INTERNATIONAL STANDARD

ISO 6529

First edition
1990-11-01

Protective clothing — Protection against liquid chemicals — Determination of resistance of air-impermeable materials to permeation by liquids

Vêtements de protection — Protection contre les produits chimiques liquides — Détermination de la résistance des matériaux imperméables à l'air à la transmission de liquides

Reference number
ISO 6529:1990(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6529 was prepared by Technical Committee ISO/TC 94, *Personal safety -- Protective clothing and equipment*.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Introduction

A simple flow-through, two compartment permeation cell, of standard dimensions is used to measure the permeation of liquid chemicals through clothing materials, corresponding breakthrough times being derived by a graphical technique, so as to enable comparisons to be made between specimens of clothing materials which may differ, for example, in thickness, density or composition.

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people for whose guidance it has been prepared and that appropriate precautions will be taken to avoid injury to health and contamination of the environment.

This page intentionally left blank

Protective clothing — Protection against liquid chemicals — Determination of resistance of air-impermeable materials to permeation by liquids

1 Scope

This International Standard describes a laboratory test method that enables an assessment to be made of the resistance to permeation by liquids afforded by clothing materials, used for industrial and agricultural applications.

The test method is only suitable for testing air-impermeable materials. It assesses the breakthrough time under laboratory conditions and the amount of test liquid that permeates thereafter. It also enables observations to be made of the effects of the test liquid on the material under test.

This test measures the permeation that arises from the combination of a process of diffusion of a test liquid from one side of a material to another, together with a secondary process of desorption into a collecting medium.

The rate of the secondary process is influenced by the diffusion rate of the liquid through the material, by the degree of distortion and gradual extension of the test specimen as increasing amounts of liquid are absorbed and by the experimental procedures used to collect and analyse the diffused liquid.

It is emphasized that the test does not necessarily simulate conditions that clothing materials are likely to be exposed to in practice. The use of test data should therefore be restricted to the broad comparative assessment of such materials according to their permeation characteristics.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 air-impermeable materials: Materials through which permanent gases cannot pass except by undergoing a process of solution.

2.2 breakthrough time: The elapsed time between the initial application of a test liquid to the appropriate surface of the material and its subsequent presence on the other side of the material, measured as described in this International Standard.

2.3 permeation: A combined process of molecular diffusion of a chemical through a solid material forming the whole or part of clothing and its desorption into a specified medium.

2.4 steady state permeation: A state that is reached when the rate of permeation becomes virtually constant.

2.5 test liquid: An individual liquid chemical or a liquid formulation of chemicals that is submitted for test by the method of this International Standard.

3 Principle

The test specimen acts as a barrier between one compartment of a permeation cell, which contains the test liquid, and another compartment through which a stream of gas or liquid is passed for the collection of diffused molecules of the test liquid or its component chemicals for analysis.

The mass of the test liquid or its component chemicals in the collecting medium is determined as a function of time after application to the test specimen, the breakthrough time and the masses permeating after breakthrough being derived graphically.

4 Reagents

4.1 Gaseous collecting medium.

Either dry air or a dry, non-flammable inert gas (e.g. nitrogen, helium).

NOTE 1 This gas is used, under continuous flow conditions, for the collection of diffused molecules from the test liquid capable of vaporizing under the conditions of the test in sufficient quantities for analysis.

4.2 Liquid collecting medium.

Either water or another liquid which does not influence the resistance of a material to permeation.

NOTE 2 This liquid is used, under continuous flow conditions, for the collection of diffused molecules of low volatility that are soluble in the collecting medium under the conditions of the test in sufficient quantities for analysis.

5 Apparatus

5.1 Permeation cell, comprising two flanged compartments, with dimensions as shown in figure 1, forming a hollow cylinder when bolted together through the flanges.

The upper compartment (or liquid compartment, see figure 1) for containment of the test liquid, is fitted with a loose cover to avoid build-up of pressure and prevent excessive contamination of the immediate environment when volatile chemicals are under test.

The lower compartment (or flow compartment) is of similar overall dimensions (see figure 1), but pipework is introduced to allow gas or liquid to circulate freely at the designated rates (5.2, 5.3) without build-up of pressure.

NOTE 3 The internal dimensions of the flow-through compartment (figure 1) and its pipework (internal diameter 4,5 mm) are critical to the performance of the test.

NOTE 4 The permeation cell and pipework should be constructed from inert materials. Brass apparatus is generally suitable for permeation tests by the gas-flow technique and polytetrafluoroethylene or glass by the liquid-flow technique.

5.2 Temperature controlled room, cabinet or water bath, to maintain temperature constant to a tolerance of ± 1°C over the period of test.

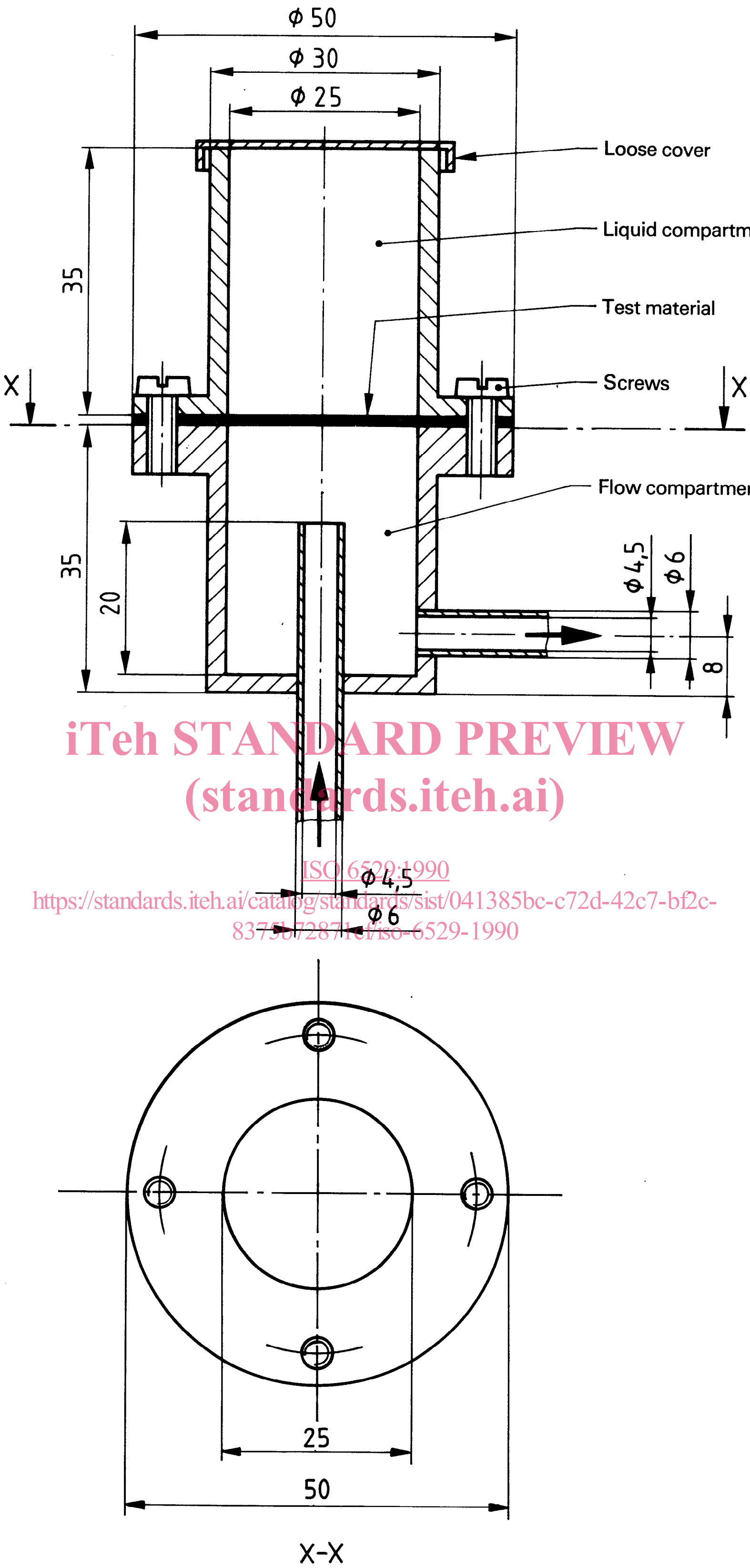
5.3 Equipment for supply of gaseous collection medium, comprising compressed gas supply (e.g. dry air, helium or nitrogen) complete with regulator, flowmeter and pipework for connection to the inlet of the flow compartment of the permeation cell. The rate of flow shall be 520 mL/min ± 52 mL/min in the direction indicated on figure 1.

NOTE 5 This is equivalent to approximately 30 compartment volume changes per minute.

The gas shall not be recirculated through the cell.

NOTE 6 The required rate of flow may be obtained either by suitable control of the gas pressure at the inlet to the permeation cell or by providing a pump at the outlet from the analyser. These alternative configurations are shown in figure 2. The choice of configuration is generally determined by the method of collection and/or detection of the test liquid or its component chemicals.

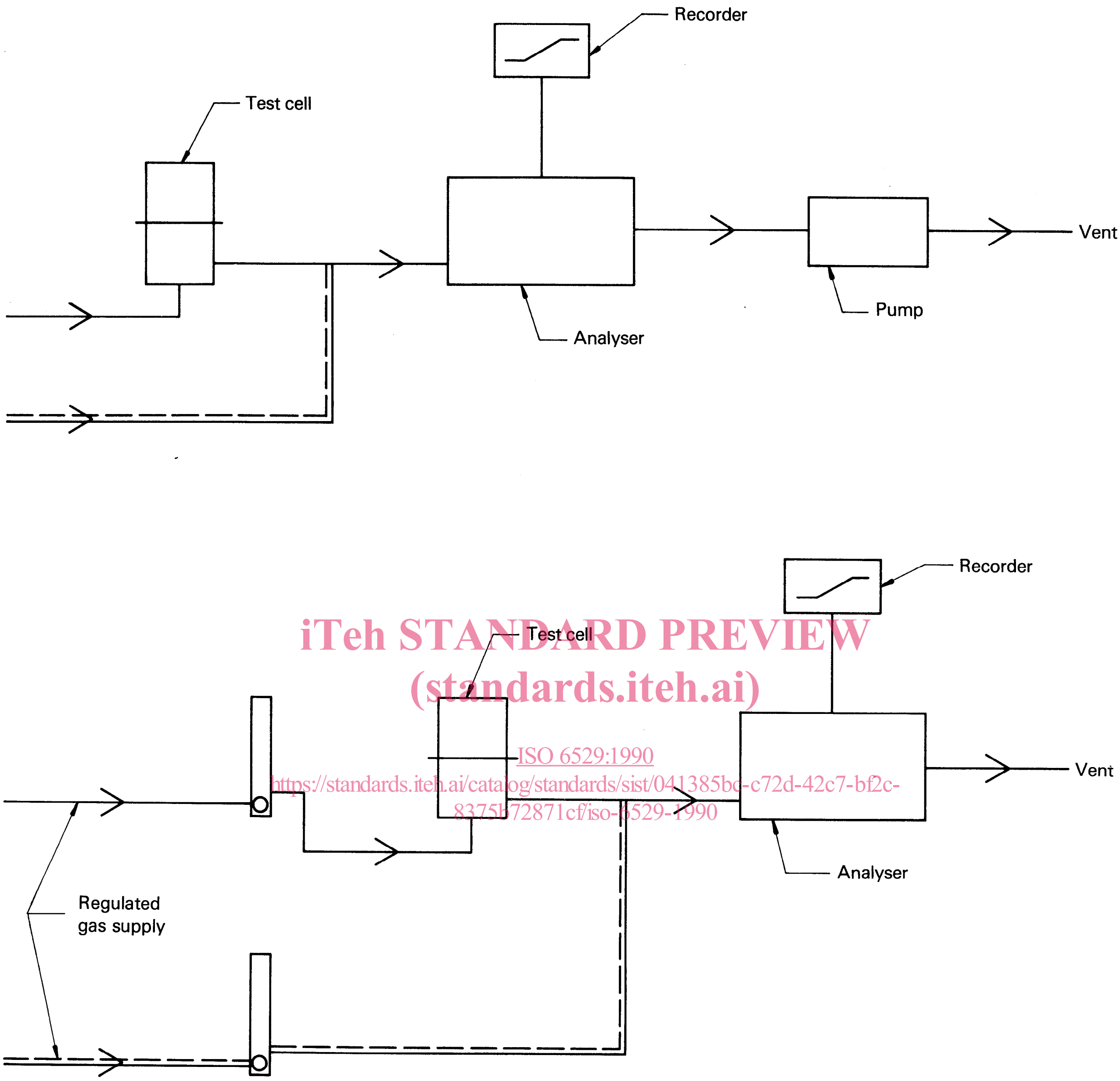
Dimensions in millimetres



Exposed area of test material : 4,91 cm^2

Volume of flow compartment : 17,2 cm^3

Figure 1 — Permeation cell



Legend:

══ ══ ══ Denotes optional arrangements to dilute the flow from the test cell.

Arrows denote direction of flow of gaseous collecting medium.

Figure 2 — The alternative arrangements of apparatus

5.4 Equipment for supply of liquid collecting medium, comprising liquid flow pump complete with regulator, flowmeter and pipework for connection to the inlet of the flow compartment of the permeation cell.

The rate of flow shall be 206 mL/min $\pm$ 21 mL/min in the direction indicated in figure 1.

NOTE 7 This is equivalent to approximately 12 compartment volume changes per minute.

The materials of construction of the equipment are such that no parts of the pump, associated pipework and flowmeter shall contaminate the liquid to be passed through the flow compartment of the permeation cell.

The collecting liquid shall not be recirculated through the permeation cell.

5.5 Equipment for measurement of the mass of test liquid or its component chemicals in the gas or liquid collecting medium, may include instruments responding directly to changes in concentration in the stream of gas or liquid, or may include absorbers and sampling equipment associated with specific analytical procedures.

NOTE 8 The analytical system should, where possible, have a minimum sensitivity for the selected component chemical of 1 µg/min/cm^2 of exposed specimen. The maximum response time should be 60 s. Whatever apparatus is coupled to the permeation cell to measure concentrations in the collecting medium, the pressure and flow of the collecting medium within the permeation cell should be maintained constant.

5.6 Stop clock, capable of measuring to the nearest second.

6 Test specimens

6.1 Selection

From a flat sample of the material submitted for test, cut from the same location a minimum of three test specimens of the same diameter as the flange of the permeation cell, avoiding as far as possible any obvious perforations, surface defects or pinholes.

NOTE 9 The testing of three similar specimens is intended to establish that the test method has been carried out correctly, as defined in 7.5.

If permeation testing is to be used to establish the uniformity of quality in a larger area of test material, e.g. a roll or sheet, then an appropriate statistical sampling technique should be used. In this case, three samples should be tested from each sampling site to demonstrate consistency of the permeation test.

NOTE 10 When defects in the test specimens may be such as to allow gross quantities of the test liquid to pass into the flow compartment, due account should be taken of the potential consequences of overloading the analytical detection equipment.

6.2 Preparation of test specimens

Use a template to mark on the test specimen the positions of the bolts used to clamp the two halves of the cell together. Cut circular holes to allow the bolts to pass freely through the test specimen when placed between the two halves of the permeation cell.

NOTE 11 If appropriate, the density and thickness of each test specimen should be assessed using techniques described in ISO 2286.

7 Procedure

7.1 Calibration

Calibrate the response of the analytical system to the test liquid or its component chemicals and, where appropriate, ensure that concentrations up to saturation of the collecting medium may be determined.

7.2 Preparation of apparatus

Mount the test specimen between the two halves of the permeation cell. Ensure that the surface of the test specimen corresponding to the outer surface when in use is uppermost in the cell, facing the compartment used to contain the test liquid. Check that the test specimen is not under tension when laid in position over the bolts. Tighten the bolts to obtain a leaktight assembly.

Where appropriate, take precautions to avoid transference of liquid from the top to the under surface of the test specimen.

NOTE 12 These precautions apply in particular if, for example, the top surface acts as a wick and the under surface is rough, when liquid may be drawn by capillary action across the top surface and reach the under surface via the bolt holes.

Place the assembled permeation cell, complete with leaktight pipework and connections to the appropriate equipment (5.3 or 5.4), in the temperature controlled room, cabinet or water bath (5.2) at the required temperature.

NOTE 13 The test should be conducted at the temperature most relevant to the use of the material or, in the absence of other preference, at 20°C.

Connect the appropriate gaseous or liquid collecting medium and adjust the flow through the permeation