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Rubber and plastics hoses and hose assemblies — Hydrostatic testing

Tuyaux et flexibles en caoutchouc et en plastique — Essais hydrostatiques

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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 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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Rubber and plastics hoses and hose assemblies*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 218, *Rubber and plastics hoses and hose assemblies*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fifth edition cancels and replaces the fourth edition (ISO 1402:2009), which has been technically revised. The main changes compared to the previous edition are as follows:

— the tolerances of the pressure in Figure 3, 7.2.2, 8.1 and 8.2 have been revised;

— the description of the failure mode in 8.3 has been revised.

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.

Rubber and plastics hoses and hose assemblies — Hydrostatic testing

1 Scope

This document specifies methods for the hydrostatic testing of rubber and plastics hoses and hose assemblies, including methods for the determination of dimensional stability.

2 Normative 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.

ISO 7751, *Rubber and plastics hoses and hose assemblies — Ratios of proof and burst pressure to maximum working pressure*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8330 apply.

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

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

— IEC Electropedia: available at http://www.electropedia.org/

4 General

Unless otherwise specified, all tests shall be carried out at standard temperature in accordance with ISO 23529.

5 Apparatus

5.1 Pressure source, capable of applying pressure at the rate specified in 7.2.2, up to the required test pressure.

5.2 Calibrated pressure gauge or **pressure transducer with digital readout**, chosen for each test so that the test pressure is between 15 % and 85 % of the full-scale reading.

In the interest of accuracy, calibrated pressure gauges or pressure transducers with digital readouts shall be checked at frequent intervals and the fitting of restrictors is recommended to minimize shock damage.

5.3 Dimensional equipment, sliding vernier callipers or micrometre, length measuring tape, circumferential measuring tape (π tape).

6 Test pieces

6.1 Hose assemblies

When hose assemblies are to be tested, the manufactured assembly length shall be used for the test.

6.2 Hoses

The hydrostatic pressure and burst tests shall be carried out on a hose test piece with a minimum free length, excluding end fittings and end reinforcements, of 600 mm when deformation is to be measured and 300 mm when it is not. When a longer test length is required for a particular hose type or size, it must be specified in the individual hose product specification.

6.3 Number of test pieces

At least two test pieces shall be tested.

7 Application of hydrostatic pressure

7.1 General

Water or another liquid suitable for the hose under test shall be used as the test medium.

WARNING — Hoses and hose assemblies pressurized by liquids can fail in a potentially dangerous manner. For this reason, the test shall be performed in a suitable enclosure. Also, the use of air and other gases as test media shall be avoided because of the risk to operators. In special cases, where such media are required for the tests, strict safety measures are imperative. Furthermore, it is stressed that, even when a liquid is used as the test medium, it is essential that all air is expelled from the test piece because of the risk of injury to the operator due to the sudden expansion of trapped air released when the hose bursts.

7.2 Procedure

7.2.1 Fill the test piece with test liquid, expelling all air, and connect to the test equipment. Close the valve and apply the hydrostatic pressure at a uniform rate of increase. Measure the pressure using a calibrated pressure gauge or pressure transducer with a digital readout (5.2).

IMPORTANT — It is important to allow unrestricted movement of the free or plugged end of the test piece during the test.

7.2.2 The rate of pressure increase shall be constant and chosen to reach the final pressure after a period of between 30 s and 60 s for hoses with nominal inside diameters up to 50 mm. For hoses with nominal inside diameters greater than 50 mm and less than or equal to 250 mm, the time needed to reach the final pressure shall be between 60 s and 240 s. For hoses with nominal inside diameters greater than 250 mm, and/or when the test hose is longer than the minimum free length specified in 6.2, the time needed to reach the final pressure shall be decided between the manufacturer and the user.

8 Hydrostatic pressure tests

8.1 Proof pressure hold test

When proof pressure tests are used to determine leakage of hoses or hose assemblies, apply the specified proof pressure in accordance with 7.2.2 and hold it neither for less than 30 s nor for more than 60 s, unless otherwise specified in the product standard, examining the test pieces during this period

for evidence of leakage, cracking, abrupt distortions indicating irregularity in material or manufacture, or other signs of failure. The tolerance of the pressure is +10 % of the specified pressure.

Unless otherwise specified for the hose, the proof pressure shall be related to the maximum working pressure by the ratio given in ISO 7751.

The test is not applicable to a curved hose.

NOTE This text uses the term “maximum working pressure” instead of the deprecated term “design working pressure”.

8.2 Measurement of deformation under pressure

8.2.1 General procedure

8.2.1.1 Setting up the test piece

When tests for determining change in length, change in outside diameter and twisting and/or warping are required, straighten the hose or hose assembly, lay it out horizontally for inspection and apply a hydrostatic pressure of 0,07 MPa (0,7 bar) approximately 5 min after completion of the proof pressure test. It is not necessary to apply 0,07 MPa (0,7 bar) when it is stable in keeping straightness without pressure. The supporting surface upon which the hose/hose assembly rests shall be flat and smooth enough to allow the hose/hose assembly to expand or contract without restriction. Alternatively, the hose/hose assembly may be supported on rollers or suspended vertically. When a section of hose is used as a test piece, it may also be placed in a test rig in a vertical position.

8.2.1.2 Reference marks

For long hoses or hose test pieces (see 6.2), while maintaining the pressure, make three reference marks (A, B and C) on the outer surface, the middle mark (B) being made approximately midway along the length of the hose, and the outer marks (A and C) 250 mm (minimum) from B. Each mark shall consist of an arc on the circumference of the hose through which is drawn a straight line perpendicular to the arc, the three lines being co-linear (see Figure 1).

For hose assemblies, measure the distance between the contact faces of the end fittings, or place the reference marks on the hose surface near the end of the inserted part of the fitting.

8.2.1.3 Measurement of initial dimensions

At the initial state [no pressure or maintain pressure of 0,07 MPa (0,7 bar) for approximately 5 min], make the appropriate measurements (see 8.2.2, 8.2.3 and 8.2.4) at the reference marks A and C with an accuracy of ±1 mm using the measuring tape (see 5.3) and record these. Also, measure the external diameter or circumference accurately.

8.2.2 Change in length at the specified test pressure

NOTE The test pressure is specified in the appropriate hose product specification and could be the maximum working pressure (see 8.1, NOTE), the proof pressure or any other pressure below the proof pressure at which the hose deformation characteristics are to be measured.

Raise the pressure to the test pressure specified in the hose product standard at the rate specified in 7.2.2 and maintain it for 5 min (or longer when specified in the hose product standard). At the end of this period, measure the length between the reference marks A and C or, in the case of hose assemblies, between the contact faces of the end fittings, with an accuracy of ±1 mm, using the measuring tape (see

5.3) and record these values. The tolerance of the pressure is +10 % of the specified pressure. Calculate the change in length, Δl, expressed as a percentage (%) of the original length, from Formula (1):

$$\Delta l = \frac{l_1 - l_0}{l_0} \times 100 \qquad (1)$$

where

l_0 is the distance between the reference marks A and C or the overall length (hose assemblies) measured at the initial state [no pressure or maintain pressure of 0,07 MPa (0,7 bar)], in metres (m);

l_1 is the distance between reference marks A and C or the overall length (hose assemblies) measured at the specified test pressure, in metres (m).

The percentage change in length, Δl, will be positive (+) in the case of an increase in length and negative (–) in the case of a decrease in length.

For an illustration of the test procedure, see Figure 3.

The complete test sequence (proof pressure — testing pressure — bursting pressure) only applies to "type tests". For routine tests, the "measuring sequence" after the proof pressure is only applicable when the relevant hose product standard specifies this.

Measure the initial length and diameter/circumference and place reference marks for twist measurement between points A and B. Measure the increase in the length, diameter/circumference, twist and warping directly in front of point C.

8.2.3 Change in external diameter at the specified test pressure, measured at the approximate middle of the hose assembly

8.2.3.1 General

The external diameter should preferably be determined from measurements of circumference made with an accuracy of 1 mm using the circumferential measuring tape according to ISO 4671. The measurements may, however, be made directly, using sliding vernier callipers having a minimum useful tip width of 5 mm.

8.2.3.2 Determination by measuring the change in external circumference

Using the circumferential measuring tape (see 5.3), measure the circumference at each of the three reference marks (A, B and C) at the initial state [no pressure or maintain pressure of 0,07 MPa (0,7 bar)] (see 8.2.1.3) and at the specified test pressure described in 8.2.2.

Calculate the change in diameter, ΔD, expressed as a percentage (%) of the original diameter, from Formula (2):

$$\Delta D = \frac{\Sigma C_1 - \Sigma C_0}{\Sigma C_0} \times 100 \qquad (2)$$

where

ΣC_0 is the sum of the circumferences at the three reference marks measured at the initial state;

ΣC_1 is the sum of the circumferences at the three reference marks measured at the specified test pressure.

8.2.3.3 Direct measurement of change in external diameter

Using the sliding vernier callipers (5.3), measure two perpendicular diameters at each of the three reference marks at the initial state (no pressure or maintain pressure of 0,07 MPa (0,7 bar) (see 8.2.1.3) and at the specified test pressure described in 8.2.2.

Calculate the change in diameter, ΔD, expressed as a percentage (%) of the original diameter, from the formula

$$\Delta D = \frac{\Sigma D_1 - \Sigma D_0}{\Sigma D_0} \times 100$$

where

$\sum D_0$ is the sum of the six diameters measured at the reference marks at the initial state;

$\sum D_1$ is the sum of the six diameters measured at the reference marks at the specified test pressure.

8.2.4 Twisting at the specified test pressure

If twisting of the hose develops under pressure, the original lines forming the reference marks will take up a helical pattern (see Figure 2).

With the hose at the specified test pressure described in 8.2.2, project a straight line along the length of the hose from reference mark A until it intersects, at C′, the circular arc at reference point C. Alternatively, for short hose assemblies, the reference marks A and C may be placed on the end fittings or on the section of the hose covering the fitting tails.

Then measure the length, s, of the circular arc CC′ to the nearest millimetre, using measuring tape (5.3).

Calculate T, the twisting per length, expressed in degrees per metre (°/m), from Formula (3):

$$T = \frac{s}{C_c \times l_0} \times 360 \tag{3}$$

where

s is the length of the circular arc CC′, in millimetres (mm);

C_c is the circumference at reference mark C, in millimetres (mm), measured as described in 8.2.3.1;

l_0 is the distance between A and C, in metres (m), as measured in 8.2.2.

8.2.5 Warping at the specified test pressure

Warping in hose tests is the deviation from a straight line drawn from fitting to fitting in a plane parallel to the surface on which the hose rests at the initial state [no pressure or maintain pressure of 0,07 MPa (0,7 bar)]. A tightly stretched cord may be used to establish the straight line from centre to centre of the fittings. The amount of warping at the specified test pressure is the maximum deviation of any portion of the hose from the straight line drawn from centre to centre of the fittings at the initial state. Express warping as the distance from this line to the centreline of the hose at the point of maximum deviation. Report the result to the nearest 5 mm.

8.3 Burst pressure test

Increase the pressure at a rate in accordance with 7.2.2 until the hose or hose assembly fails. Leakage at the end fitting, fitting blow-off, or ruptures within 25 mm from the terminal of fitting or a distance equal to external diameter of the hose, whichever is greater, is considered as failures in the performance of the assembly.