Bundesanstalt für Materialforschung und -prüfung

Report

on the Re-Check of a Flange Gasket Material for Oxygen Service

Reference Number	2-1479/2011 E
Copy	1st Copy of 2 Copies
Customer	Frenzelit-Werke GmbH Frankenhammer 7 95460 Bad Berneck
Order Date	June 14, 2011
Reference	EMP / BWI
Receipt of Order	June 20, 2011
Test Samples	Gasket material novaflon 500 for use in flanged connections in piping, valves and fittings or other components for gaseous oxygen at 200 °C and 30 bar; BAM-Order No.: 2.1/50 695
Receipt of Samples	June 20, 2011
Test Date	June 23, 2011 to July 28, 2011
Test Location	BAM - Working Group "Safe Handling of Oxygen"; building no. 41, room no. 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 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: August 2010; Rule BGR 500 "Betreiben von Arbeitsmitteln" part 2, chapter 2.32 "Betreiben von Sauerstoffanlagen", paragraph 3.17 "Lubricants and sealing materials", Edition: April 2008.

TEST REPORT

All pressures of this report are excess pressures.
This test report consists of page 1 to 4 and annex 1 to 2.

1 Documents and Test Samples

The following documents and samples were submitted to BAM:

1	Application
10	Disks Gasket Material Novaflon 500 Diameter 140 mm; Thickness 2 mm Colour: White

2 Testmethods

The gasket material was already tested by BAM for the first time in 2005, reference number II-1492/2005. This time, a re-check was carried out to evaluate the compatibility of the gasket material for gaseous oxygen service at temperatures up to 200 °C. For this purpose, a determination of the autogenous ignition temperature (AIT) and a flange test in high pressure oxygen were performed at the same final oxygen pressure as in 2005.

3 Results

3.1 Autogenous Ignition Temperature (AIT)

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	28	70	450
2	28	70	456
3	28	70	457
4	28	70	447
5	28	70	451

In five tests with an initial oxygen pressure of p_I = 28 bar, an AIT of 452 °C was determined with a standard deviation of ± 4 °C. The final oxygen pressure p_F at ignition is 70 bar.

3.2 Flange Test

The test method is described in annex 2.

Results:

Number of Tests	Oxygen Pressure [bar]	Temperature [°C]	Notes
1	30	200	Only those parts of the gasket burn that project into the pipe.
2	30	200	Only those parts of the gasket burn that project into the pipe.

In two tests at 30 bar oxygen pressure and 200 °C, only those parts of the gasket burned that project into the pipe; the fire was neither transmitted to the steel nor did the gasket burn between the flanges. The flange remained gas-tight.

4 Evaluation

The gasket material Novaflon 500 had been already tested for use in flanged connections in piping, valves and fittings or other components for gaseous oxygen at 200 °C and 30 bar and evaluated under the reference number II-1492/2005 in 2005.

The tests have shown that the autogenous ignition temperature of the gasket material novaflon 500 is 452 °C at 70 bar oxygen pressure. The standard deviation of the AIT is ± 4 °C. This shows, that the AIT of Novaflon 500 is significantly lower compared to the AIT of the material in 2005. Regarding technical safety, the decrease in AIT from 473 °C down to 452 °C can be neglected for the scheduled operating conditions.

On basis of the re-check results there are no objections with regard to technical safety to use the gasket material in flange connections made of copper, copper alloys or steel at following conditions:

Maximum Temperature	Maximum Oxygen Pressure
200 °C	30 bar

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

This evaluation does not cover the use of the material for liquid oxygen service. For this application, a particular test for reactivity with liquid oxygen needs to be carried out.

5 Comments

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 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, August 23, 2011

Division 2.1
"Gases, Gas Plants"

on behalf

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Working Group
"Safe Handling of Oxygen"

on behalf

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Copies:

1. Copy: Frenzelit-Werke GmbH
2. Copy: BAM – Working Group "Safe Handling of Oxygen"

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Annex 1

<u>Determination of the Autogenous Ignition Temperature in High Pressure Oxygen</u>

A mass of approximately 0.1 g to 0.5 g of the pasty or of the divided solid sample is placed into an autoclave (34 cm^3 in volume) with a chrome/nickel lining. Liquid samples are applied onto ceramic fiber.

The autoclave is pressurized to the desired pressure p_a at the beginning of the test A low-frequency heater inductively heats the autoclave in an almost linear way at a rate of 110 K/min. The temperature is monitored by means of a thermocouple at the position of the sample.

The pressure in the autoclave is measured by means of a pressure transducer. Pressure and temperature are recorded. During the test, as the temperature increases, the oxygen pressure increases within the autoclave. The ignition of the sample can be recognized by a sudden rise in temperature and pressure. The oxygen pressure on ignition p_e is calculated.

It is important to know the oxygen pressure p_e, as the autogenous ignition temperature of a material is a function of pressure. It may decrease as the oxygen pressure increases.

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Annex 2

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.