BAM
Bundesanstalt für Materialforschung und -prüfung

Report

on Testing a Spiral Wound Gasket Material for Reactivity with Oxygen

Reference Number	2-1447/2014 I E
Copy	1. Copy of 2 Copies
Customer	Amtec Messtechnischer Service GmbH Hoher Steg 13 74348 Lauffen
Order Date	June 12, 2014
Reference	PO 708287
Receipt of Order	June 13, 2014
Test Samples	Spiral wound gasket Flexitallic Class 600, undisclosed batch, for use in flanged connections in piping, valves and fittings or other components for gaseous oxygen service at pressures up to 35 bar and at temperatures up to 300 °C; BAM Order-No.: 2.1/52 151
Receipt of Samples	June 16, 2014
Test Date	July 9 to 29, 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 German Social Accident Insurance Institution for the raw materials and chemical industry, 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

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

TEST REPORT

1 Documents and Test Samples

The following documents and samples were submitted to BAM:

1 Test Application

5 Spiral wound gaskets Flexitallic Class 600, undisclosed batch
nonmetallic sealing material press-fitted between two metal rings
Outer-Ø: 150 mm, Inner-Ø: 121 mm, and
Outer-Ø: 112 mm, Inner-Ø: 81 mm,
Thickness: 4 mm

2 Test Methods

According to BAM's test procedure, only the nonmetallic sealing material of a spiral wound gasket is tested. Therefore, the press-fitted nonmetallic sealing material was removed from the two metal rings.

To evaluate the compatibility of nonmetallic sealing material, undisclosed batch, for gaseous oxygen service at pressures up to 35 bar and at temperatures up to 300 °C, a determination of the autogenous ignition temperature (AIT) at 35 bar and an investigation of the aging resistance at 35 bar oxygen pressure and at 325 °C were carried out.

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	13	35	> 500
2	13	35	> 500
3	13	35	> 500
4	13	36	> 500
5	13	35	> 500

Up to temperatures of 500 °C, no ignition of the sample could be detected in five tests with initial oxygen pressures of p_I = 13 bar. The final oxygen pressure p_F was approximately 35 bar.

3.2 Artificial Aging

The test method is described in annex 2.

Results:

Time [h]	Temperature [°C]	Oxygen Pressure [bar]	Mass Change [%]
100	325	35	- 0.8

After aging of the test sample at 35 bar oxygen pressure and 325 °C, the test sample was apparently unchanged. The sample lost 0.8 % in mass.

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	13	35	> 500
2	13	35	> 500
3	13	35	> 500
4	13	35	> 500
5	13	35	> 500

Up to temperatures of 500 °C, no ignition of the aged sample could be detected in five tests with initial oxygen pressures of p_I = 13 bar. The final oxygen pressure p_F was 35 bar. This shows, that, as the non-aged sample, also the aged sample did not ignite at temperatures up to 500 °C.

4 Summary and Evaluation

The tests have shown that no ignition of the non-aged and of the aged nonmetallic sealing material of the spiral wound gasket Flexitallic Class 600, undisclosed batch, could be detected up to temperatures of 500 °C.

At a temperature of 325 °C and an oxygen pressure of 35 bar, the nonmetallic sealing material of the spiral wound gasket Flexitallic Class 600, undisclosed batch, proved to be sufficient aging resistant. The sample lost 0.8 % in mass.

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 300 °C, the nonmetallic sealing material of the spiral wound gasket Flexitallic Class 600, undisclosed batch, fulfills this criterion.

On basis of the test results and the pre-condition that any oxygen pressure impacts in piping, valves and fittings or in other components for gaseous oxygen service could excluded and the same quality of the nonmetallic material will be used that has been tested, there are no objections with regard to technical safety, to use the spiral wound gasket Flexitallic Class 600, undisclosed batch, in flanged connections made of copper, copper alloys or carbon steel at following operating conditions:

Maximum Temperature [°C]	Maximum Oxygen Pressure [bar]
300	35

This applies to male/female flanges and flanges with tongue and groove. As the spiral wound gasket Flexitallic Class 600, undisclosed batch, has an inner retaining metal ring, it may also be used in flat faced flanges.

This evaluation does not cover the use of the spiral wound gasket Flexitallic Class 600, undisclosed batch, for liquid oxygen service. For this case, a particular test for reactivity with liquid oxygen needs to be carried out.

5 Comments

The test results refer exclusively to the batch of the nonmetallic material of the spiral wound gasket Flexitallic Class 600.

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, August 28, 2014

Division 2.1
"Gases, Gas Plants"

On behalf of

Dr. Thomas Kasch

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Annex 1

Determination of the Autogenous Ignition Temperature in High Pressure Oxygen

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.

Annex 2

Testing for Aging Resistance in High Pressure Oxygen

A sample with known mass is exposed to high-pressure oxygen at elevated temperature in an autoclave for 100 hours. The temperature, at which the sample is aged, is at least 100 °C lower than the autogenous ignition temperature of the sample.

This test shows whether the sample gradually reacts with oxygen or whether it undergoes other visible changes. If there is no change in appearance, in mass, and in the autogenous ignition temperature of the material, it is considered aging resistant.