International Standard

ISO 4080

Fifth edition
2024-06

Rubber and plastics hoses and tubing, and their assemblies — Determination of permeability to gas

Tuyaux et tubes en caoutchouc et en plastique, et leurs assemblages — Détermination de la perméabilité au gaz

Reference number
ISO 4080:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 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).

ISO draws attention to the possibility that the implementation of this document may involve the 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.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 4080:2009), which has been technically revised.

The main changes are as follows:

— revised gas permeability test as a whole;

— title changed;

— terms 3.1 and 3.2 added.

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 tubing, and their assemblies — Determination of permeability to gas

WARNING — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

1 Scope

This document specifies three methods to determine the permeability to gas by measuring the volume of gas diffusing through a rubber or plastics hose or length of tubing used for gas applications in a specified time.

— Method 1 is for determining the permeability of the complete hose wall or length of tubing wall, excluding end fittings, to the test gas.

— Method 2 is for determining the permeability at the hose and fitting interface to the test gas.

— Method 3 is for precisely determining the permeability of the complete hose or length of tubing, including end fittings.

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 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 purpose of this document, the terms and definitions given in ISO 8330 and the following apply.

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

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

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

3.1
end fitting
device attached to the end of a hose or tubing to facilitate connection to equipment constituting hose assembly

Note 1 to entry: End fitting can include an attached matching part to facilitate the test, if necessary.

3.2
permeability
property of a material of transmitting gases and liquids by passage through one surface and out at another surface by diffusion and sorption processes

Note 1 to entry: Not to confuse with “porosity”.

Note 2 to entry: The property of a permeability involves the diffusion of molecules, called the permeant, through a membrane or interface. The permeability property works through diffusion< the permeant will move from high concentration to low concentration across the interface.

Note 3 to entry: In a pressurized hose the permeant can pass from the inside of the hose to the outside through the hose lining and cover.

[SOURCE: ISO 8330:2022, 3.8.5]

4 Test pieces

4.1 Method 1

The test piece shall be a length of hose or tubing fitted with end fittings long enough to ensure that the length of the exposed hose or tubing under the gas-collecting trough is 1 m ± 0,01 m. The test piece shall have a pricked cover or a textile braid cover.

4.2 Method 2

The test piece shall be a length of hose fitted with end fittings. It shall have a length of 1 m ± 0,01 m between the end fittings. The test piece shall be a textile reinforced hose with an unpricked cover.

NOTE The type of coupling used and the method by which the fittings are fixed to the test piece can affect the permeability results obtained using this method.

4.3 Method 3

The test piece shall be a length of hose or tubing fitted with end fittings. It shall have a minimum test length of 0,5 m with ± 1 % tolerance between the end fittings. A test length of 1 m ± 0,01 m between the end fittings may be used when comparison of test result among the three methods are necessary.

NOTE The type of end fittings used and the method by which the end fittings are fixed to the test piece can affect the permeability results obtained using this method.

5 Apparatus

Schematic layouts of the test arrangements for the three test methods are shown in Figure 1 to Figure 3.

5.1 Gas supply, provided with a suitable pressure regulator gauge and emergency excess flow shutoff valves in case of test piece failure.

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.

5.3 Water bath, capable of being maintained at a specified temperature and of sufficient length to accommodate the test piece.

5.4 Gas-collecting apparatus, comprising measuring cylinders and in some instances additional apparatus appropriate to each of the three methods, as illustrated in Figure 1 (collecting trough), Figure 2 (collecting funnels) and Figure 3 (collecting funnel and transparent glass tube), respectively. The capacity and accuracy of the measuring cylinders shall be selected in accordance with the volume of gas that is expected to be collected.

A transparent glass tube may be replaced with a tube made from acrylic, polycarbonate and similar materials, or with a transparent collecting trough large enough to cover the whole test piece to collect escaped gas.

5.5 Barometer, to record the barometric pressure during the test.

5.6 Two thermometers, to record the water temperature and air temperature at the gas-collection point(s).

6 Test conditions

6.1 Test pieces

No test shall be carried out within 24 h of manufacture on rubber or plastics hoses or lengths of tubing. Before testing, the test pieces shall be conditioned in accordance with ISO 23529 for at least 3 h at the specified temperature and humidity.

Conditioning of test pieces is excluded for routine testing or maintenance inspection.

6.2 Test temperature

Unless otherwise specified in the product standard, the test shall be carried out at a temperature of 23 °C ± 2 °C for ambient and water bath. If there is an agreement between the interested parties, the test may be carried out at any temperature.

6.3 Test gas

The test shall be carried out using the test gas specified in the product standard. If there is an agreement between the interested parties, other test gases may be used.

Water-soluble gas cannot be quantified.

6.4 Test pressure

Unless otherwise specified in the product standard, the test shall be carried out at a gas pressure of 1 MPa. If there is an agreement between the interested parties, the test may be carried out at other test pressures.

7 Procedure

7.1 General

Guidance on permeability is provided in Annex A, Figure A.1.

Guidance on test methods and their application is provided in Annex B, Table B.1.

The instructions in this subclause are common to all three test methods and shall be followed before method-specific procedures. Use one test piece for each method.

Measure the inside diameter of the test piece if the result is expressed in an amount per surface area.

Connect one end of the test piece to the specified gas supply (5.1) with a suitable connector.

Purge the test piece with test gas for 30 s to expel the air and then seal the test piece by blanking off the other end.

Adjust the temperature of the water bath (5.3) to the specified value.

Before conducting the permeability test, the test piece shall be immersed in water and checked for any leakage.

If the permeability is required to be determined at different pressures, test at the lowest pressure first and then at increasing pressure levels.

In order to keep bubbles of the collected gas from sticking to the surface of the collecting devices, these should be washed with a surface active agent or the like before starting the test.

7.2 Method 1

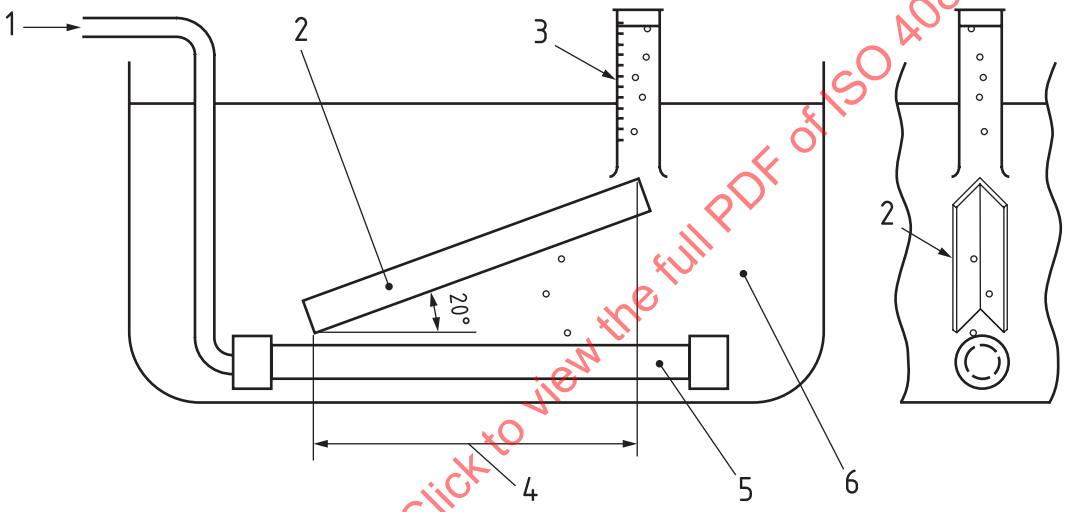
Immerse the test piece in the water bath and place the collecting trough so that it is inclined at approximately 20° to the horizontal (see Figure 1). The size of the collecting trough should be sufficient to collect all the gas bubbles over the 1 m length of the test piece.

Position the measuring cylinder as shown in Figure 1 to collect and measure any gas which diffuses through the entire hose or length of tubing.

Apply the specified gas pressure to the test piece and maintain it for at least 24 h. Following this period, depending on the period to reach steady-state, collect the gas for 6 h or record the time to collect between 450 cm^3 and 500 cm^3 of gas per metre.

If the volume of gas collected after 6 h is less than 3,0 cm^3/m, measure the volume of gas collected in a 24 h period. If the volume of gas collected after 24 h is more than 1,0 cm^3, then this can be taken as the reading.

Repeat the measurement until two successive gas volume readings are within 5 % of each other. Use the average of these two successive readings to calculate the permeability.



Key

1 gas supply
2 collecting trough
3 measuring cylinder
4 test length[a]
5 test piece
6 water bath

[a] 1 m ± 0,01 m

Figure 1 — Schematic apparatus for method 1

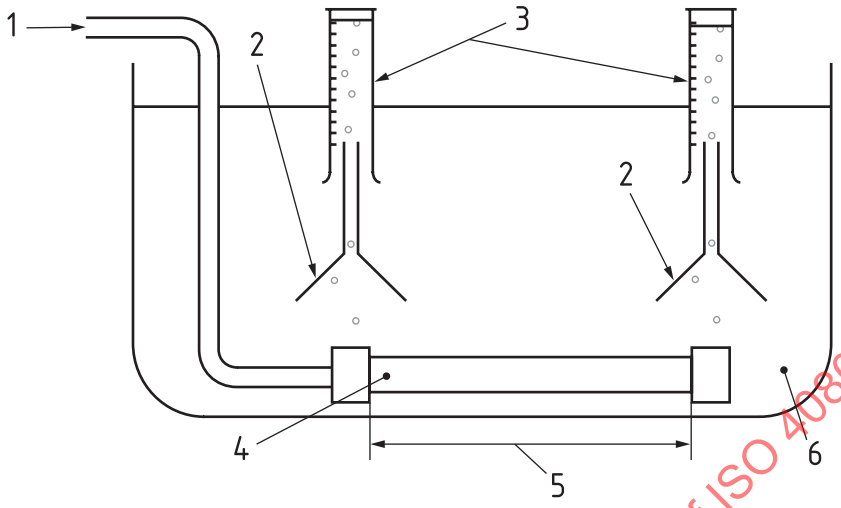
7.3 Method 2

Maintaining the test piece at the specified test temperature outside of the water bath, apply the specified gas pressure to the test piece and maintain it for at least 24 h. Following this period, depending on the period to reach steady-state, immerse the test piece in the water bath (5.3) at the specified temperature (see Figure 2).

Position the two measuring cylinders and the collection funnels as shown in Figure 2 to collect and measure any gas which escapes from the two ends of the test piece for a period of 1 h. Record the total volume of gas collected as the first reading. Then remove the test piece from the water bath and hold it at the specified temperature and gas pressure for 24 h. After 24 h, reimmerse the test piece in the water bath and collect and measure the gas as previously.

Repeat the measurement until two successive gas volume readings are within 5 % of each other. Use the average of these two successive readings to calculate the permeability.

NOTE It is important to remove the test piece from the water bath after each 1 h period and to not leave it immersed since the exposed textile reinforcement can swell and lead to unrepresentative results.



Key

1 gas supply
2 collecting funnels
3 measuring cylinders
4 test piece
5 test length[a]
6 water bath

[a] 1 m ± 0,01 m

Figure 2 — Schematic apparatus for method 2

7.4 Method 3

Insert the test piece into the glass tube and immerse in the water bath so that they are inclined at approximately 20° to the horizontal (see Figure 3).

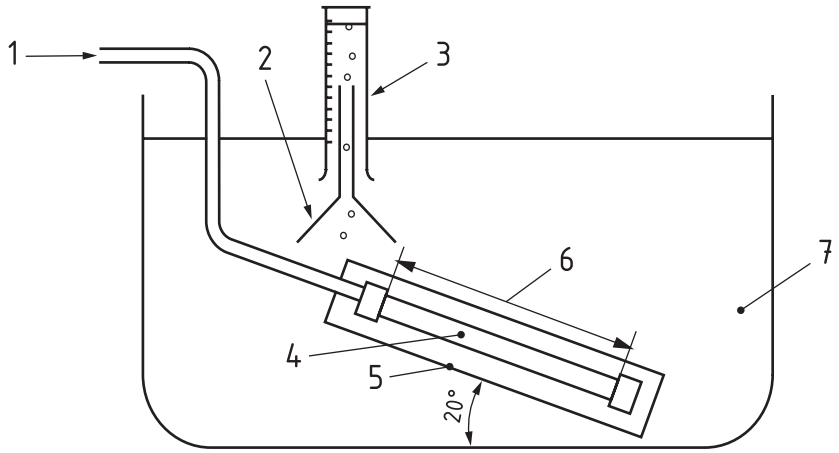
Position the measuring cylinder and the collection funnel as shown in Figure 3 to collect and measure any gas which escapes from the whole test piece.

Apply the specified gas pressure to the test piece and maintain it for at least 24 h. Following this period, depending on the period to reach steady-state, collect the gas for 6 h or record the time to collect between 450 cm^3 and 500 cm^3 of gas per metre.

If the volume of gas collected after 6 h is less than 3,0 cm^3/m, measure the volume of gas collected in a 24 h period. If the volume of gas collected after 24 h is more than 1,0 cm^3, then this can be taken as the reading.

Repeat the measurement until two successive gas volume readings are within 5 % of each other. Use the average of these two successive readings to calculate the permeability.

NOTE The results of method 1 and method 3 are not comparable because the test length of method 3 includes nipple length at both ends.



Key

1 gas supply
2 collecting funnel
3 measuring cylinder
4 test piece
5 transparent glass tube (open-ended)
6 test length[a]
7 water bath

[a] 0,5 m minimum with ± 1 % tolerance

Figure 3 — Schematic apparatus for method 3

8 Expression of results

The permeability is calculated with respect to the length of the hose or tubing and to the surface area of the hose lining and the tubing.

Correct the volume of gas measured by method 1, method 2 and method 3 to a standard temperature of 273,15 K and a standard pressure of 101,325 kPa in dry conditions in cubic centimetre per metre per hour [$cm^3/(m{\cdot}h)$] using Formula (1):

$$\frac{273{,}15\times V\,(p-p_{\mathrm{w}})}{t\,L\,(271{,}15+\theta)} \qquad (1)$$

where

V is the volume, in cubic centimetres (cm^3), of gas collected (accuracy ± 2,0 cm^3);

P is the barometric pressure, in kilopascals (kPa), at the time of collection (accuracy ± 0,07 kPa);

p_{w} is the saturated vapour pressure of water, in kilopascals (kPa), at temperature θ as specified in Annex C, Table C.1 (accuracy ± 0,1 kPa);

t is the time, in hours (h), during which the gas was collected (accuracy ± 10 s);

L is the free length, in metres (m), of the hose (accuracy ± 0,001 m);

Θ is the temperature, in degrees Celsius (°C), of the gas-collection unit at the time of collection (accuracy ± 0,10 °C).

The amount can be converted to an amount per square meter of the area of inner surface of hose per hour [$cm^3/(m^2{\cdot}h)$].

9 Test report

The test report shall include the following information for each test undertaken:

a) a reference to this document with year of publication, i.e. ISO 4080:2024;

b) the method used;

c) a description of the hose/assembly or tubing tested, and whether it was pricked or unpricked;

d) the test length shown on each method;

e) the test pressure;

f) the test temperature;

g) the test gas;

h) the results obtained for each test piece;

i) any deviations from the procedure and unusual features noted during the test;

j) the date of the test.

Annex A
(informative)

Guidance on permeability

A.1 Permeability passage

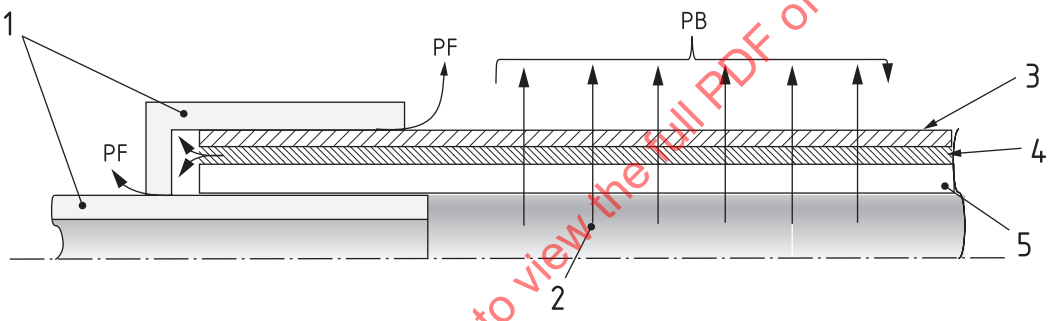
There are two permeability passages:

— gas transmit through one surface and out at another surface by diffusion and sorption, shown in Figure A.1 as “PB”.

— gas transmit through hose reinforcement at ends of hose or fitting, shown in Figure A.1 as “PF”.

Permeability is distinguished from leakage, which is the escape of gas by assembly fault.

Measurement is conducted after reaching steady-state of permeability.



Key

1	end fitting	5	lining
2	gas	PB	permeability passage through hose/tubing body
3	cover	PF	permeability passage through hose fitting
4	reinforcement		

Figure A.1 — Permeability passage through hose/tubing body and hose fitting

A.2 Relationship between permeability passage and the mechanism of the methods

A.2.1 Method 1

Method 1 collects the gas that only escapes from permeability passage PB. In order for the gas to escape and come outside through the permeability passage PB, the hose cover is pricked or textile braid.

In order to accurately collect the gas, the collecting trough is inclined at approximately 20° to the horizontal and the horizontal projected length is equal to the specified length (1 m ± 0,01 m). Permeated gases along the trough are collected in a measuring cylinder placed at the top of the trough.

A.2.2 Method 2

Method 2 collects the gas that only escapes from permeability passage PF at both ends. If the hose is textile reinforced with unpricked cover, the gas transmits through the lining, travels within the reinforcement (textile) layer for the length of the hose and escapes at the end fittings, where it is collected.

If the cover is more permeable than the lining, the gas can also escape through the cover. Gas escaping through the cover cannot be collected with this method.

A.2.3 Method 3

Method 3 precisely collects the gas that escapes both from permeability passage PB and PF as assembled hose. As this method cannot separate the volume of gas from permeability passage PB and PF, if each volume needs to be measured, conduct the measurement using method 1 or method 2.

NOTE Method 3 is not suitable for textile reinforced with unpricked cover as the test piece is left immersed in the water bath and exposed textile reinforcement can swell and lead to unrepresentative results.

Annex B
(informative)

Guidance on test methods and their application

In the product standard, it is recommended to determine at least the following:

— method to be used (method 1, 2 or 3);

— test gas;

— test pressure;

— test temperature;

— pass/fail criteria.

The phenomenon of permeability is different based on materials, construction and presence or absence of pricking. Therefore, it is important to know the applicability of each method when making a product standard.

For hoses not listed in Table B.1, the method to be used for the permeability test can be decided by the interested parties.

Table B.1 — Guidance on test methods and their application

Key point		Method 1	Method 2	Method 3
Prerequisite		Confirming no leakage before permeability test		
Test duration		To be continued until reaching steady-state of permeability		
Expression of result		$cm^3/(m^2 \cdot h)$ or $cm^3/(m^2 \cdot s)$		
Applicability	Textile reinforced with pricked cover	X	N/A	X
	Textile reinforced with unpricked cover	N/A	X	N/A
	Wire and textile reinforced textile braid cover	X	N/A	X
	Wire and textile reinforced with pricked cover	X	N/A	X
	Wire braid/spiral reinforced with pricked or unpricked cover	N/A	N/A	X
	Tubing	X	N/A	X
Important notes		Small amount may be diffused through hose/ tubing ends.	Some amount may be diffused through hose body depending on permeability of the cover. If the cover material has a greater permeability than the lining material, the gas can escape along the whole length and not be collected.	Preferred method for permeability. It is not possible to separate the amount of gas escaping from the hose or tubing body and the amount escaping from hose and fitting interface