
**Plastics piping systems for the conveyance
of water intended for human consumption —
Migration assessment — Determination
of migration values for plastics pipes**

*Systèmes de canalisations en plastiques pour le transport d'eau destinée
à la consommation humaine — Évaluation de la migration — Détermination
des valeurs de migration des tubes plastiques*



Foreword

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International Standard ISO 8795 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

This second edition cancels and replaces the first edition (ISO 8795:1990), which has been technically revised.

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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Plastics piping systems for the conveyance of water intended for human consumption — Migration assessment — Determination of migration values for plastics pipes

1 Scope

This International Standard specifies a method for the determination of the migration of constituents from the internal surface of plastics pipes. Organoleptic and microbiological assessments are not included.

It applies to all plastics pipes to be used for the conveyance of water intended for human consumption and raw water used for the production of water intended for human consumption. It concerns constituents which are extractable from a pipe by water. It provides for a modification in procedure as necessary depending upon the size of the pipe.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of the publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3696:1987, *Water for analytical laboratory use – Specification and test methods*.

ISO 7393-2:1985, *Water quality – Determination of free chlorine and total chlorine – Part 2: Colorimetric method using N,N-diethyl-1,4-phenylenediamine, for routine control purposes*.

3 Definitions

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

3.1 migration: Movement of a substance from the material of the plastic pipe into another material (a test liquid).

3.2 test liquid: Water of specified quality for migration testing.

3.3 migration value (M): The mass of the constituent(s) extracted, at a specified temperature and over a specified time, from a specified inner surface area of a pipe test piece in contact with a test liquid.

3.4 tap water: Water intended for human consumption.

4 Principle

The test pieces are first allowed to stand with tap water inside them for a fixed length of time, and then washed with tap water for a specified length of time.

They are then filled with the specified test liquid at a specified temperature and maintained thus for a series of specified migration periods.

NOTE – The following test parameters are set by the standard concerned:

- a) the test liquid(s) (see 5.2) ;
- b) the test temperature T , if other than that given in clause 6 ;
- c) the number of pairs of test pieces (see 8.3) ;
- d) the constituents to be determined, both in testing the test pieces and in the blank test, and the required accuracy, taking account of 9.5 (see also clause 10).

5 Reagents

5.1 Water, conforming to grade 3 of ISO 3696:1987, with the following characteristics:

- a) a conductivity of ≤ 10 mS/m at 25 °C;
- b) total organic carbon (TOC) content $\leq 0,2$ mg/l (as carbon);
- c) negligible concentrations of any measurable substance which may interfere with the determination of a) and b).

5.2 Test liquids

NOTE – The methods of preparing these test liquids are given in annex A.

5.2.1 Water, conforming to 5.1.

5.2.2 Chlorinated water, made from water conforming to 5.1, with an active-chlorine concentration of $(1,0 \pm 0,2)$ mg/l.

5.2.3 Acidic water, comprising water conforming to 5.1 adjusted to a pH of $(4,5 \pm 0,1)$ with a KH_2PO_4 buffer solution conforming to A.1.2.

5.2.4 Chlorinated acidic water, comprising water conforming to 5.1 adjusted to a pH of $(4,5 \pm 0,1)$ with a KH_2PO_4 buffer solution conforming to A.1.2 and with an active-chlorine concentration of $(1,0 \pm 0,2)$ mg/l.

5.2.5 Alkaline water, comprising water conforming to 5.1 adjusted to a pH of $(9,0 \pm 0,1)$ with a boric acid buffer solution conforming to A.1.3.

5.3 Choice of test liquid

5.3.1 For cold-water applications, the test liquid shall conform to 5.2.1 to 5.2.5 inclusive.

5.3.2 For warm- and hot-water applications (see clause 6), the test liquid shall conform to 5.2.1.

6 Apparatus

6.1 Connections, stoppers and containers, made of material which is inert under the specified test conditions, such as glass or PTFE or stainless steel (see also annex B).

All surfaces (connections, stoppers, containers) in contact with water shall be tested for migration prior to being used.

NOTE – It is recommended only to use PTFE if there is a small contact area with the test liquid; it is thus not suitable for containers.

6.2 Thermostatically controlled enclosure, capable of maintaining the relevant test temperature(s) (see clause 7) to within ± 2 °C.

7 Test conditions

The relevant test conditions shall be as stated in the system standard concerned for each application and each material.

Unless otherwise specified in the standard concerned, the test temperature shall be as follows:

- a) for cold-water applications: (23 ± 2) °C;
- b) for warm-water applications: either (60 ± 2) °C or (70 ± 2) °C, depending on the class of pipe;
- c) for hot-water applications: (90 ± 2) °C.

8 Test pieces

8.1 General

The pipe shall be manufactured at least 14 days before any test pieces are taken.

8.2 Preparation

For each test, take two lengths of pipe, each of sufficient length and inner surface area S to have the volume V necessary to determine, with the required accuracy, the amounts of any constituent(s) which migrate.

The value of S/V shall not be less than 5 dm^{-1} , where:

S is the inner surface area of the test piece in contact with the test liquid, in square decimetres;

V is the volume of the test liquid, in litres.

However, for pipes with nominal diameters in excess of 80 mm, the value of 5 dm^{-1} for S/V cannot be achieved. The test arrangement shall therefore be modified to one of those given in annex B.

NOTE – The value of S/V is dependent on the analytical requirements for each constituent of interest, and in particular on the minimum concentration to be determined [see item d) in the note to clause 4]. The lowest value for S/V is then the deciding value.

8.3 Number

The number of pairs of test pieces tested shall be as specified in the standard concerned.

9 Procedure

9.1 General

9.1.1 Carry out the procedure given in 9.2 to 9.5 in duplicate, simultaneously on each test piece.

Complete the sequence consisting of conditioning (9.2), washing (9.3) and finally migration (9.4) within 10 days (see 9.1.2).

9.1.2 Carry out a blank test in parallel with 9.1.1, under the same conditions (test liquid, test temperature, migration time) and using the same stoppers in a container of sufficient volume conforming to 6.1, but made of glass.

Determine, at the end of each migration period (see 9.4), the concentration C_0 of each specified constituent [see item d) in the note to clause 4] and of any associated substances which will affect the accuracy.

NOTE – If a bulk supply of test liquid is used for the duplicate tests, then one blank test is sufficient.

9.2 Conditioning

9.2.1 When testing at 23 °C

9.2.1.1 Close one end of each test piece, using a stopper (see 6.1).

9.2.1.2 Fill the test piece with tap water and let it stand for $(24 \pm 0,5)$ h at the test temperature (see clause 7).

9.2.1.3 At the end of this period, empty out the water and remove the stopper. Wash the test piece as described in 9.3.

9.2.2 When testing at elevated temperatures

9.2.2.1 Close one end of each test piece, using a stopper (see 6.1).

9.2.2.2 Fill the test piece with tap water at the test temperature (see clause 7) and let it stand for $(7,5 \pm 0,5)$ h at the test temperature.

9.2.2.3 At the end of this period, empty out the water, refill the test piece with fresh tap water which has been brought to the test temperature and let the test piece stand for $(16 \pm 0,5)$ h at the test temperature.

9.2.2.4 At the end of this period, empty out the water and remove the stopper. Wash the test piece as described in 9.3.

9.3 Washing

9.3.1 Connect the test piece to a supply of tap water using a suitable connector (see 6.1) in such a way that the test surface is completely covered during washing.

9.3.2 Let the tap water flow through the test piece at a speed between 2 m/min and 4 m/min.

9.3.3 Maintain the water flow for a period between 60 min and 70 min.

9.3.4 At the end of this period, stop the water flow and rinse out the test piece using water conforming to 5.1.

9.4 Migration test

9.4.1 Close one end of each of the washed test pieces with a stopper (see 6.1).

9.4.2 Fill the test piece with the specified test liquid (see clause 4 and 5.2). Close the other end of each test piece with a stopper (see 6.1) and maintain the filled test piece at the specified temperature for (72 ± 1) h.

9.4.3 Assess the migration at the end of this first test (or migration) period by removing one of the stoppers, emptying the test liquid from the test piece into a suitable container and determining, to the specified accuracy, the amount of each specified constituent present C_1 (see 9.5 and clause 10).

9.4.4 For any subsequent migration period, repeat steps 9.4.2 and 9.4.3 to determine C_n , where n is the number of successive migration periods.

9.5 Analysis of constituents

Decant the test liquid into a container made of inert material (see 6.1) and, if necessary, allow to cool to (23 ± 2) °C, taking all necessary precautions to protect the test liquid.

Carry out the required analyses using suitable analytical methods. The substances determined, the detection limit and the accuracy of the method, i.e. the permissible random error and systematic error (bias), shall be as specified in the standards concerned.

10 Expression of results

Express the measured concentrations of the constituents which have migrated into the test liquid in milligrams per litre. Calculate the migration value for each constituent, using the following equation:

$$M_{24} = \frac{1}{3} C_{72} \times \frac{V}{S}$$

where

M_{24} is the migration value, in milligrams per square decimetre, for a period of 24 h, for the constituent concerned;

C_{72} is the concentration of the constituent, in milligrams per litre, after a period of 72 h, where $C_{72} = C_1$ {or C_n } - C_0 ;

V is the volume of the test liquid, in litres;

S is the inner surface area of the test piece, in square decimetres, in contact with the test liquid.

Express the values of M and C as $M_{t;a}^T$ and $C_{t;a}^T$

where

- T is the migration temperature, in degrees Celsius;
- t is the migration time, in hours;
- a is the number of the migration period.

EXAMPLES

$M_{24;1}^{23}$ is M for the first migration period, at 23 °C, for a time t of 72 h divided by 3;

$M_{24;3}^{70}$ is M for the third migration period, at 70 °C, for a time t of 72 h divided by 3;

$C_{72;1}^{23}$ is C for the first migration period, at 23 °C, for a time t of 72 h;

$C_{72;3}^{70}$ is C for the third migration period, at 70 °C, for a time t of 72 h.

NOTE – The migration value is independent of the size of the pipe tested since it is expressed in mass per unit surface area per unit time. Since the migration time is 72 h and the unit of time used is 24 h, it is necessary to introduce a factor 1/3 into the equation. For practical reasons, it is assumed that the migration takes place linearly with time. By virtue of the fact that M is expressed in the form $M_{t;a}^T$, it is easy to see which migration time t , which migration temperature T and which migration period a was used.

11 Test report

The test report shall include the following information:

- a) a reference to this International Standard and to the referring standard;
- b) all details necessary for complete identification of the pipe tested, including the following:
 - 1) the name of the manufacturer and the production site,
 - 2) the name and type of material,
 - 3) the pipe markings, including the manufacturing code,
 - 4) the dimensions of the pipe tested (nominal diameter and nominal wall thickness),
 - 5) a description of the test piece;
- c) the analytical method (including its accuracy and detection limit) used to determine the constituent(s) concerned;
- d) the volume of the test liquid V , in litres, and the inner surface area, S , in square decimetres, of the test piece in contact with the test liquid;
- e) the test liquid, the type of buffer and the test temperature;

- f) the concentrations $C_{72;a}^T$ and C_0 , in milligrams per litre, and the calculated migration value $M_{24;a}^T$, in milligrams per square decimetre per 24 h [$\text{mg}/(\text{dm}^2 \cdot 24 \text{ h})$] for each constituent determined for each of the two test pieces after the first, and all subsequent migrations;
- g) the arithmetic mean of $C_{72;a}^T$ and $M_{24;a}^T$ of the duplicate test pieces (see 9.1.1) for each constituent determined after the first and any subsequent migration period;
- h) any factor which may have affected the result, such as any incident which may have occurred or any operation not specified in this International Standard;
- i) the date of the test.

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Annex A (normative)

Test liquids

A.1 Chemical solutions

A.1.1 Sodium hypochlorite (NaOCl) solution

Dilute, on the day of use, a solution of commercially available sodium hypochlorite (technical grade) with water conforming to 5.1 to give a 0,1 % by mass of available chlorine.

NOTE – The sodium hypochlorite solution used as the test liquid is not sufficiently stable to be stored.

A.1.2 Acidic buffer solution (pH 4,5)

Prepare the acidic buffer solution by dissolving 13,61 g of potassium dihydrogen phosphate (KH_2PO_4) in 1 000 ml of water conforming to 5.1 and diluting 1 ml of this solution to 100 ml with water conforming to 5.1.

Subsequently add 1,2 ml of 0,1 mol/l HCl.

A.1.3 Alkaline buffer solution (pH 9,0)

Prepare a stock alkaline buffer solution by mixing solution A (see below) with 1 000 ml of solution B (see also below).

Solution A consists of 420 ml of 0,1 mol/l sodium hydroxide prepared using water conforming to 5.1.

Solution B is prepared by dissolving 6,18 g of boric acid in a 0,1 mol/l solution of potassium chloride in water conforming to 5.1 and making up to (1 000 ± 1) ml with the same 0,1 mol/l potassium chloride solution.

Subsequently dilute this stock alkaline buffer solution 100 times with water conforming to 5.1.

A.2 Preparation of test liquids

A.2.1 Chlorinated water

Add, to water conforming to 5.1, a sufficient quantity of sodium hypochlorite (NaOCl) solution (A.1.1) to give an active-chlorine concentration of (1,0 ± 0,2) mg/l.

Determine this concentration in accordance with ISO 7393-2.

A.2.2 Acidic water

Add, to water conforming to 5.1, a sufficient amount of phosphate buffer solution (A.1.2) to obtain a pH of (4,5 ± 0,1).

A.2.3 Chlorinated acidic water

Determine in accordance with ISO 7393-2 the active-chlorine concentration in the acidic water prepared as specified in A.2.2. Add a sufficient quantity of a sodium hypochlorite (NaOCl) solution (A.1.1) to give an active-chlorine concentration of $(1,0 \pm 0,2)$ mg/l.

A.2.4 Alkaline water

Add, to water conforming to 5.1, a sufficient amount of alkaline buffer solution (A.1.3) to obtain a stable pH of $(9,0 \pm 0,1)$.

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Annex B (normative)

Additional procedures for testing pipes with nominal diameters in excess of 80

B.1 Test assemblies

Use one of the test assemblies shown in figures B.1 and B.2.

Take precautions to ensure that there is no loss of test liquid during the migration periods.

B.2 Washing the test pieces

Wash the test pieces either in accordance with 9.3 or in accordance with the procedure given in annex C which avoids the use of large quantities of water.

In cases of dispute, the procedure given in 9.3 shall be used.

B.3 Blank test

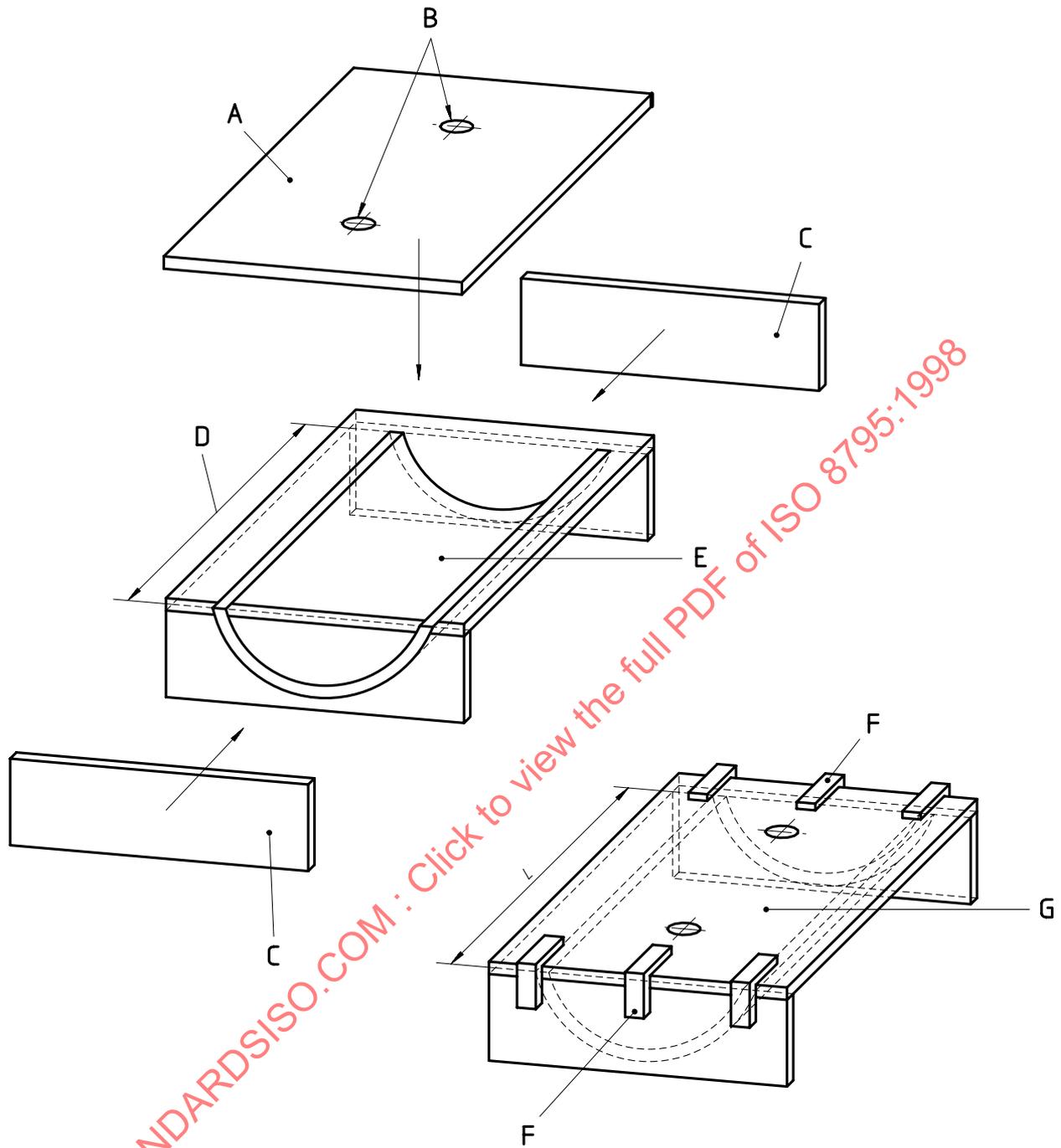
Carry out the blank test in accordance with 9.1.2, ensuring that all materials that are in contact with the test liquid are included in the blank test and that they are present at the same S/V ratio as in the actual test arrangement.

B.4 Sealing

Silicones shall not be used for sealing purposes.

Seal the test assemblies mechanically, as follows:

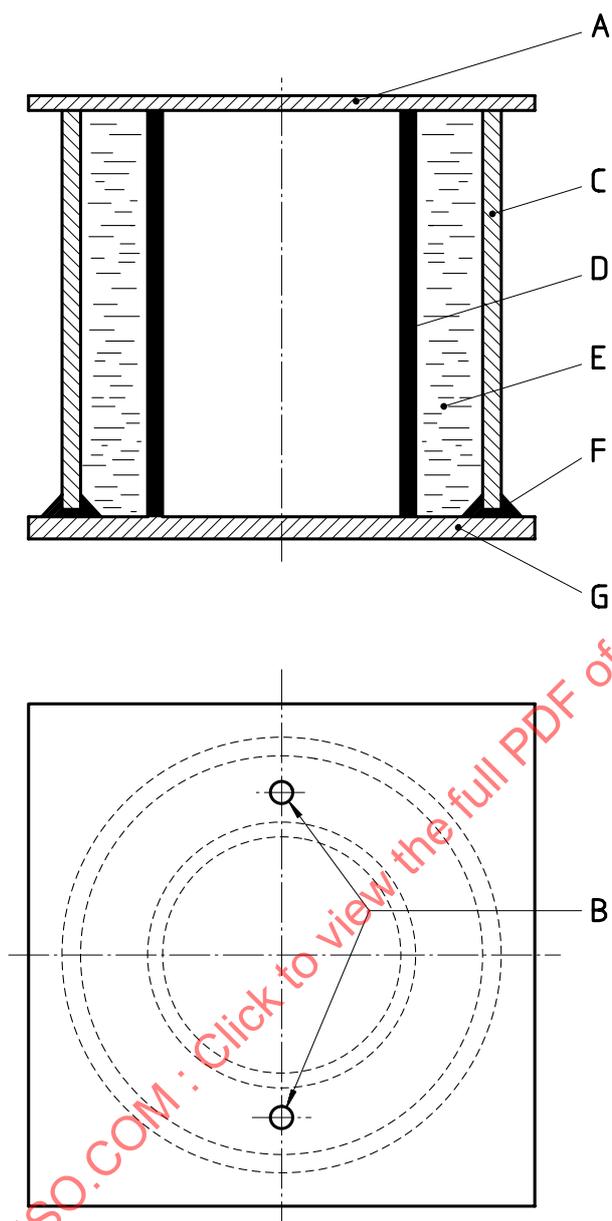
Fix the end pieces to the test pieces to give a liquid-tight seal, using clamps or bolts for instance. If a seal cannot be achieved, then use PTFE tape or film in the form of a gasket, reducing to a minimum the surface area of the gasket in contact with the test liquid (see 6.1).



Key

- A Glass or stainless-steel cover
- B Filling and/or air-escape hole
- C Stainless-steel end piece
- D Length of test piece (= L)
- E Test piece
- F Clamps or bolts
- G Test piece completely filled with test liquid

Figure B.1 – Type 1 test assembly



Key

- A Glass or stainless-steel cover
- B Filling and/or air-escape hole
- C Wall of pipe
- D Glass or stainless-steel cylinder
- E Test liquid (completely filling gap)
- F PTFE seal between pipe end and plate
- G Glass or stainless-steel plate

Figure B.2 – Type 2 test assembly

B.5 Calculation of value of S/V for the test assembly

For the test assembly shown in figure B.1, calculate the value of S/V as follows:

From the cross-section of the pipe-segment test piece, calculate the arc length a and the area A of the hatched sector shown in figure B.3, using the following equations:

$$a = \frac{\alpha}{360} \times \pi d_i \quad \dots(B.1)$$

where

a is the length of the arc running round the inside surface of the pipe segment, in millimetres;

d_i is the internal diameter of the pipe from which the segment was taken, in millimetres;

α is the angle subtended by the pipe segment at the centre of the pipe, in degrees, given by the equation

$$\cos(\alpha/2) = \frac{d_i - 2h}{d_i} \quad \dots(B.2)$$

where

h is the height of the hatched sector, in millimetres.

$$A = \left[\frac{\alpha}{360} \times 0,25\pi(d_i)^2 \right] - \left[(0,5d_i - h)^2 \times \tan(\alpha/2) \right] \quad \dots(B.3)$$

where

A is the area of the hatched sector, in square millimetres.

$$S = 10^{-4} \times a \times L \quad \dots(B.4)$$

where

S is the internal surface area, in square decimetres, of the pipe segment exposed to the test liquid;

L is the length of the pipe segment, in millimetres.

$$V = 10^{-6} \times A \times L \quad \dots(B.5)$$

where

V is the volume of test liquid in the pipe segment, in litres.

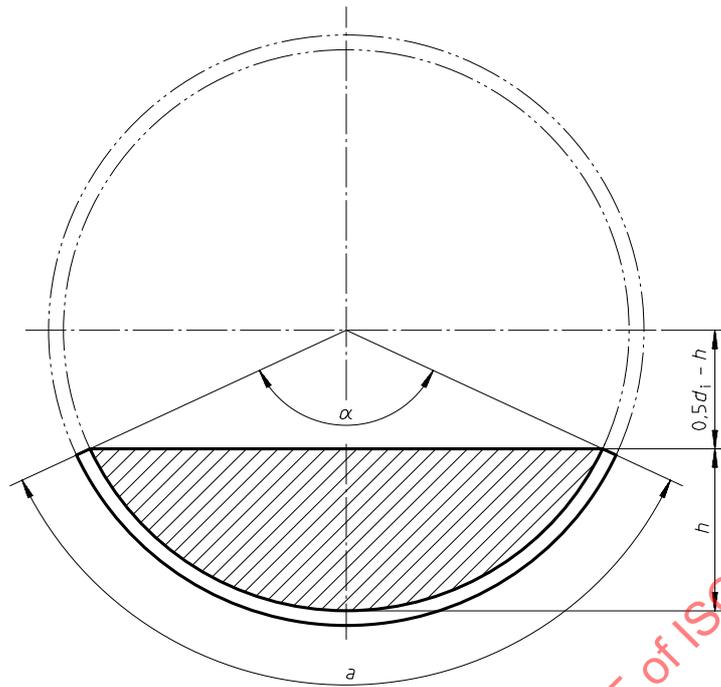


Figure B.3 – Cross-section through pipe-segment test piece

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