [bar]	AIT [°C]
1	21	54	465
2	21	54	463
3	21	54	464
4	21	53	459
5	21	54	464

In five tests with an initial oxygen pressure of p_I = 21 bar, an AIT of 463 °C was determined with a standard deviation of ± 2 °C. The final oxygen pressure p_F at ignition is approximately 54 bar. This show, that the AIT of the aged sample is almost unchanged compared to the AIT of the non-aged sample within the precision of measurement.

3.3 Flange Test

According to the above-mentioned operating conditions of Durlon® 9002, for use as a gasket material the flange test was performed at 52 bar oxygen pressure and at a temperature of 260 °C. The test method is described in annex 3.

Results:

Test No.	Oxygen Pressure [bar]	Temperature [°C]	Notes
1	52	260	Only those parts of the gasket burn that project into the pipe. The flange remains gas-tight.
2	52	260	Same behavior as in test no. 1
3	52	260	Same behavior as in test no. 1
4	52	260	Same behavior as in test no. 1
5	52	260	Same behavior as in test no. 1

In five tests at 52 bar oxygen pressure and at a temperature of 260 °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 remains gas-tight.

3.4 Reactivity with Liquid Oxygen on Mechanical Impact

In general, a nonmetallic material is not compatible with liquid oxygen, if reactions occur at a drop height of 0.17 m (impact energy 125 Nm) or less. The test method is described in annex 4.

Results:

Test No.	Drop Height [m]	Impact Energy [Nm]	Reaction
1	1.00	750	severe
2	0.83	625	no reaction
3	0.83	625	severe
4	0.67	500	no reaction
5	0.67	500	severe
6	0.50	375	severe
7	0.33	250	no reaction
8	0.33	250	no reaction
9	0.33	250	no reaction
10	0.33	250	no reaction
11	0.33	250	severe
12	0.17	125	no reaction
13	0.17	125	no reaction
14	0.17	125	no reaction
15	0.17	125	no reaction
16	0.17	125	no reaction
17	0.17	125	no reaction
18	0.17	125	no reaction
19	0.17	125	no reaction
20	0.17	125	no reaction
21	0.17	125	no reaction

At a drop height of 0.17m (impact energy 125 Nm), in ten separate tests, no reaction of the test sample with liquid oxygen could be detected.

4 Summary and Evaluation

The tests have shown the autogenous ignition temperature of the gasket material Durlon® 9002, is 459 °C at 53 bar oxygen pressure. The standard deviation of the AIT is ±6° C.

At a temperature of 285 °C and an oxygen pressure of 52 bar, the material proved to be aging resistant. The mass of the test sample did not change. The tests have shown that the autogenous ignition temperature of the aged gasket material is 463 °C at 54 bar oxygen pressure. The standard deviation of the AIT is ±2 °C. This show, that the AIT of the aged sample is almost unchanged compared to the AIT of the non-aged sample within the precision of measurement.

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. As the maximum operating temperature is 260 °C, the gasket material Durlon® 9002 fulfills this criterion.

On a basis of the test results and the results of the flange test, there are no objections with regard to technical safety, to use Durlon® 9002 as a gasket material with a maximum thickness of 3 mm in flange connections made of copper, copper alloys or steel at following conditions:

Maximum Temperature [°C]	Maximum Oxygen Pressure [bar]
260	52

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

According to BAM-Standard "Testing for Reactivity with Liquid Oxygen on Mechanical Impact", described in annex 4, Durlon® 9002 meets the minimum requirements. Hence, there are no objections with regard to technical safety to use the material in valves and fittings or other components for liquid oxygen service. In this case, a limitation to a particular pressure range is not necessary as compression of liquid oxygen causes no significant change in concentration and therefore has no considerable influence on the reactivity of the material.

5 Comments

This evaluation is based exclusively on the test results of the gasket material Durlon 9002®, undisclosed batch number.

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 performed by BAM.

For safety reason, it is not justifiable to use our BAM reference number without additional information about the purpose of use and the maximum operating conditions.

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

BAM Federal Institute for Materials Research and Testing
12200 Berlin, November 21, 2014

Division 2.1
"Gases, Gas Plants"

On behalf of

Dr. Thomas Kasch

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