BS 1970:2006

BRITISH STANDARD

Hot water bottles manufactured from rubber and PVC –

Specification

ICS 83.140.99; 97.180

Publishing and copyright information

ISBN 0 580 49353 9

The following BSI references relate to the work on this standard:
Committee reference PRI/68
Draft for comment 06/30134942 DC

Publication history

First published May 1953
First revision November 1961
Second revision June 1984
Third revision September 2001
Fourth revision November 2006

Amendments issued since publication

Amd. no.	Date	Text affected

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard was published by BSI and came into effect on 31 October 2006. It was prepared by Technical Committee PRI/68, *Hot water bottles*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 1970:2001, which is withdrawn.

Information about this document

This new edition represents a full revision of the standard, based on current knowledge and recent research funded by the DTI.

Hot water bottle manufacture has evolved and encompasses new production methods that were not reflected in the requirements of the 2001 edition. This revision has attempted to address these new production techniques by requiring hot water bottles to be tested as products and not the materials they are manufactured from.

The "full thickness" tensile strength and the newly introduced full thickness tear strength are requirements that assess the material, production method and mould design. The aim of this standard is to provide the minimum specification for safe hot water bottles and, in so doing, prevent some of the injuries that might have been a consequence of unsafe products.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

Attention is drawn to the Toys (Safety) Regulations 1995 (UK Statutory Instrument SI 1995 No. 204) which is applicable to hot water bottles that have any play value in the form of toys, or that include toys. Attention is also drawn to BS EN 71-1:2005, *Safety of toys – Specification for mechanical and physical properties.*

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 cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for the physical properties and performance of both rubber and PVC hot water bottles, designed for complete or partial filling with hot water by the user.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the reference cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 903-A6, *Physical testing of rubber – Part A6: Method for determination of compression set at ambient, elevated or low temperatures*
[ISO 815]

BS 903-A26, *Physical testing of rubber – Part A26: Method for determination of hardness (hardness between 10 IRHD and 100 IRHD)*
[ISO 48]

BS 2071, *Specifications for Soxhlet extractors*

BS EN 71-1:2005, *Safety of toys – Mechanical and physical properties*

BS EN 71-3:1995, *Safety of toys – Part 3: Specification for migration of certain elements*
[BS 5665-3:1995]

BS EN ISO 527-1, *Plastics – Determination of tensile properties – General principles*
[BS 2782-3:Method 321, ISO 527-1]

BS EN ISO 527-3, *Plastics – Determination of tensile properties – Test conditions for films and sheets*
[BS 2782-3:Method 326E]

BS ISO 34-1, *Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 1: Trouser, angle and crescent test pieces*

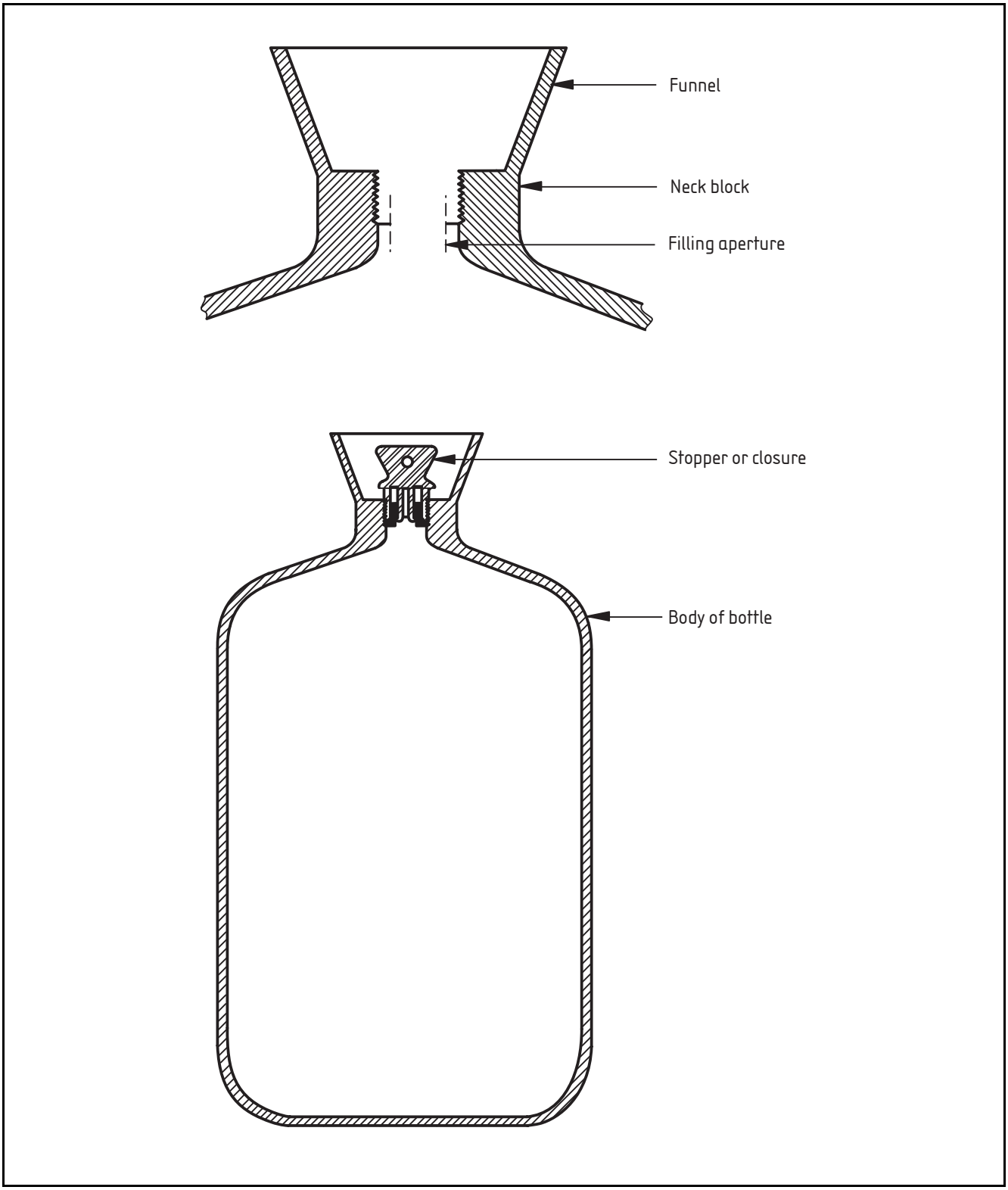
BS ISO 37, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

BS ISO 188, *Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests*
[BS 903-A19]

BS ISO 2285, *Rubber, vulcanized or thermoplastic – Determination of tension set under constant elongation, and of tension set, elongation and creep under constant tensile load*

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

Figure 1 **Hot water bottle components**



3 Composition

When tested in accordance with BS EN 71-3:1995, the hot water bottle shall not contain proportions (by mass) of migratory elements in excess of the limits in Table 1 of BS EN 71-3:1995.

4 Physical properties

4.1 Visual examination

See Figure 1 for hot water bottle components.

When inspected with the naked eye, the hot water bottle shall not exhibit:

a) inclusions of foreign matter;

b) tears, blisters, cuts; or

c) any other defects that could adversely affect the safe performance of the hot water bottle.

NOTE Attention should be paid to the neck–body intersection where trimming can result in a nick which acts as a stress raiser that weakens the product in this area.

The visual examination shall continue during the preparation of test pieces as the discovery of any of these detrimental defects will constitute failure to conform to this standard.

4.2 Thickness

The hot water bottle shall, at no point on its surface, have a thickness less than that shown in Table 1, according to its capacity and the material of construction.

Thickness shall be determined in accordance with the method in Annex A, and the capacity determined in accordance with the appropriate method in Annex B.

Table 1 **Minimum thickness of hot water bottles**

Rubber hot water bottles		**PVC hot water bottles**	
Capacity ml	**Minimum thickness** mm	**Capacity** ml	**Minimum thickness** mm
< 2 000	1.4	< 800	1.5
≥ 2 000	1.5	≥ 800 < 2 000	1.7
		≥ 2 000	1.8

4.3 Filling characteristics

The minimum filling aperture shall not be less than 18 mm diameter.

If the diameter of the filling aperture is less than 20.3 mm, the bottle shall be equipped with an integral filling funnel having a minimum capacity of 60 ml with the stopper fitted, and extending beyond the height of the stopper.

5 Closures

5.1 General

The hot water bottle shall be provided with a stopper that, when tested in accordance with **C.3**, Test 1 and **C.4**, Test 2 shall show no visible leakage and no visible damage to the closure.

When tested in accordance with **C.5**, Test 3, the closure and any of its detachable parts shall not fit entirely in any orientation within the small parts cylinder having dimensions as in Figure C.1.

5.2 Test for separation of screwed closures

When tested in accordance with Annex D, there shall be no leakage or separation between:

a) the stopper and the ferrule;

b) the ferrule and the neck block;

c) the neck block and the body of the hot water bottle.

There shall be no other visual defects that could impair the integrity of the bottle.

5.3 Rubber components

If a rubber washer is used as part of a screw stopper or if a rubber plug (push-in rubber stopper) is provided, the rubber shall have a hardness of between 55 IRHD and 80 IRHD, when determined in accordance with BS 903-A26, Method N.

The rubber compound from which a plug or washer is manufactured shall have a compression set of not greater than 30%, when determined in accordance with BS 903-A6, using Type 1 test pieces, for 24^{0}_{-2}h with a temperature of (70 ± 1) °C maintained during the compression period.

When tested in accordance with **C.4**, Test 2, the rubber washer shall not exhibit a loss of thickness greater than 30%.

6 Performance

6.1 Leakage

The hot water bottle body shall show no visible leakage when inflated with air to a minimum pressure of (14 ± 0.5) kPa and immersed in water for a minimum time of 5 s.

6.2 Strength of bonded (or welded) seams

If present, bonded (or welded) seams shall withstand a minimum tensile force of 72 N when tested in accordance with Annex E.

6.3 Pressure test

The hot water bottle shall show no visible leakage when tested in accordance with Annex F.

6.4 Tensile stress–strain properties

6.4.1 General

Rubber hot water bottles shall be tested in accordance with **6.4.2**. The full thickness tensile properties as specified in **6.4.2.1**, **6.4.2.2** and **6.4.2.3** shall be determined in accordance with BS ISO 37, using Type 1 dumb-bell test pieces, unless the shape of the bottle is such that Type 1 dumb-bells cannot be cut from it, when Type 2 dumb-bell test pieces shall be used.

PVC hot water bottles shall be tested in accordance with **6.4.3**. The full thickness tensile properties as specified in **6.4.3.1**, **6.4.3.2** and **6.4.3.3** shall be determined in accordance with BS EN ISO 527-1 using a rate of grip separation of 500 mm/min. BS EN ISO 527-3 Type 5 dumb-bell test pieces shall be used, unless the shape of the bottle is such that Type 5 dumb-bells cannot be cut from it, when BS ISO 37 Type 2 dumb-bell test pieces shall be used.

The full thickness tensile properties shall be determined on the hot water bottle without removing any embossing or ribbing from the test pieces. The strength shall be calculated as the maximum load in newtons at break divided by the width of the central parallel portion of the dumb-bell used.

NOTE The width is normally taken from measurements made on the cutter.

A minimum of three test pieces (preferably five) shall be taken in two directions from the hot water bottle. If the embossing or ribs are unidirectional, the test pieces shall be taken so that their major axis is parallel to the embossing or ribs and at right angles to the embossing or ribs. If the embossing or ribs are not unidirectional, take test pieces in two directions at right angles to incorporate the possible maximum and minimum strength.

6.4.2 Tensile tests for rubber hot water bottles

6.4.2.1 Tensile stress–strain properties before ageing

When tested in accordance with **6.4.1**, the tensile strength shall be not less than 22.5 N/mm width and the elongation at break shall be not less than 500%.

6.4.2.2 Tensile stress–strain properties after ageing

After ageing the test pieces in an air circulating oven for (168 ± 2) h at a temperature of (70 ± 1) °C in accordance with BS ISO 188, the tensile strength shall be not less than 17.0 N/mm width and the elongation at break shall be not less than 425%.

6.4.2.3 Tensile stress–strain properties after immersion

After continuous immersion of the test pieces in distilled water of a temperature of (70 ± 1) °C for (95 ± 1) h, the tensile strength shall be not less than 21.0 N/mm width and the elongation at break shall be not less than 425%. The test pieces shall be measured before immersion in the water. After the immersion period, the test pieces shall be stored in water at (23 ± 2) °C for a period of not less than 16 h and not more than 96 h before testing.

6.4.3 Tensile tests for PVC hot water bottles

6.4.3.1 Tensile stress–strain properties before ageing

When tested in accordance with **6.4.1**, the tensile strength shall be not less than 12 N/mm width and the elongation at break shall be not less than 200%.

6.4.3.2 Tensile stress–strain properties after ageing

After ageing in an air circulating oven as described in BS ISO 188 for (168 ± 2) h at a temperature of (100 ± 2) °C and, when tested in accordance with **6.4.1**, the tensile strength shall be not less than 12 N/mm width and the elongation at break shall be not less than 200%.

6.4.3.3 Tensile stress–strain properties after extraction

After Soxhlet extraction with water of the test pieces over (168 ± 2) h using an apparatus in accordance with BS 2071, the tensile strength of the test pieces shall be not less than 12 N/mm width and the elongation at break shall be not less than 200% when tested in accordance with **6.4.1**.

6.5 Other material specific requirements

6.5.1 Tension set for rubber hot water bottles

When determined in accordance with Annex G, the tension set shall be not more that 20% of the original length.

6.5.2 Percentage mass change after extraction for PVC hot water bottles

After Soxhlet extraction with water of the test pieces over (168 ± 2) h, using an apparatus in accordance with BS 2071, the percentage mass change shall be –5% to +15% inclusive.

6.5.3 Creep resistance for PVC hot water bottles

When tested in accordance with Annex H, the percentage creep shall not be greater than 50%.

6.6 Tear strength

The full thickness tear strength shall be determined in accordance with BS ISO 34-1 using crescent test pieces. A minimum of five pieces shall be used, unless the shape of the bottle is such that five test pieces cannot be cut from it, when three pieces shall be used.

The full thickness tear strength shall be determined on the hot water bottle without removing any embossing or ribbing from the test piece. The strength shall be calculated as the maximum load in newtons at break. The test pieces shall be taken in two directions from the hot water bottle. If the embossing or ribs are unidirectional, the test pieces shall be taken so as their major axis is parallel to the embossing or ribs and at right angles to the embossing or ribs. If the embossing or ribs are not unidirectional, take test pieces in two directions at right angles to incorporate the possible maximum and minimum strength.

The unaged full thickness tear strength shall have a minimum value of not less than that shown in Table 2.

Table 2 **Full thickness tear strength**

Rubber hot water bottles	**PVC hot water bottles**
80 N	60 N

7 Marking

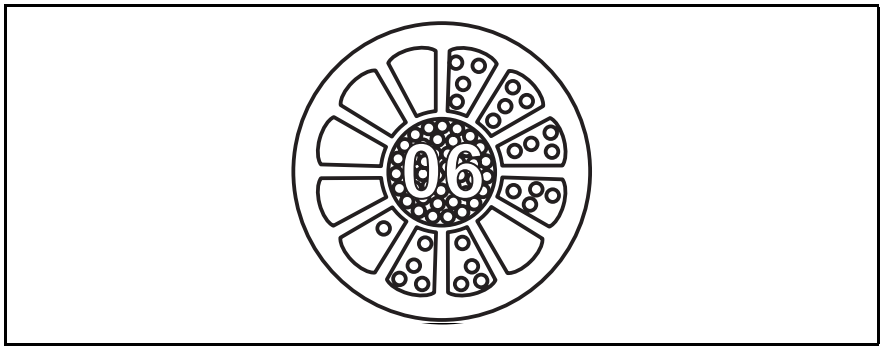
Each hot water bottle shall be legibly and permanently marked with the number and date of this British Standard, i.e. BS 1970:2006[1)] and, additionally, with the following in the form of a simple code:

a) name or trade mark of the manufacturer or supplier;

b) a date daisy (see Figure 2) indicating:

- year of manufacture (centre circle);
- month of manufacture (12 segments marked continuously clockwise from January, January being the top right-hand segment);
- week of manufacture (marks within segments).

Figure 2 **Example of date daisy**



NOTE This example depicts week of manufacture first week in August 2006 with no production in May.

1) Marking BS 1970:2006 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

8 Informative labelling

8.1 General

Each hot water bottle shall be accompanied by the identification of the European manufacturer, or the UK distributor for bottles manufactured outside the European Union, and the following warning in the format given:

"WARNING – HOT WATER BOTTLES CAN CAUSE BURNS.

AVOID PROLONGED DIRECT CONTACT WITH THE SKIN".

If the hot water bottle contains natural rubber, a clear and legible statement shall accompany the product as follows:

"This hot water bottle is made of natural rubber".

8.2 Hot water bottles with screw stoppers

Each hot water bottle shall be accompanied by at least the following instructions, depending on the design designated by the manufacturer.

a) Hot water bottles designed for partial filling.

"When filling this hot water bottle, do not use boiling water and fill to a maximum of two-thirds capacity. Hold the bottle by the neck in an upright position and fill slowly to avoid hot water splashing back. Expel air from the bottle by lowering it carefully onto a flat surface until water appears at the opening. Screw the stopper sufficiently tight to ensure that there is no leakage. Finger-tight should be adequate.

Do not fill using water from the domestic hot water system as this can considerably shorten the life of the hot water bottle.

Prevent contact with hot surfaces.

Prevent contact with oil or grease.

When not in use, drain completely and keep, with the stopper removed, in a cool, dry, dark place. Prevent exposure to sunlight. Do not place anything on top of the bottle.

Check the bottle and stopper for wear and damage at regular intervals.

Retain these instructions for future reference."

OR

b) Hot water bottles designed to be completely filled.

"When filling this hot water bottle, do not use boiling water. Hold the bottle by the neck in an upright position and fill slowly to avoid hot water splashing back. Fill until water appears at the opening. Screw the stopper sufficiently tight to ensure that there is no leakage. Finger-tight should be adequate.

Do not fill using water from the domestic hot water system as this can considerably shorten the life of the hot water bottle.

Prevent contact with hot surfaces.

Prevent contact with oil or grease.

When not is use, drain completely and keep, with the stopper removed, in a cool, dry, dark place. Prevent exposure to sunlight. Do not place anything on top of the bottle.

Check the bottle and stopper for wear and damage at regular intervals.

Retain these instructions for future reference."

8.3 Hot water bottles with closures other than screw stoppers

Each hot water bottle shall be accompanied by at least the following instructions, depending on the design designated by the manufacturer. Additional text relevant to the design of the hot water bottle shall be included where stated.

a) Hot water bottles designed for partial filling.

"When filling this hot water bottle, do not use boiling water and fill to a maximum of two-thirds capacity. Hold the bottle by the neck in an upright position and fill slowly to avoid hot water splashing back. Expel air from the bottle by lowering it carefully onto a flat surface until water appears at the opening. Insert the stopper securely.

Do not fill using water from the domestic hot water system as this can considerably shorten the life of the hot water bottle.

Prevent contact with hot surfaces.

Prevent contact with oil or grease.

When not in use, drain completely and keep, with the stopper removed, in a cool, dry, dark place. Prevent exposure to sunlight. Do not place anything on top of the bottle.

Check the bottle and stopper for wear and damage at regular intervals.

Retain these instructions for future reference."

OR

b) Hot water bottles designed to be completely filled.

"When filling this hot water bottle, do not use boiling water. Hold the bottle by the neck in an upright position and fill slowly to avoid hot water splashing back. Fill until water appears at the opening. Insert the stopper securely.

Do not fill using water from the domestic hot water system as this can considerably shorten the life of the hot water bottle.

Prevent contact with hot surfaces.

Prevent contact with oil or grease.

When not in use, drain completely and keep, with the stopper removed, in a cool, dry, dark place. Prevent exposure to sunlight. Do not place anything on top of the bottle.

Check the bottle and stopper for wear and damage at regular intervals.

Retain these instructions for future reference."

9 Packaging

If a flexible film bag is used for packaging, the following warning shall be printed on the film in the format given:

"PLASTIC BAGS CAN BE DANGEROUS. TO AVOID DANGER OF SUFFOCATION, KEEP THIS BAG AWAY FROM BABIES AND CHILDREN."

Annex A (normative) Determination of thickness

A.1 Apparatus

A.1.1 *Thickness gauge*, for locating the thinnest point of the bottle face, conforming to Method A of BS ISO 23529.

A.1.2 *Thickness gauge*, for determining the thickness, conforming to Method D of BS ISO 23529.

A.2 Procedure

Cut the bottle round the periphery to separate the two faces of the bottle. Locate the thinnest point on either face. At the thinnest point, cut a test piece of suitable size. Measure the thickness and record the minimum thickness to the nearest 0.01 mm.

Annex B (normative) Determination of capacity

B.1 Method 1

B.1.1 Apparatus

B.1.1.1 *Laboratory thermometer or similar device*, capable of measuring the temperature to an accuracy of 0.5 °C.

B.1.1.2 *Volumetric container*, of Grade A quality and of greater capacity than the bottle being measured.

B.1.2 Procedure

Suspend the hot water bottle in a vertical position and fill it with water at (23 ± 2) °C until water appears at the opening. After five minutes, top up the water, if necessary, to the previous level. Transfer the water to a volumetric container graduated in millilitres and take the total volume of water as the capacity of the hot water bottle.

B.2 Method 2

B.2.1 Apparatus

B.2.1.1 *Laboratory balance*, accurate to 0.1 g.

B.2.2 *Procedure*

Weigh and record the mass of the empty hot water bottle (M_1), including the stopper. Suspend the hot water bottle in a vertical position and fill it with distilled water at (23 ± 2) °C until water appears at the opening. After five minutes, top up the water, if necessary, to the previous level. Fit the stopper and weigh and record the mass of the full hot water bottle (M_2).

Calculate the volume of the hot water bottle as $M_2 - M_1$, taking the density of distilled water at (23 ± 2) °C to be 1 g/ml.

Annex C (normative) Tests for closures

C.1 Apparatus

C.1.1 *Laboratory thermometer or similar device*, capable of measuring the temperature to an accuracy of 0.5 °C.

C.1.2 *Torque wrench or torque screwdriver*, capable of being set to or read to an accuracy of 0.1 N·m. It shall have a suitable adapter that fits the stopper and provides the application of the torque through the axis of the stopper.

C.1.3 *Compression apparatus consisting of a Grade 1 tensile machine*, capable of generating a compressive force of 0.9 kN. The upper and lower platens shall be horizontal and shall have flat smooth faces and be of sufficient thickness to prevent significant deformation under the loading. The platen size shall be large enough to accommodate the main body of the bottle excluding the neck.

C.1.4 *Thickness gauge*, for locating the thinnest point of the bottle face, conforming to Method A of BS ISO 23529.

C.2 Filling the bottles prior to tests

Fill the bottles according to a) or b).

a) Filling prior to test for bottles designed to be partially filled.

   Fill the hot water bottle to two-thirds of its capacity. Expel all the air by lowering the bottle carefully onto a flat surface and insert the appropriate stopper.

b) Filling prior to test for bottles designed to be completely filled.

   Fill the hot water bottle in an upright position until water appears at the opening and insert the appropriate stopper.

C.3 Test 1

Using water at a temperature of (85 ± 2) °C, either partially fill or complete fill the hot water bottle as specified in **C.2**a) or **C.2**b) appropriate to the design of the bottle. For screw stoppers, tighten the stopper to a torque of (2 ± 0.1) N·m; for push-in stoppers, push the stopper in fully. Immediately place the bottle in a horizontal position and apply a force of $0.9^{+0.09}_{0}$ kN, evenly distributed over the surface of the bottle, for at least five minutes. Check for any visible leakage.

C.4 Test 2

Measure the thickness of the rubber washer, if fitted.

NOTE The washer might not be removable for child safety reasons, and the measurement of the thickness with respect to another datum point will be necessary.

Using water that has just gone off the boil, partially fill or completely fill the bottle as specified in **C.2**a) or **C.2**b) appropriate to the design of the bottle. For screw stoppers, tighten the stopper to a torque of (2 ± 0.1) N·m; for push-in stoppers, push the stopper in fully. Invert the hot water bottle and suspend it vertically for 10^{+1}_{0} min. Remove the stopper and empty the bottle.

Repeat the cycle of filling the hot water bottle, suspending it for 10 min and then emptying it, for a total of 20 cycles in a continuous period of up to 168 h. Check for any visible leakage during the test and examine the stopper after the test for any visible damage.

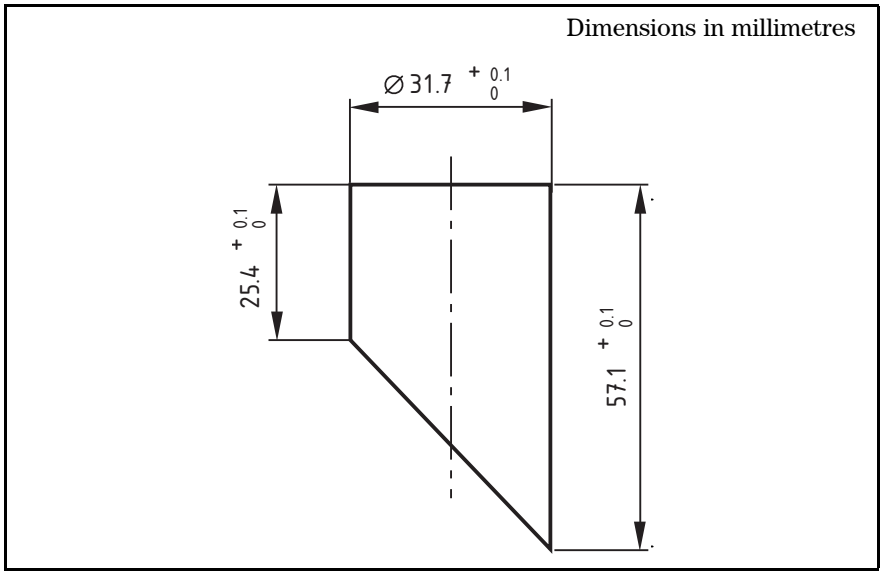
Measure the thickness of the rubber washer, if fitted, after the test and determine the loss of thickness as a percentage of the original thickness.

C.5 Test 3

Place the closure or any of its detachable parts, without compressing and in any orientation, in a cylinder having dimensions as in Figure C.1. The closure or any of its detachable parts shall not fit entirely within the cylinder.

The closure shall be tested in accordance with BS EN 71-1: 2005, **8.2**, in conjunction with BS EN 71-1: 2005, **8.4** tension test.

Figure C.1 **Small parts cylinder**



Annex D (normative) Test for separation of screw stoppers

D.1 Apparatus

D.1.1 *Torque wrench or torque screwdriver*, capable of being set to or read to an accuracy of 0.1 N·m. It shall have a suitable adapter that fits the stopper and provides the application of the torque through the axis of the stopper.

D.1.2 *Tensile machine*, capable of generating of tensile force of 0.5 kN between the upper and lower platen. The upper shall be equipped with a tensile jaw capable of holding the stopper. The bottom platen shall be equipped with a jaw capable of securely holding the body of the hot water bottle without tearing any part.

D.2 Procedure

Ensure that the hot water bottle is at standard laboratory temperature [(23 ± 2) °C]. Insert the stopper and tighten to a torque of (2 ± 0.1) N·m. Apply a force of 0.5 kN between the body of the bottle and the stopper. Maintain this load for five minutes. Fill the bottle as described in **C.2** with water of (23 ± 2) °C and then apply a continuous compressive force of $0.9^{+0.09}_{0}$ kN to the body of the bottle for 2 min ± 30 s using the equipment described in Annex F. Inspect for visible leakage and for any separation of the stopper.

Annex E (normative) Seam test

Cut from the hot water bottle, six equally spaced strip test pieces 12.5 mm wide and with a minimum length of 115 mm at right angles to and around the seam. Insert the test piece in the jaws of a tensile testing machine and, using a rate of grip separation of 500 mm/min, apply sufficient force to break the test piece completely. Record the maximum force required.

Report the result as the median of the individual values determined for the six test pieces.

Annex F (normative) Determination of pressure resistance

F.1 Apparatus

F.1.1 *Test apparatus*, with smooth upper and lower plates at least the size of the bottle without contact with the neck. All contact edges of the plates shall have smooth edges of approximately 3 mm radius and be free from any sharp corners. The apparatus shall be capable of cycling the upper plate to apply a load of between 0 kN and 0.9 kN in not less than 3 s, dwelling at the maximum load for a minimum of 3 s, before returning to zero load in a minimum of 3 s and not less than five cycles per minute.

F.2 Procedure

Place the filled hot water on the lower plate of the test apparatus. Fill the hot water bottle as described in **C.2** with water at (23 ± 2) °C. Perform the cycle for 500 cycles. On completion, the hot water bottle shall be examined for leakage or other detrimental effect.

Annex G (normative) Determination of tension set

G.1 Apparatus

The apparatus listed in BS ISO 2285 (with the exception of the oven) shall be used.

G.2 Test piece

The test piece shall be the Type 1 dumb-bell described in BS ISO 37, or the Type 2 dumb-bell if the shape of the bottle is such that Type 1 dumb-bells cannot be cut from it.

Three full thickness test pieces shall be tested.

G.3 Conditioning and marking of test pieces

Condition and mark the test pieces in accordance with BS ISO 2285.

G.4 Procedure

Carry out the test at (23 ± 2) °C. Measure the reference length of the non-strained test piece. Insert the test piece symmetrically in the grips of the straining device so that, when it is stretched, the force will be distributed uniformly over the cross-section and the reference lines will remain substantially parallel. Stretch the test piece at a steady rate to an elongation of (350 ± 10)%, in not less than 10 s and not more than 30 s, and hold it at this elongation for 10^{+1}_{0} min. If the test piece is inadvertently stretched beyond the specified elongation, discard the test piece and repeat the test using a further test piece.

NOTE Continuous attention might be necessary to maintain the elongation if the test piece tends to creep slowly from the grips.

After the 10 min, release the test piece quickly, but without allowing it to snap back, and place it on a smooth flat surface to recover for 10^{+1}_{0} min. After recovery, measure the distance between the centres of the two reference lines.

G.5 Expression of results

Calculate the tension set by subtracting the original distance between the reference lines from the distance between the reference lines after recovery and expressing this difference as a percentage of the original distance. Report the result as the median of the individual values determined for three test pieces.

Annex H (normative) Determination of creep resistance

H.1 Principle

The percentage elongation of rectangular test pieces is determined after one hour under constant load conditions and, for the purpose of this standard, is defined as creep resistance.

H.2 Test pieces

Three full thickness test pieces shall be prepared with their principal axes parallel to either the width or length of the bottle. Each test piece shall be a rectangular strip (150 ± 1) mm long and (10 ± 0.1) mm wide. Each test piece shall be marked centrally with a reference length, where the bench marks are 50 mm apart.

H.3 Conditioning

The test pieces shall be conditioned for not less than 16 h at (23 ± 2) °C and at (50 ± 5)% relative humidity before testing.

H.4 Procedure

Suspend each test piece and apply a force of $20^{+0.2}_{0}$ N to the lower end. After 10, 20, 40 and 80 min, measure the separation of the bench marks to the nearest 1 mm, without removing the force. Plot the values of percentage elongation at 10, 20, 40 and 80 min on a linear scale against the logarithmic values of the times and interpolate the value at one hour as the percentage creep.

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