BRITISH STANDARD

BS EN
374-3:2003

Protective gloves against chemicals and micro-organisms —

Part 3: Determination of resistance to permeation by chemicals

The European Standard EN 374-3:2003 has the status of a British Standard

ICS 13.340.40

BSI British Standards

National foreword

This British Standard is the official English language version of EN 374-3:2003. It supersedes BS EN 374-3:1994 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PH/3, Protective clothing, to Subcommittee PH/3/8, Protective gloves, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 16 September 2003

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 42646 7

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 374-3

September 2003

ICS 13.340.40

Supersedes EN 374-3:1994

English version

Protective gloves against chemicals and micro-organisms - Part 3: Determination of resistance to permeation by chemicals

Gants de protection contre les produits chimiques et les micro-organismes - Partie 3: Détermination de la résistance à la perméation des produits chimiques

Schutzhandschuhe gegen Chemikalien und Mikroorganismen - Teil 3: Bestimmung des Widerstandes gegen Permeation von Chemikalien

This European Standard was approved by CEN on 24 July 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 374-3:2003 E

Contents

-page

Foreword

This document (EN 374-3:2003) has been prepared by Technical Committee CEN /TC 162, "Protective clothing including hand and arm protection and lifejackets", of which the secretariat is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

This document supersedes EN 374-3:1994.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

EN 374 consists of the following Parts under the general title, *Protective gloves against chemicals and micro-organisms*:

– *Part 1: Terminology and performance requirements.*

– *Part 2: Determination of resistance to penetration.*

– *Part 3: Determination of resistance to permeation by chemicals.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

A simple flow-through, two-compartment permeation cell, of standard dimensions, is used to measure quantitatively the permeation of chemicals through protective glove materials. Breakthrough time is measured and used as a measure of protection.

1 Scope

This European Standard specifies the determination of the resistance of protective glove materials to permeation by potentially hazardous non-gaseous chemicals under the condition of continuous contact.

It is emphasised that the test does not represent conditions likely to be found in service, and the use of test data should be restricted to comparing materials chiefly on a relative basis in broad categories of breakthrough times.

2 Normative references

This European Standard incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate place in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 374-1, *Protective gloves against chemicals and micro-organisms — Part 1: Terminology and performance requirements.*

ISO 4648, *Rubber, vulcanised or thermoplastic — Determination of dimensions of test pieces and products for test purposes.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions in EN 374-1 apply with the following terms and definitions:

3.1
collecting medium
a medium in which the test chemical is freely soluble to saturation mass or volume fraction greater than 0,5 %

3.2
delay time
time between actual arrival of the test chemical on the collecting side of the specimen and the time when the analytical instrumentation responds to it

3.3
permeation rate
the mass of test chemical permeating the glove per unit area per unit time (in µg cm^{-2} min^{-1})

3.4
closed loop
breakthrough detection system in which the collecting medium is re-circulated through the sampling compartments of the test cell. Closed loop systems are not used with gaseous collection media

3.5
open loop
breakthrough detection system where the collecting medium passes through the sampling compartment of the test cell without re-circulation. Open loop systems may be used with either liquid or gaseous collection media

4 Test principle

The resistance of a protective glove material to permeation by a solid or liquid chemical is determined by measuring the breakthrough time of the chemical through the glove material.

In the permeation test apparatus the glove material separates the test chemical from the collecting medium.

The collecting medium, which can be a gas, a liquid or a solid, is analysed quantitatively for its concentration of the chemical and thereby the amount of that chemical that has permeated the barrier as a function of time after its initial contact with the glove material.

5 Collecting media

5.1 General

In situations were both the gaseous and another collecting medium can be used, the gaseous collecting medium shall be used.

5.2 Gaseous collecting medium

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

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

5.3 Liquid collecting medium

Water or other liquid which does not influence the resistance of a material to permeation.

NOTE This liquid is circulated or stirred, and it is used for the collection the test chemical permeating the tested material.

5.4 Other collecting medium

In certain cases where a chemical cannot be collected either by gaseous or liquid collecting media, other collecting media may be used such as porous polymers in powder form. The adaptation of the test procedure and the calculation have still to be developed.

6 Apparatus

6.1 Permeation cell

Components of the permeation test system shall not interact with the test chemical.

The permeation cell consists of two compartments, separated by the test specimen. The specimen's outer surface is in contact with the test chemical, whereas the specimen's inner surface is in contact with a collecting medium.

The permeation cell is constructed of two glass sections with an internal diameter of 51 mm at their open ends (see figures 1 and 2). The section containing the test chemical is 22 mm long; the section containing the collecting medium is 35 mm long. The limit deviation for each dimension shall not be greater than $\pm$ 2 mm.

Materials other than glass may be used, particularly when testing with chemicals which are incompatible with glass, e. g. hydrofluoric acid.

The open ends of the sections are fitted with connecting joints. The inlets and outlets of the sections are equipped with appropriate stopcock valves. The inlet of the section containing the test chemical may be closed by a stopper or a valve.

When assembled, the two glass sections are held together by flanges made of aluminium, stainless steel or any other suitable material. The specimen is positioned between the two flanges (see figure 1).

Alternative permeation cells may also be used, provided the precision and bias of the test results are found to be equivalent with the reference cell described in 6.1.

6.2 Temperature controlled room, cabinet or water bath

Temperature controlled room, cabinet or water bath, able to maintain the temperature of the permeation cell constant to within ± 1 °C over the complete duration of the test. The use of water baths shall be restricted to the testing of gloves without textile liner, except when adequate measures are taken to prevent the migration of water, e. g. by sealing the permeation cell in a waterproof envelope.

6.3 Gas supply, e. g. dry air, nitrogen or helium (in case of a gaseous collecting medium)

The gas supply, including a regulator and a flow meter, is connected to the inlet of the collector compartment of the permeation cell. The rate of flow through this compartment shall be equivalent to 5 (± 0,5) volume changes per minute. The volume of the collector compartment shall be measured accurately, e. g. by weighing the cell before and after filling the compartment with water.

NOTE The required rate of flow can be obtained preferably by a flow regulator or at least by a suitable control of the gas pressure at the inlet of the collector compartment or by using a pump at the outlet of the analyser. The choice of configuration is generally determined by the method of collection and/or detection of the test chemical.

6.4 Liquid pump and stirrer (in case of a liquid collecting medium)

The liquid in the collector compartment shall be stirred sufficiently to assure an adequate degree of mixing in all parts of the compartment. The flow rate shall be kept constant to within ± 10 %.

No part of the pump, stirrer or any other equipment connected to it shall contaminate the liquid passing through the collector compartment of the permeation cell.

6.5 Equipment for the quantitative determination of the test chemical or its components in the collecting medium

The analytical system shall be sufficiently sensitive for the test chemical to measure a permeation rate of 1 µg cm^{-2} min^{-1}. The delay time of the analytical system shall be measured. If the delay time is greater than 60 s, the breakthrough time shall be corrected by the real delay time. In case of mixtures the analytical equipment should be capable of detecting all relevant components. The pressure and flow of the collecting medium shall be kept constant regardless of the type of analytical apparatus used.

The analytical equipment can include instruments responding directly to concentration changes in the stream of gas or liquid. Absorbers and sampling equipment associated with specific analytical techniques may also be used. Examples of suitable analytical detection techniques are UV- and IR-spectrophotometry, gas and liquid chromatography, colorimetry and radionuclide tagging detection counting.

6.6 Time measuring device

A device capable of measuring elapsed times up to at least 480 min, to the nearest second.

7 Test specimens

7.1 Each material specimen to be tested shall have a minimum cross dimension of the same diameter as the flange of the permeation cell (68 mm in the case of the reference cell).

7.2 The sample shall be taken from the area tested for penetration. In the case of homogeneous design, one sample from the palm of three gloves shall be tested. In the case of irregular and/or multiple constructions, one sample shall be tested from each area, seams included. Two additional samples shall be tested on two other gloves taken from the area having the lowest breakthrough time.

8 Procedure

8.1 Calibration

The response of the complete collecting/analytical test system to the test chemical is calibrated in order to determine the analytical sensitivity and the delay time.

8.2 Preparation of test specimens and apparatus

The sample shall be conditioned for 24 h at a temperature of (23 ± 2) °C. The thickness is measured at the centre of each test specimen according to the method given in ISO 4648.

The test specimen is mounted between the two halves of the permeation cell. It should not be under tension when so positioned. The outer surface of the glove material should be in contact with the test chemical. The bolts of the assembly should be tightened to ensure the system is leak tight.

The assembled permeation cell is placed in a temperature controlled room, cabinet or water bath (see 6.2) at the specified temperature.

8.3 Test conditions

The standard test temperature shall be (23 ± 1) °C. Breakthrough time is affected by temperature and so additional tests may be run at other temperatures if they are relevant to the use of the gloves.

The gas or liquid stream is connected to the cell and the flow adjusted to the required rate (see 6.3 and 6.4). After the system has stabilised and has been connected to the detection equipment (see 6.5) the flow is rechecked.

8.4 Assessment of breakthrough time

The breakthrough time of a chemical (or mixture) is deemed to have occurred when the sum of the permeation rates of each individual component reaches the rate of 1 µg cm^{-2} min^{-1}. See 8.5.1 and the formulas in 8.5.2.

8.5 Test procedure for determination of the permeation rate

8.5.1 General

The test chemical, at the required test temperature (± 1 °C), is introduced into the challenge compartment of the permeation cell (see figure 1) and time measuring device is started (see 6.6). The compartment containing the test chemical shall be completely filled during the period of the test.

8.5.2 Open loop system

According to the equipment used (see 6.5) either the analysis measurements are taken continuously or discrete samples are withdrawn at suitable intervals of time. In the latter case the mid-point in the time elapsing between the drawing of successive samples and the difference in time between one such mid-point and the next is recorded. It is assumed that the entry of the test chemical into the collecting medium is constant.

The permeation rate is

$$P = \frac{(C_i)\,F}{A} \qquad (1)$$

P is the permeation rate in an open loop system,

C_i is the concentration of chemical in collecting medium at time t_i, in microgram per litre,

F is the flow rate of the collecting medium expressed in litre per minute,

A is the exposed area of the material specimen in square centimetres.

8.5.3 Closed loop system

Using a closed loop system breakthrough is deemed to have occurred when the calculated permeation rate reaches 1µg $cm^{-2}min^{-1}$.

The average permeation rate between two subsequent samplings, when samples are withdrawn, analysed, and replaced prior to further sampling or when the volume of discrete samples is insignificant relative to the total volume (for example microlitre aliquots) or when the test chemical is measured in situ, is calculated as follows:

$$P_i = \frac{(C_i - C_{i-1})\,V_t}{(t_i - t_{i-1})\,A} \qquad (2)$$

The average permeation rate between two subsequent samplings, when discrete samples of significant volume are removed from the collecting medium, is calculated as follows:

$$P_i = \frac{(C_i - C_{i-1})(V_t - [i-1]\,V_s)}{(t_i - t_{i-1})\,A} \qquad (3)$$

In case of replenishment of the collecting medium after each discrete sample the calculation becomes:

$$P_i = \frac{\left[(C_i - C_{i-1})\left[\frac{V_t - V_s}{V_t}\right]V_t\right]}{(t_i - t_{i-1})\,A} \qquad (4)$$

The following symbols have been used in the equations:

P_i is the permeation rate, in µg min^{-1} cm^{-2},

A is the area of the material specimen in contact, in square centimetres;

i is an indexing number assigned to each discrete sample, starting with i = 1 for the first sample;

t_i is the time at which discrete sample i was removed, in minutes;

C_i is the concentration of chemical in collecting medium at time t_i, in micrograms per litre;

V_t is the total volume of the collection medium, in litres,

V_S is the volume of discrete sample removed from the collection medium, in litres.

NOTE If permeation rates are observed to diminish with time, it is possible that the collecting medium is becoming saturated. The method should be changed to an open loop system and the flow rate increased.

8.5.4 Examination for degradation

Each test specimen is inspected for degradation immediately after opening the test cell and the changes are noted.

8.6 Expression of results

8.6.1 When a permeation rate of 1 μg cm^{-2} min^{-1} is detected, then the breakthrough time is reported in minutes (rounded to the nearest whole minute) for each test specimen. If the permeation rate does not reach 1 μg cm^{-2} min^{-1} then the duration of the test is reported. The lowest breakthrough time is used for the determination of the performance level.

8.6.2 The test temperature (in °C) and the temperature range during the test are reported.

9 Test report

9.1 For each protective glove material tested a report is prepared that describes the resistance of the material to the test chemical at the test temperature.

9.1.1 The manufacturer's reference for the material submitted for test is reported.

9.1.2 The thickness of each material specimen to the nearest 0,01 mm is reported. The average thickness is calculated and reported for the test specimens tested for each material type.

9.1.3 The name of the test chemical is reported and if it is multicomponent, the concentration of each component, if known.

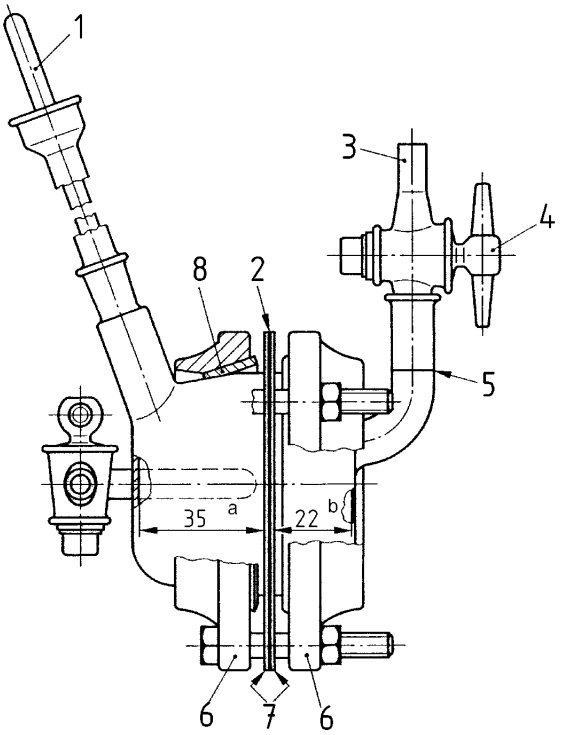
9.1.4 The test results expressed according to 8.6 are reported.

9.1.5 Any deviation from the test method shall be reported.

9.2 Any physical changes observed on the test specimens (8.5.4) are reported.

9.3 For each protective glove material tested, all relevant information shall be reported, such as: the collecting medium, loop system, the number of compartment volume changes per minute, the analytical technique used.

Dimensions in millimetres



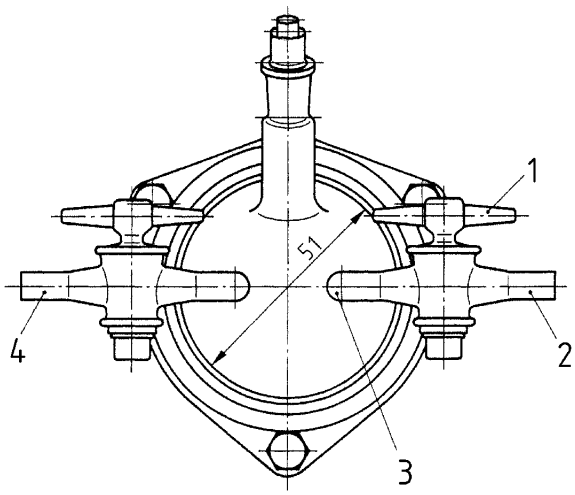
Key

1 Replaceable stirring rod to allow continuous monitoring with air or nitrogen
2 Specimen
3 Inlet
4 Stop valve
5 Fill level
6 Test cell holders: flanges usually made from aluminium
7 Material specimen holder : seals made usually from PTFE
8 Chamber retaining wedge

a) Sampling compartment for collecting medium (gas or liquid) with total collecting volume of approximately 100 ml
b) Challenge compartment for test chemical

Figure 1 — Example of test cell / Side view

Dimensions in millimetres



Key

1 Stop valve
2 Inlet
3 Liquid or gas sampling tube
4 Outlet

Figure 2 — Example of test cell / Rear view

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/686/EEC.

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The clauses of this standard specify a test method relating to EN 374-1 to support requirements of Directive 89/686/EEC, Annex II, clause 3.10.2.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL