

**BAM**Bundesanstalt für
Materialforschung
und -prüfung

Report

on Testing a Gasket Material for Reactivity with Oxygen

Reference Number II-2077/2006 I E
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1 Application

Customer W.L. Gore & Associates GmbH
Wernher-von-Braun-Straße 18
85640 Putzbrunn

Order Date July 21, 2006

Receipt of Order July 26, 2006

Test Samples GORE® GR Gasket, GR30 for use in flanged connections
in gaseous oxygen piping at temperatures up to 60 °C
and for liquid oxygen service.
BAM-Order No. II.1/ 48 596

Receipt of Samples July 28, 2006

Test Date September 21, 2006 to November 2, 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 Compatibility“
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

All pressures of this report are excess pressures.

This test report consists of page 1 to 4 and annex 1 to 2.

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In case a German version of the test report is available, exclusively the German version is binding.

TEST REPORT

2 Documents and Test Samples

The following documents and samples were submitted to BAM:

- 1 test application
- 1 Safety Data Sheet,
- 1 Material Data Sheet
- 15 disks of GORE® GR Gasket, GR30
diameter 140 mm; thickness 3 mm
colour: white

3 Test Methods and Results

A determination of the autogenous ignition temperature (AIT) was not necessary as GORE® GR Gasket, GR30 is not for use at temperatures greater than 60 °C.

3.1 Flange Test

The test method is described in annex 1.

Results:

Number of tests	Oxygen pressure [bar]	Temperature [°C]	Notes
1	40	60	Only those parts of the gasket burn that project into the pipe.
2	40	60	Only those parts of the gasket burn that project into the pipe.
3	40	60	Only those parts of the gasket burn that project into the pipe.
4	40	60	Only those parts of the gasket burn that project into the pipe.
5	40	60	Only those parts of the gasket burn that project into the pipe.

At 40 bar oxygen pressure and 60 °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 40 bar and 60 °C. The same result was obtained as before.

3.2 Reactivity with Liquid Oxygen on Mechanical Impact

The test method is described in annex 2.

Results:

Test No.	Drop heights [m]	Impact energy [Nm]	Reaction
1	0,5	375	ignition on 1. impact
2	0,33	250	no reaction
3	0,33	250	no reaction
4	0,33	250	no reaction
5	0,33	250	no reaction
6	0,33	250	no reaction
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	no reaction

No reaction of the material GORE® GR Gasket, GR30 with liquid oxygen could be detected at drop heights of 0,33 m (impact energy 250 Nm), in ten separate tests.

4 Evaluation

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 GORE GR Gasket, GR30 in flange connections made of copper, copper alloys or steel at following conditions:

Maximum Oxygen Pressure up to 40 bar	Maximum Temperature up to 60 °C
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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 GORE® GR Gasket, GR30 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 November 30, 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, November 17, 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

Copies:

1. Copy: W.L. Gore & Associates GmbH
2. Copy: BAM – Working Group "Safe Handling of Oxygen"

Annex 1

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.

Annex 2

Testing for Reactivity with Liquid Oxygen on Mechanical Impact

Approximately 0.5 g of the liquid or divided sample is placed into a sample cup (height = 10 mm; diameter = 30 mm), made of 0.01 mm copper foil. Liquid oxygen is poured into the cup over the sample which is then exposed to the mechanical impact of a plummet (mass = 76.5 kg). The drop height of the plummet can be varied. A steel anvil with a chrome/nickel steel plate supports the sample cup. The anvil, having a mass eight times of the plummet, is supported by four damping elements mounted on the steel frame of the test apparatus that rests on a concrete base.

A reaction of the sample with liquid oxygen is usually indicated by a flame and a more or less strong noise of an explosion. The impact energy, at which no reaction occurs, is determined in varying the drop height of the plummet. This result shall be confirmed in a series of ten consecutive tests under the same conditions. The tests are finished, if reactions can be observed at impact energies of 125 Nm or less (equivalent to a drop height of the plummet of 0.17 m or less). In this case, with regard to technical safety, the material is not suitable for liquid oxygen service.