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Gas cylinders — Compatibility of cylinder and valve materials with gas contents —

Part 5: Test methods for evaluating plastic liners

Bouteilles à gaz — Compatibilité des matériaux des bouteilles et des robinets avec les contenus gazeux —

Partie 5: Méthodes d'essai pour l'évaluation des liners en plastique

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Foreword

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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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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 58, *Gas cylinders*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 23, *Transportable gas cylinders,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 11114 series can be found on the ISO website.

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.

Introduction

Non-metallic materials are used for the manufacturing of liners of some composite gas cylinders and therefore are in contact with gas contents.

The compatibility of plastic liners with gas cylinder contents is a key parameter for the manufacturing of composite gas cylinders with plastic liners. Therefore, it is necessary to clarify such compatibility and to give test procedures and evaluation parameters.

This document provides some testing methodologies to evaluate suitability of plastic materials concerning the risks identified in ISO 11114-2. Furthermore, this document is intended to be used together with the design standard (e.g. ISO 11515, EN 12245) which gives the requirements for certain tests, as well as the criteria, while this document describes the test procedure.

Gas cylinders — Compatibility of cylinder and valve materials with gas contents —

Part 5:
Test methods for evaluating plastic liners

1 Scope

This document specifies some gas compatibility test methods to evaluate plastic materials suitable for use in the manufacture of composite gas cylinder liners. It is also applicable to the evaluation of the suitability of plastic matrix materials used for Type 5 cylinders.

Some fluids like water, used for cylinders testing, can react positively or negatively when in contact with plastic liners. This compatibility issue is not covered by this document.

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 178, *Plastics — Determination of flexural properties*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 3167, *Plastics — Multipurpose test specimens*

ISO 8256, *Plastics — Determination of tensile-impact strength*

ISO 10286, *Gas cylinders — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10286 and the following 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 https://www.electropedia.org/

3.1
blister
localized delamination or void within the liner material that looks like a bubble

3.2
maximum permissible filling mass
maximum mass of gas in kg which is allowed in a filled cylinder

Note 1 to entry: This term applies to liquefied gas.

[SOURCE: ISO 24431:2016, 3.13]

3.3
Type 5 cylinder
fully wrapped cylinder without a liner and with composite reinforcement on both the cylindrical portion and dome ends

4 General requirements

This document is designed to determine the suitability of the materials with regard to the risks identified in ISO 11114-2 and to evaluate materials not listed in ISO 11114-2.

Two types of tests can be performed:

a) tests on discs or other specimens (see Clause 5);

b) tests on cylinders (see Clause 6).

To determine the suitability of materials for a given liner, testing shall be performed on cylinders in accordance with Clause 6.

The tests on specimens should only be performed to compare different plastic materials (e.g. to select the most suitable material) or to check if some zones on the liner permeate more than others, or both.

Tests on disc or specimen are difficult in case of Type 5 cylinders. Therefore, tests on cylinders are recommended.

Some substances (e.g. moisture, sulfur compounds) can have a positive or negative effect on the material performance, and this shall be taken into account when designing and carrying out tests. These substances can be present in the gas or released by the plastic materials, or both.

Analysis of test gas shall be recorded to identify any possible contamination (e.g. moisture, sulfur compounds, etc.) both prior to and after the test.

5 Tests to be performed on specimens

5.1 Permeation test

5.1.1 Disc samples

The disc samples shall be taken either from a liner or using samples manufactured according to the intended process, such as injection moulding or blow moulding (e.g. to select the most suitable material).

NOTE 1 Treatments such as curing can affect the properties of the liner materials.

It is recommended that all process steps that influence the behaviour of the liner material that are applied to the finished cylinder, including thermal treatment, are applied to the specimens.

In case of comparison between two or more materials, it is recommended that samples are manufactured using the same process. Preferably, the process should match the intended liner manufacturing process. It is also possible to check which process is the most appropriate liner manufacturing process.

An external diameter of the test specimen disk between 40 mm and 80 mm is typically recommended.

The thickness of the sample can vary depending on the thickness of the liner and the pressure to be applied during the test.

The dimensions (including thickness), the preparation and the manufacturing process of the sample, as well as the location of the disc, shall be recorded.

NOTE 2 If sample preparation includes machining, this will affect the permeation due to the non-homogeneity of the sample.

The moisture content and outgassing of the test specimen can affect measurement results of the disc sample permeation test. It is recommended to dehumidify and outgas the test specimen, for example, heating to 65 °C under vacuum (~10 to 50 mbar[1)]) until < 0,1 % mass loss over a period of 24 h is observed.

5.1.2 Test bench and set-up

The test cell concept (see Figures 1 and 2) allows pressurization of one side of the test sample and support of the low-pressure side while allowing the permeated test gas to flow through and exit to the detector. Detection and measurement of the permeated gas can be accomplished by several methods, including (but not limited to):

— measurement by permeated volume (e.g. using a pipette);

— measurement by mass spectroscopy;

— measurement by gas concentration in a fixed volume (ppm[2)]);

— measurement by pressure rise in a fixed volume;

or by any other equivalent methods.

The permeated gas shall be connected to the detector.

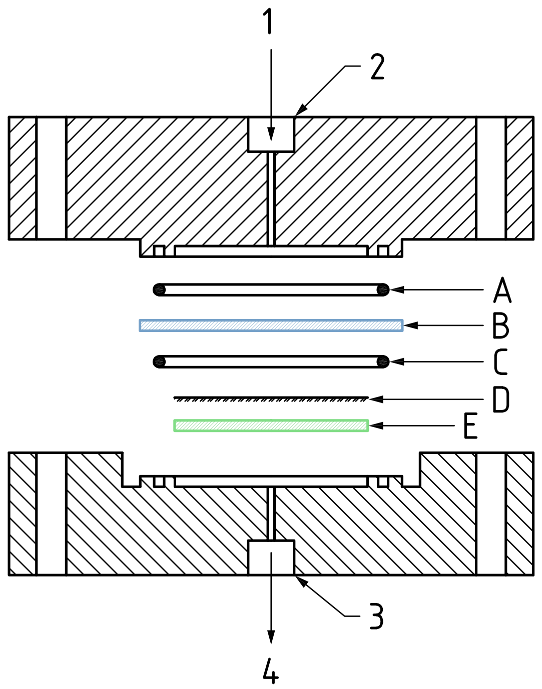
The exposed surface of the disc should have typically a diameter of 30 mm if the external diameter is equal to 40 mm.

Elastomer O-rings may be used to seal against the test specimen, as any permeation through the O-ring on the high-pressure side will exit the test cell without interfering with the permeated gas measurement. The permeation that occurs in the low-pressure O-ring will be minimal as the pressure of the permeated gas is low and therefore the concentration will be low.

Coupon-level permeation at pressure requires physical support on the low-pressure side which allows the permeated gas to exit to the detector. In order to have reproducible permeation results, it is critical to have the same contact area against the test specimen. This shall be achieved by using a wire-mesh screen (e.g. 150 µm opening to US-100 mesh) which will provide a consistent contact surface area between tests. The sintered metal shall be then used as the physical support behind the mesh.

1) In this document the unit bar is used, due to its universal use in the field of technical gases. It should, however, be noted that bar is not an SI unit, and that the corresponding SI unit for pressure is Pa (1 bar = 10^5 Pa = 10^5 N/m^2).

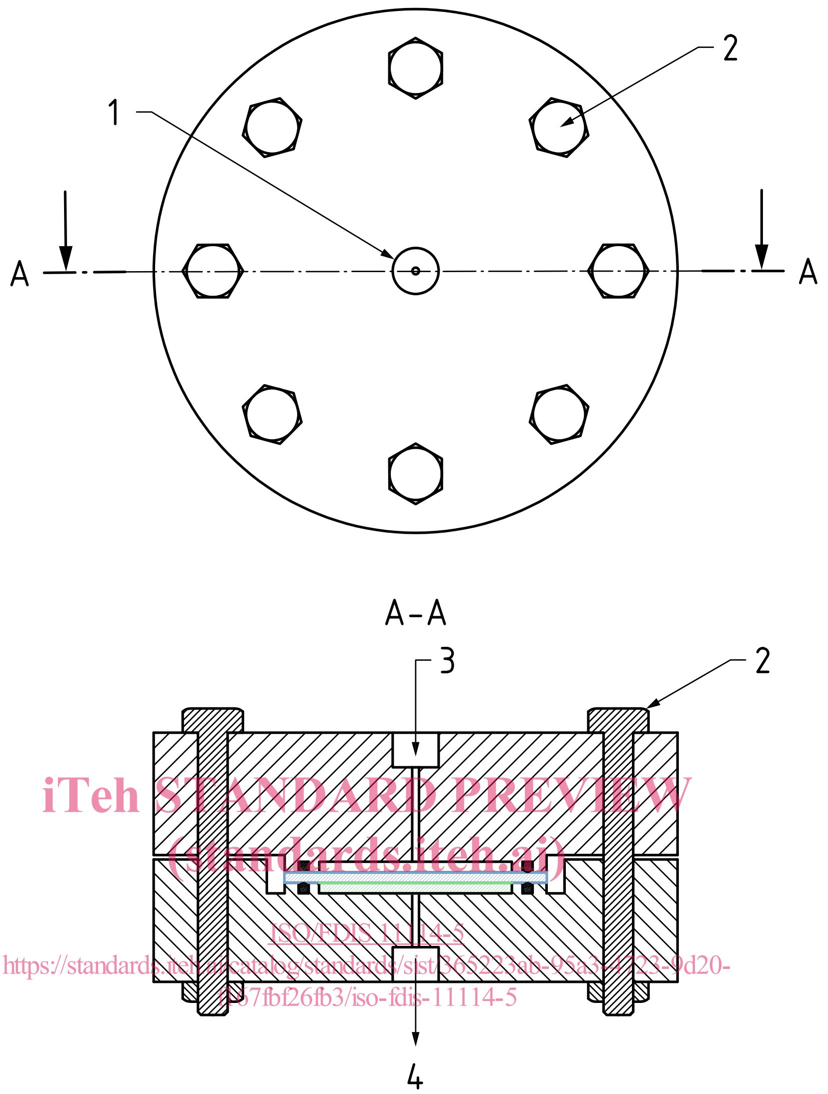
2) ppm = parts per million.



Key

1	high pressure gas	A	elastomer O-ring for sealing on the high-pressure side of the test specimen
2	high pressure gas port	B	liner test specimen
3	low pressure gas port	C	elastomer O-ring for sealing on the low-pressure side (permeation side) of the test specimen
4	to detector	D	wire mesh for uniform contact area on test specimen
		E	sintered metal support disk to allow permeated gas to exit test sample to detector

Figure 1 — Expanded schematic representation of the high-pressure permeation cell



Key

1 high-pressure gas inlet

2 high tensile bolts ×8

3 high-pressure gas

4 to detector

Figure 2 — Schematic representation of the high-pressure permeation cell

5.1.3 Procedure

The disc shall be degassed and de-humidified according to the recommendations given in 5.1.1.

A tightness/leak test shall be carried out in order to make sure that there is no leak at the edges (e.g. up to 180 bar with helium for high pressure hydrogen applications).

The permeability shall be measured at a given temperature and under pressure, which shall be recorded on the relevant test report.

NOTE Experience has shown that tests performed at higher temperatures (e.g. 65 °C) can result in softening of some plastic materials resulting in inconsistent results by this method.