BAM
Bundesanstalt für
Materialforschung
und -prüfung

12200 Berlin, Germany
P: +49 30 8104-0
F: +49 30 8104-7 2222

TEST REPORT

on Testing a Nonmetallic Material for Reactivity with Oxygen

Reference Number	18025405E
Our Reference	02-3523
Copy	1. copy of 2 copies
Customer	Loxeal s.r.l. via Marconato 2 20811 Cesano Maderno (MI) Italy
Date of Request	June 15, 2018
Your Reference	- - -
Receipt of Signed Contract	July 10, 2018
Test Samples	Adhesive thread sealant LOXEAL 58-11, batch 815111
Receipt of Samples	June 26, 2018
Test Date	July 17 to 18, 2018
Test Location	BAM – Division 2.1 „Gases, Gas Plants"; building no. 41
Test Procedure or Requirement according to (in the current version)	DIN EN 1797 und ISO 21010 "Cryogenic Vessels - Gas/Material Compatibility"; Annex of code of practice M 034-1 (BGI 617-1) "List of nonmetallic materials compatible with oxygen", by German Social Accident Insurance Institution for the raw materials and chemical industry; TRGS 407 Technical Rules for Hazardous Substances "Tätigkeiten mit Gasen - Gefährdungsbeurteilung" chapter 3 "Informationsermittlung und Gefährdungsbeurteilung" and chapter 4 "Schutzmaßnahmen bei Tätigkeiten mit Gasen"

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

1 Documents and Test Samples

The following documents and samples were submitted to BAM:

1 Test application
Safety-related investigation on the adhesive thread sealant Loxeal 58-11, batch 815111, for gaseous oxygen service at temperatures up to 60 °C, the adhesive LOXEAL 58-11 shall be tested in liquid and in cured condition.

1 Safety Data Sheet Loxeal 58-11
(6 pages, Loxeal s.r.l., revision: 7, date of issue: 13/03/2018)

1 Dispenser with 100 ml fill quantity of Loxeal 58-11, batch 815111,
Color: Yellow

2 Applied Test Methods

The adhesive thread sealant Loxeal 58-11, batch 815111, shall be used for gaseous oxygen service at temperatures up to 60 °C. In practical applications it cannot be guaranteed that the product will be always fully cured. Therefore, for technical safety reasons, the liquid and the cured product were tested.

The following test methods were applied:

2.1 Testing for Ignition Sensitivity to Gaseous Oxygen Impacts

Generally, this test method is required if rapid oxygen pressure changes on the material cannot be safely excluded in usage.

3 Preparation of Samples

According to BAM´s test procedure, liquids are mixed with inert ceramic fibers. The mixing ratio is varied to achieve a creamy consistency. In this case, the mixing ratio was 1 : 9 (1 g ceramic fibers mixed with 9 g Loxeal 58-11, batch 815111).

The liquid material had been thinly applied between two copper plates and had been allowed to dry at room temperature for 24 hours. Thereafter, the cured material was scraped off from the copper plates and was cut into parts of ca. 1 mm to 2 mm in edge length.

4 Tests

4.1 Ignition Sensitivity Testing to Gaseous Oxygen Impacts

The test method is described in annex 1. Based on the specified use condition by the customer, the test was performed at 60 °C.

4.1.1 Assessment Criterion

According to DIN EN 1797 „Cryogenic Vessels - Gas/Material Compatibility" and to ISO 21010 „Cryogenic Vessels - Gas/Material Compatibility" the criterion for a reaction of the sample to gaseous oxygen impacts is a temperature rise of at least 20 °C.

If the sample exhibits a change in color, or in consistency after testing, this is also considered as a positive reaction by BAM for safety reasons, even if there is no temperature rise detectable of at least 20 °C.

4.1.2 Results

4.1.2.1 Liquid Material

In each of the test series, the initial oxygen pressure p_I was at ambient pressure.

Sample Temperature t_i [°C]	Final Oxygen Pressure p_F [bar]	Reaction
60	15	reaction on 2. impact
60	10	no*
60	10	no*

* within a series of five consecutive impacts

In two separate tests, each consisting of a series of five consecutive impacts, no reactions of the sample with oxygen could be observed at following conditions:

Sample Temperature t_i [°C]	Final Oxygen Pressure p_F [bar]
60	10

4.1.2.2 Cured Material

In each of the test series, the initial oxygen pressure p_I was at ambient pressure.

Sample Temperature t_i [°C]	Final Oxygen Pressure p_F [bar]	Reaction
60	15	no*
60	20	reaction on 1. impact
60	15	no*

* within a series of five consecutive impacts

In two separate tests, each consisting of a series of five consecutive impacts, no reactions of the sample with oxygen could be observed at following conditions:

Sample Temperature t_i [°C]	Final Oxygen Pressure p_F [bar]
60	15

5 Summary of the Test Results

In two separate tests, each consisting of a series of five consecutive impacts, no reactions of the liquid sample with oxygen at 60 °C and a final pressure of 10 bars were observed.

In two separate tests, each consisting of a series of five consecutive impacts, no reactions of the cured sample with oxygen at 60 °C and a final pressure of 15 bars were observed.

6 Opinion and Interpretation

The adhesive thread sealant Loxeal 58-11, batch 815111, shall be used for gaseous oxygen service at temperatures up to 60 °C.

On basis of the test results, the requirements for lubricants according to attachment 1 of code of practice M034, annex 2 of code of practice M034-1, Technical Rules for Hazardous Substances TRGS 407 and BAM´s safety philosophy, there are no objections regarding technical safety, to use the adhesive thread sealant Loxeal 58-11, batch 815111, for gaseous oxygen service at following operating conditions:

Maximum Temperature [°C]	Maximum Oxygen Pressure [bar]
60	10

This evaluation does not cover the use of the adhesive thread sealant Loxeal 58-11, batch 815111, for liquid oxygen service. For this application, a particular test for reactivity with liquid oxygen needs to be carried out.

7 Comments

This safety-related investigation considers the fact, that rapid oxygen pressure changes - so-called oxygen pressure surges – cannot be safely excluded in usage.

Our opinion and interpretation are based exclusively on the results of the tested sample of a particular batch.

Our experience shows, that the safety characteristics of a product may vary from batch to batch. Therefore, today, we recommend batch testing of products, that are included for oxygen service. In this context, we would like to mention our paper from September 2009: "The Importance of Quality Assurance and Batch Testing on Nonmetallic Materials Used for Oxygen Service", Journal of ASTM International, Vol. 8th; Paper ID JAI102309. This publication can be purchased at www.astm.org.

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.

The product may 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.

Bundesanstalt für Materialforschung und -prüfung (BAM)
12200 Berlin

July 23, 2018

Division 2.1 "Gases, Gas Plants"

By order

Dr. Thomas Kasch

Distribution list: 1. copy: Loxeal s.r.l.
2. copy: BAM - Division 2.1 "Gases, Gas Plants"

Annex 1

Testing for Ignition Sensitivity to Gaseous Oxygen Impacts

Approximately 0.2 g to 0.5 g of the pasty or divided solid sample is placed into a heatable steel tube, 15 cm^3 in volume. In case of liquids to be tested, ceramic fibre, soaked with the sample, is used. The sample tube is connected by a 750 mm long pipe (internal diameter 14 mm) and a pneumatically operated quick opening valve to a high-pressure oxygen accumulator.

A heater allows to set the sample tube to the test temperature t_a After the tube and pipe are at test pressure p_I, the quick opening valve is opened and preheated oxygen of 60 °C and of pressure p_F flows abruptly into the pipe and tube. In this way, the oxygen in the tube and in the pipe is almost adiabatically compressed from pressure p_I to p_F in 17.5 ms ±2.5 ms (according to DIN EN 1797 and ISO 21010) and heated. If there is a reaction of the sample with oxygen, indicated by a steep temperature rise in the tube, further tests with a new sample are performed at a lower pressure ratio p_F/p_I. If, however, no reaction of the sample with oxygen can be detected after a waiting period of 30 seconds, the tube is de-pressurized and the test is repeated (up to four times) until a reaction takes place. This means, each test series consists of a maximum of five single tests with the same material under the same conditions. If no reaction can be observed, even after the fifth single test of a test series, testing is continued with new samples at greater pressure ratios p_F/p_I, until finally that pressure ratio is determined, at which no reaction can be observed within a test series of five single tests.If the repetition of that test series with a new sample shows the same result, the test can be finished or continued at a different test temperature t_a.