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Low-temperature sealing capability of elastomeric seals — Test methods

Capacité d'étanchéité à basse température des joints en élastomère — Méthodes d'essai

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ISO 20344, Personal protective equipment — Test methods for footwear

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Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see ~~www.iso.org/directives~~www.iso.org/directives).

~~Attention is drawn~~ISO draws attention to the possibility that ~~some of~~ the ~~elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights. in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights. ~~Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).~~

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This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 7, *Sealing devices*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~www.iso.org/members.html.

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Introduction

There are several existing specifications to determine the low-temperature characteristics of elastomeric seal materials. There are also proprietary functional test procedures that aim to identify the minimum operating temperature for seals; however, all of these rely on the seal being energized by the pressure of the test fluid before being subjected to low temperature.

This specification gives details of a test procedure to act as a guide to the minimum operating temperature of elastomeric seals when used in static sealing applications when pressure is applied after cooling, the more commonly encountered situation.

Low-temperature sealing capability of elastomeric seals — Test methods

1 Scope

This specification details a test method for static O-ring seals in elastomeric materials which are subject to pressurized gas media at low temperatures. It gives guidance on the design of test equipment, standard test parameters, and reporting criteria. It does not specify performance criteria that should be agreed upon between supplier and customer.

The test procedure may be used to test seals of alternate size and design or using alternative media but such deviations shall be detailed separately on the report form and the results shall not be used to determine the minimum operating temperature of seals of any other configuration than that tested.

2 Normative ~~References~~references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies:

~~<std>ISO 3601-1, *Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes*</std>~~

~~<std>ISO 3601-2, *Fluid power systems — O-rings — Part 2: Housing dimensions for general applications*</std>~~

~~<std>ISO 3601-3, *Fluid power systems — O-rings — Part 3: Quality acceptance criteria*</std>~~

~~<std>ISO 5598, *Fluid power systems and components — Vocabulary*</std>~~

ISO 3601-1, *Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes*

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ISO 3601-3, *Fluid power systems — O-rings — Part 3: Quality acceptance criteria*

ISO 5598, *Fluid power systems and components — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms, and definitions given in ISO 5598 apply and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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— ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/

3.1
minimum seal temperature
minimum temperature at which the test seal holds the test pressure at the end of the test

3.2
zero leakage
gas leak rate considered to be negligible for the purposes of the test and equal to a displacement of less than 20 cm^3/h equivalents to no discernible bubbles

Note 1 to entry: The zero leakage is as defined as in ISO 10423.

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3.3
room temperature
standard temperature of the test facility usually considered to be in the range of (20 ± 5) °C

3.4
surface roughness

- ~~3.4.1 The surface roughness of the O-ring housing and any mating part has a significant impact on the life and sealing performance of the O-ring.~~
- ~~3.4.2 Unless otherwise agreed, surface roughness values shall be in accordance with Table 1 of ISO 3601-2:2016 .~~
- ~~*NOTE All surfaces against which a seal operates should be free from scratches, burrs, gouges, scores, nicks, tool chatter, spiral machining marks (circumferential marks), or other defects along the operating axis of the seal as these may reduce sealing efficiency and the life of the seal.*~~
- ~~3.4.3 ISO 21920-2:2021 for surface roughness measurement require new statements for roughness requirements. If due to the short measuring length, an exact roughness is not measurable, a visual inspection using master parts is permitted.~~
- ~~3.4.4 Unless otherwise agreed, the material ratio, R_{mr}, should be 50 % to 80 % for surfaces of mating parts, determined at a cut depth of C = 0,25 Rz, relative to a reference profile line of C_o = 0,05 Rmr~~

surface roughness of metal parts refers to the finely spaced irregularities on the surface due to manufacturing processes or wear, influencing performance, durability, and aesthetics

Note 1 to entry: The surface roughness of the O-ring housing and any mating part has a significant impact on the life and sealing performance of the O-ring.

Note 2 to entry: Unless otherwise agreed, surface roughness values shall be in accordance with ISO 3601-2:2016, Table 1.

Note 3 to entry: All surfaces against which a seal operates should be free from scratches, burrs, gouges, scores, nicks, tool chatter, spiral machining marks (circumferential marks), or other defects along the operating axis of the seal as these may reduce sealing efficiency and the life of the seal.

Note 4 to entry: ISO 21920-2 for surface roughness measurement require new statements for roughness requirements. If due to the short measuring length, an exact roughness is not measurable, a visual inspection using master parts is permitted.

Note 5 to entry: Unless otherwise agreed, the material ratio, R_{mr}, should be 50 % to 80 % for surfaces of mating parts, determined at a cut depth of C = 0,25 Rz, relative to a reference profile line of C_o = 0,05 R_{mr}

3.5
housing material
selection based on availability, thermal conductivity, and corrosion resistance of the material.

Note 1 to entry: It is recommended to use: AISI 316L or EN X2CrNiMo17-12-2 (1.4404) or ISO 4404-316-03-I.

4 Test apparatus

4.1 The test apparatus shall be designed in accordance with the drawing shown using the housing material with the surface roughness defined following the Annex A and shall consist of a suitable test cell with 3 major components:

4.1.1 Solid cylindrical test plug, containing a groove on its outer diameter to suit a test O- ring size - 316 (ISO 3601-1-316A-21.59x5.33-N)in accordance with ISO 3601-1 when used in a static piston sealing application.

4.1.2 Outer cylindrical test shroud with a bore to suit the test O-ring and an external means of sealing to retain the test fluid under pressure – normally an O-ring which will remain flexible at a temperature at least 10 °C below the minimum test temperature.

4.1.3 Cylindrical cap which fits around the test shroud and is sealed on its bore by the flexible O-ring and contains suitable fittings to allow the ingress of the test medium.

Means shall be provided to ensure centralization of the test plug within the test shroud such that the extrusion gap on the low-pressure side of the test seal does not exceed the requirements of ISO 3601-2

Seal sizes to ISO 3601-1-023A-26.70x1.78-N, ISO 3601-1-120A-25.07x2.62-N, or ISO 3601-1-213A-23.39x3.53-Ncan also be used but in those cases, the inside diameter of the seal housing shall be adjusted to suit the appropriate cross-section of the seal (see Annex C).

4.2 Test cell shall be provided with:

4.2.1 Means of cooling such that the temperature at the test cell can be reduced at a controlled rate of 60 °C/h (±10 °C/h).

4.2.2 Means of measuring the temperature of the test seal, positioned within (2 ± 0,5) mm of either the inner or outer diameter of the test seal.

4.2.3 Means of detecting leakage, bypassing the test seal by a mass flow meter with a minimum flow range lower than 20 cm^3/h – alternatively a leakage tube directly connected to the test cell and terminating within a water bath may be used where discernible bubbles of leakage can be observed. Leakage tube should have an inside diameter of (6 ± 0,5) mm.

4.2.4 Means of an arrangement by which the test medium may be applied under pressure to the test cell and the pressure within the cell measured.

4.2.5 Alternative sealing solution needed if the test temperature falls below the minimum seal temperature of the fixture dummy static O-ring.

NOTE The expected minimum seal temperature can be estimated by use of other material or functional tests e.g. ISO 812, ISO 815-2, ISO 1432, ISO 2921.

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5 Test condition

5.1 Temperature

Tests shall be carried out at a range of temperatures from room temperature down to at least 10 °C below the expected minimum seal temperature.

NOTE The expected minimum seal temperature can be estimated by use of other material or functional tests e.g. ISO 812, ISO 815-2, ISO 1432, ISO 2921.

5.2 Test medium

The test medium shall be nitrogen gas.

5.3 Test pressure

The test pressure applied to the seals shall be selected based on the application, the predefined test pressures are:

— 5 MPa +0,25 /-0;

— 10 MPa +0,5/-0;

— 15 MPa +0,75/-0.

NOTE: Alternatively, different test pressures can be used as an option in agreement with the customers' requirements.

6 Pre-test procedure

6.1 Inspect the test seals for conformity to their dimensional specification in accordance with ISO 3601--1 and visually in accordance with ISO 3601-3 Grade N and record their actual cross-section and inside diameter.

6.2 Install the dummy static O-ring and test seal in their respective grooves – the test seals shall not be lubricated.

6.3 Assemble the test cell and all relevant connections and monitoring devices.

6.4 Pressurize the cell with nitrogen to 1,5 MPa at ambient room temperature at a rate of approximately 0,5 MPa/min.

6.5 Hold the cell at 1,5 MPa for 2 min and check that there is zero leakage.

6.6 Apply the test pressure for 2 min and check that there is zero leakage.

6.7 Release the pressure.

7 Test ~~Procedure~~procedure

7.1 Reduce the temperature of the test cell and seal (see 4.2.1) to a temperature 5 °C above the expected minimum seal temperature and hold for a minimum of 5 minutes after the fixture temperature has remained stable (±0,5 °C) for at least 5 min.

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7.2 Apply the test pressure and check for leakage.

7.2.1 If leakage is observed release the test pressure and raise the temperature by 5 °C and hold for a minimum of 5 min after the temperature has remained stable (±0,5 °C) for at least 5 min then repeat the procedure from 7.2 onwards.

7.2.2 If zero leakage is observed hold pressure for 5 min.

7.3 If zero leakage is observed release the test pressure and reduce the temperature by a further 5° and hold for a minimum of 5 min after the temperature has remained stable (±0,5 °C) for at least 5 min.

7.4 Repeat the test procedure from 7.2 onwards until a temperature is reached where the seal fails to hold pressure.

7.5 Release the pressure and raise the temperature by 1 °C, hold for a minimum of 5 min after the temperature has remained stable (±0,5 °C) for at least 5 min, and then apply the pressure.

7.5.1 If leakage is observed release the test pressure and raise the temperature by 1 °C and hold for a minimum of 5 min after the temperature has remained stable (±0,5 °C) for at least 5 min then repeat the procedure from 7.5 onwards.

7.5.2 If zero leakage is observed hold pressure for 5 min.

7.6 Continue the process from clause 7.5 onwards until a temperature is reached at which the pressure can be held for 5 minutes with zero leakage – this is the minimum seal temperature.

7.7 The start point for each repeated test shall be 5 °C higher than the previous minimum seal temperature.

7.8 A new set of seals shall be used in every new test run.

7.9 A minimum of 5 test runs shall be carried out for each material. The final minimum seal temperature reported shall be the average of 3 of those 5 individual samples disregarding the highest and lowest sample value.

8 Test report

8.1 Record all test data on a seal test report form (an example is shown in Annex B).

8.2 Publishing of results.

When publishing results for consumption by potential users the following data shall be included:

— Standard reference (i.e. ISO 5119~~:); —~~) and the ~~Issue Number~~issue number;

— Seal material;

— Test pressure;

— Minimum seal temperature.

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