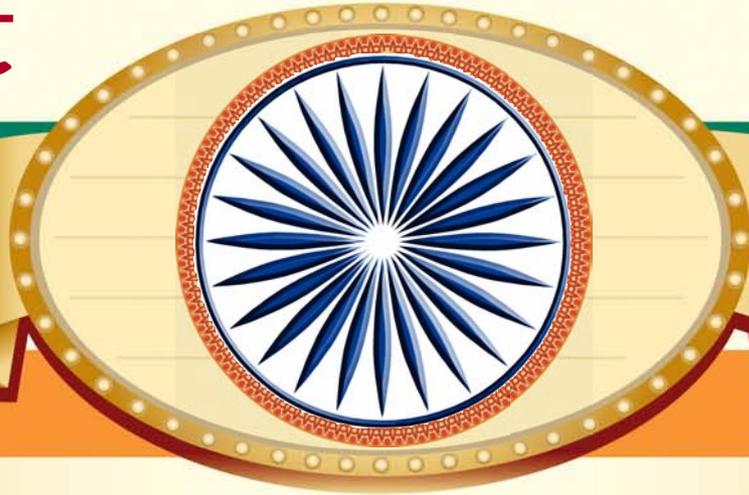


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मानक



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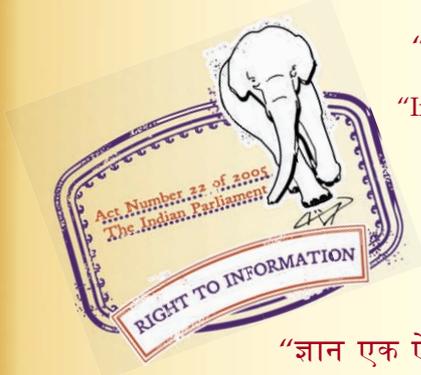
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IS 12235-1 to 19 (2004): Thermoplastics Pipes and Fittings
- Methods of Test [CED 50: Plastic Piping System]



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भारतीय मानक

थर्मोप्लास्टिक पाईप व फिटिंगें — जाँच के तरीके

(पहला पुनरीक्षण)

Indian Standard

**THERMOPLASTICS PIPES AND FITTINGS —
METHODS OF TEST**

(*First Revision*)

ICS 83.080.20, 83.140.30, 91.140.60

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (Parts 1 to 19) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Piping Systems Sectional Committee had been approved by the Civil Engineering Division Council.

Plastics pipes and fittings, including PVC-U pipes and fittings are now being used for varied applications. As some of these tests are common to pipes made from other thermoplastics materials, the title of this standard has been changed to generally be applicable to such pipes, if the referring standard permits. Several Indian Standards have now been published where further technological advancements in the field of PVC-U pipes advocated the inclusion of pipes with sockets for use with elastomeric sealing rings in IS 4985 : 2000 'Unplasticized PVC pipes for potable water supplies'. Further, changes in the specifications of PVC-U pipes as a result of the revision of IS 4985 made the addition of further tests necessary. Two further tests for the performance of joints made with elastomeric sealing rings became necessary. Modifications have been made in the procedures for testing the resistance to external blows, formerly known as impact resistance, and in the hydrostatic pressure test. A procedure for the resistance of PVC-U pipes to dichloro methane has also been added, as has been a procedure for the determination of the content of titanium dioxide.

With the advent of globalization and the likelihood of exports, the committee felt that this standard should be brought more in line with international standards. While formulating this standard considerable assistance has been drawn from the following International Standards:

- ISO 161-1 : 1996 Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1 : Metric series
- ISO 1183 : 1987 Plastics — Methods for determining the density and relative density of non-cellular plastics
- ISO 2507-1 : 1995 Thermoplastics pipes and fittings — Vicat softening temperature — Part 1 : General test method
- ISO 3451-1 : 1997 Plastics — Determination of ash — Part 1 : General methods
- ISO 3451-5 : 1989 Plastics — Determination of ash — Part 5 : Polyvinyl chloride
- ISO 4422-5 : 1997 Pipe and fittings made of unplasticized polyvinyl chloride (PVC-U) for water supply — Specifications — Part 5 : Fitness for purpose of the system
- ISO 6401 : 1985 Plastics — Homopolymer and copolymer resins of vinyl chloride — Determination of residual vinyl chloride monomer — Gas chromatographic method
- ISO 9969 : 1994 Thermoplastics pipe — Determination of ring stiffness
- ISO 13844 : 2000 Plastic piping system — Elastomeric sealing ring type socket joints of unplasticized polyvinyl chloride (PVC-U) for use with PVC-U pipes — Test method for leak high under negative pressure
- ISO 13845 : 2000 Plastics piping systems — Elastomeric sealing-ring-type socket joints for use with unplasticized polyvinyl chloride (PVC-U) pipes — Test method for leaktightness under internal pressure and with angular deflection
- ISO 13846 : 2000 Plastics piping systems — End-load-bearing and non-end-load-bearing assemblies for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 1 MEASUREMENT OF DIMENSIONS

1 SCOPE

This standard (Part 1) specifies the method for measurement of outside diameter, wall thickness, length, and internal diameters and depths of pipe sockets of thermoplastics pipes and fittings, including those made from unplasticized PVC.

2 REFERENCES

The standards listed below contain provisions, which through references in this text constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
IS 1269	Legal metrology material measures of length
(Part 1) : 1997	Woven metallic and glass fibre tape measurement (<i>second revision</i>)
(Part 2) : 1997	Steel tape measures

3 MEASUREMENT OF MEAN OUTSIDE DIAMETER

3.1 Precision Required

The precision required in each measurement is 0.1 mm.

3.2 Principle

The determination of the circumference of the pipe and division by 3.142 (π).

3.3 Measuring Apparatus

An ordinary flexible tape which comply with the following requirements:

- a) It shall be made of stainless steel or some other suitable material,
- b) It shall permit the reading to the nearest 0.05 mm,
- c) It shall be graduated in such a way that neither its own thickness nor the thickness of the graduation has any effect on the result of the measurement, and
- d) It shall have sufficient flexibility to conform exactly to the circumference of the pipe.

3.3.1 A Pi-tape with an accuracy of at least 0.05 mm may be used for direct measurement of mean outside diameter.

3.4 Procedure

Apply the tape on the whole of the circumference perpendicular to the end of the pipe. The reading shall be taken only under these conditions.

3.5 Expression of the Result

Calculate the mean outside diameter to the next higher 0.1 mm. If a Pi-tape has been used, round off the reading to the next higher 0.1 mm.

NOTE — The measurement of diameters less than or equal to 40 mm may be obtained from the average of 4 uniformly distributed measurements of diameters using vernier calipers. For higher diameters up to 110 mm, Pi-tapes or vernier calipers shall be used taking the average of two measurements at right angles.

4 MEASUREMENT OF OUTSIDE DIAMETER AT ANY POINT

4.1 Precision Required

The precision required in each measurement is 0.5 mm.

4.2 Principle

Determine the maximum and minimum outside diameters of the cross-section; several outside diameters being measured until the maximum and minimum diameters have been found.

4.3 Measuring Apparatus

Sliding vernier calipers permitting reading to the nearest 0.05 mm.

4.4 Procedure

Place the fixed jaw of the sliding calipers on one side of the pipe and the moving jaw on the other side, perpendicular to the axis of the pipe, and close the jaws until they make a firm contact with the surface of the pipe. Take the reading after checking that the calipers are in the correct position with relation to the pipe. Take other measurements along the same cross-section of the pipe, turning the calipers in the plane of the cross-section until the maximum and minimum values have been obtained.

4.5 Expression of the Result

Round off the readings to the next higher 0.1 mm and note the readings of the smallest and largest values measured for the same cross-section.

5 MEASUREMENT OF WALL THICKNESS

5.1 Method of Measurement

The wall thickness shall be measured by any of the three methods given in 5.1.1, 5.1.2 and 5.1.3.

5.1.1 Dial Gauge Method

5.1.1.1 Precision required

The precision required in each measurement of wall thickness is 0.05 mm.

5.1.1.2 Measuring apparatus

The wall thickness shall be measured by a dial gauge complying with the following requirements:

- a) It shall permit a reading up to 0.01 mm,
- b) It shall be equipped with a fixed rod or anvil forming a rigid unit with the apparatus,
- c) The extremity of the plunger (movable contact point) shall be hemispherical in shape with a radius of approximately 1.0 mm, and
- d) The surface of the fixed and movable contact points shall be smooth and be made of hard steel.

5.1.1.3 Procedure

Raise the plunger with the moving contact point. Introduce the fixed contact point inside and perpendicular to the axis of the pipe and apply it without force to the inside surface of the pipe wall. Free the plunger and seek a position for the apparatus which provides the lowest reading.

5.1.1.4 Expression of the result

Round off the reading so obtained to the nearest 0.1 mm.

5.1.2 Micrometer Method

5.1.2.1 Precision required

The precision required in each measurement of wall thickness is 0.05 mm.

5.1.2.2 Measuring apparatus

The wall thickness shall be measured with a micrometer on which both the fixed and the moving contact point shall be hemispherical.

5.1.2.3 Procedure

Insert the fixed contact point so that it rests on the inner surface of the pipe wall. Hold the micrometer radial to the pipe at the point of contact. Screw in the moving

contact point with the ratchet grip until the shaft freewheels on the outer surface of the pipe wall.

5.1.2.4 Expression of the result

Round off the reading so obtained to the nearest 0.1 mm.

5.1.3 Ultrasonic Gauge Method

5.1.3.1 Precision required

The precision required in each measurement is 0.05 mm.

5.1.3.2 Measuring apparatus

The wall thickness shall be measured with an ultrasonic gauge with a least count of 0.01 mm.

5.1.3.3 Procedure

Follow the procedure recommended by the manufacturer of the instrument.

5.1.3.4 Expression of the result

Round off the reading so obtained to the nearest 0.1 mm.

6 MEASUREMENT OF SOCKET LENGTH (DEPTH) AND SOCKET DIAMETERS

6.1 Precision Required

Precision required in each measurement shall be accurate to 0.05 mm.

6.2 Measuring Apparatus

- a) Vernier calipers capable of measuring inside diameters, with a least count of 0.02 mm, and
- b) Vernier depth gauge with a least count of 0.02 mm.

6.3 Procedure

6.3.1 Socket Length (Depth) L , Maximum and Minimum Socket Mouth and Root Diameters, Including Ovality

- a) Using the vernier depth gauge, take a minimum of four measurements, equally spaced around the circumference, of the full inside length, L , of the socket. Calculate and record the mean of the readings obtained;
- b) Using the internal micrometer, telescopic gauge or other device of equal or greater accuracy, take a minimum of four measurements both at socket root and socket mouth, making sure that the former is measured at the determined socket length (depth), L . Determine the maximum and minimum socket and root diameters; and
- c) Record the maximum and minimum socket mouth and root diameters obtained. Values shall be rounded off to the nearest 0.1 mm with

values ending in 0.05 mm being rounded upwards.

6.3.2 Mean Socket Mouth and Root Diameters

Calculate and record the mean of the maximum and minimum socket mouth and root diameters determined in 6.3.1 (b). Values shall be rounded off to the nearest 0.1 mm with values ending in 0.05 mm being rounded upwards.

6.3.3 Mean Internal Diameter of Socket, d_{im} at Mid-Point of Socket Length

- a) Calculate the mid-point of the socket length from the values of the socket length obtained in 6.3.1 (a),
- b) Using a vernier depth gauge, mark off the mid-point of the socket length at four points, at right angles to each other, around the inner circumference of the socket, and
- c) Using the internal micrometer, measure the two internal diameters of the socket at the points marked off in 6.3.3 (b) in the cross-sectional plane of the mid-point of the length of the socket. Calculate the mean and record

the values. Values shall be rounded off to the nearest 0.1 mm with values ending in 0.05 mm being rounded off upwards.

7 MEASUREMENT OF OVERALL LENGTH OF PIPE

7.1 Precision Required

Precision required in each measurement shall be accurate to 1 mm.

7.2 Apparatus

Metric, woven metallic or glassfibre tape conforming to IS 1269 (Part 1) or metric, steel tape conforming to IS 1269 (Part 2).

7.3 Procedure

7.3.1 Using the tape measure, take a minimum of four measurements, equally spaced around the circumference, of the overall length of the pipe parallel to the axis of the pipe.

7.3.2 Calculate and record the mean of the readings obtained .

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 2 DETERMINATION OF VICAT SOFTENING TEMPERATURE

1 SCOPE

This standard (Part 2) specifies a method for the determination of the Vicat softening temperature for thermoplastics pipes and fittings.

2 PRINCIPLE

The determination of the temperature at which a standard indenter penetrates 1 mm into the surface of the test specimen, cut from the wall of a pipe or fitting, under a test load of 50 ± 1 N. During the test, the temperature is raised at a uniform rate.

The temperature at 1 mm penetration is quoted as the Vicat softening temperature (VST) in °C.

3 APPARATUS

3.1 Rod — Provided with the load carrying plate (see 3.4), held in a rigid metal frame so that it can move freely in the vertical direction, the base of the frame serving to support the test specimen under the indenting tip at the end of the rod (see Fig. 1).

3.2 Indenting Tip — Preferably of hardened steel, 3 mm long, of circular cross-section, and area 1.000 ± 0.015 mm², fixed at the bottom of the rod (see 3.4). The lower surface of the indenting tip shall be plane and perpendicular to the axis of the rod and be free from burrs.

3.3 Micrometer Dial Gauge — Graduated in divisions of 0.01 mm, to measure the penetration of the indenting tip into the test specimen. The thrust of the dial gauge, which contributes to the thrust on the test specimen, shall be known and shall comply with the requirements of 3.4.

3.4 Load-Carrying Plate — Fitted to the rod (see 3.1), and suitable weights adjusted centrally so that the total thrust applied to the test specimen can be made up to 50 ± 1 N (5.097 ± 0.1 kgf). The combined masses of the rod, indenting tip and load-carrying plate shall not exceed 1 N (100 g).

NOTE — If the rod and the components of the frame do not have the same linear coefficient of expansion, their differential change in length introduces an error into the readings. A blank test shall be carried out for each apparatus using a test piece of rigid metal of low coefficient of thermal expansion. This test shall cover the whole range of service temperatures and a correction term shall be determined for each temperature. If the correction term is greater than or equal to 0.02 mm, its algebraic

sign shall be noted and the correction shall be applied to each test by adding it to the value observed for apparent penetration. It is recommended that the apparatus be constructed using an alloy with a low coefficient of thermal expansion.

3.5 Heating Bath — Containing a suitable liquid (see Notes 1 and 2) in which the apparatus is placed so that the specimen is at least 35 mm below the surface of the liquid. An efficient stirrer shall be provided. The heating bath shall be equipped with a means of control so that the temperature is capable of being raised at a uniform rate of $50 \pm 5^\circ\text{C/h}$ (see Note 4). This heating rate shall be considered to be met if, over every 5 m interval during the test, the temperature change is within the specified limits.

NOTES

1 Liquid paraffin, transformer oil, glycerol and silicone oils may be suitable liquid heat-transfer media, but other liquids may be used. In all cases, it shall be established that the liquid chosen is stable at the temperature used and does not affect the material under test.

2 If no suitable liquid can be found for use as a heat-transfer medium as defined in Note 1, some different heating arrangement, for example, air, may be used. If air is used as the heat-transfer medium, it should be noted that errors in the quoted softening point may arise, unless care is taken to correct for possible differences in temperature between the air and the specimen.

3 A uniform rate of temperature rise can be obtained by controlling the heat input either manually or automatically, although the latter is strongly recommended. One method of operation found to be satisfactory is to provide an immersion heater adjusted to give the correct rate of temperature rise at the starting temperature of the test, and then to increase the power input (either in the same heater or in a subsidiary heater) by adjustment of a rheostat or a variable transformer.

4 It is desirable to have a cooling coil in the liquid bath in order to reduce the time required to lower the temperature between determinations. This must be removed or drained before starting a test, as boiling of coolant can affect temperature rise.

3.6 Thermometer (or any other accurate temperature-measuring device) of appropriate range, and with graduations at least at each 0.5°C . The scale error at any reading shall not exceed 0.5°C . If a mercury-in-glass thermometer is used, it shall be calibrated for the depth of immersion as required under 5.3.

4 TEST SPECIMENS

4.1 Preparation

4.1.1 Two test specimens shall be used for each sample. The test specimen shall consist of segments of

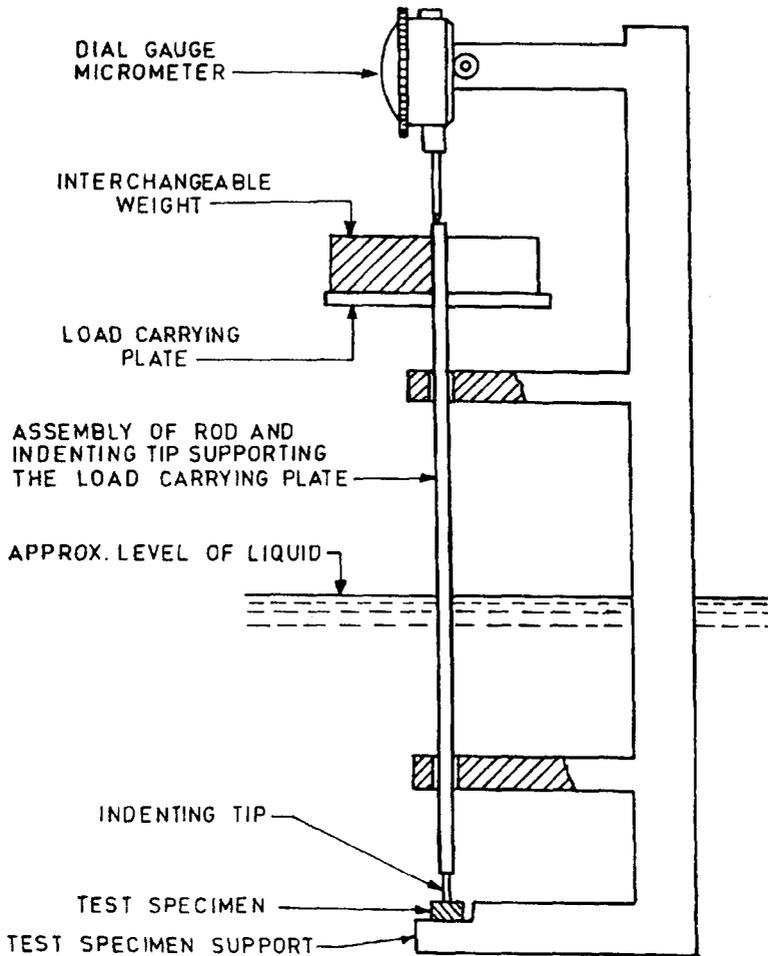


FIG. 1 SCHEMATIC DIAGRAM OF APPARATUS FOR DETERMINATION OF THE VICAT SOFTENING TEMPERATURE

rings removed from pipes or fittings, limited by cross-sections and having the following dimensions:

Length : approximately 50 mm measured along the circumference of the ring.

Width : between 10 mm and 20 mm.

4.1.2 If the wall thickness of the pipe is greater than 6 mm, reduce it to 4 mm by machining the outer surface of the pipe only, by a suitable technique.

4.1.3 Test pieces of thickness between 2.4 mm and 6 mm shall be tested as they are.

4.1.4 If the wall thickness of the pipe is less than 2.4 mm, each test piece shall comprise of three ring segments superimposed so as to obtain an overall thickness of at least 2.4 mm. The lower segments, which will serve as the base, shall be flattened by heating them to 140°C for 15 min, while resting a thin metal plate on them.

4.1.5 Use two test pieces for each test, but provide additional test pieces, in case the difference between the results is too great.

4.2 Conditioning

Condition the test pieces for 5 min at a temperature about 50°C lower than the expected VST of the product under test.

5 PROCEDURE

5.1 Bring the heating bath to a temperature about 50°C lower than that expected for the VST of the product under test (*see 3.5, Note 4*). Maintain this temperature constant.

5.2 Mount the test specimen horizontally under the indenting tip (*see 3.2*) of the unloaded rod (*see 3.1*), which shall rest on the concave surface of the test specimen.

In the case of pipes or fittings with a wall thickness of less than 2.4 mm, the indenting tip shall rest on the concave surface of the non-flattened segment, the latter being placed on the flattened segment.

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The indenting tip shall at no point be less than 3 mm from the edge of the test piece.

5.3 Immerse the apparatus in the heating bath in the bulb of the thermometer or the sensing portion of the temperature measuring device shall be at the same level and as close as possible to the test piece.

5.4 Position the indenting tip and, after 5 min, add to the load carrying plate the weight required so that the total thrust on the test piece is 50 ± 1 N. Record the reading on the micrometer dial gauge or other indentation-measuring instrument, and set the instrument to zero.

5.5 Raise the temperature of the bath at a uniform rate of $50 \pm 5^\circ\text{C/h}$. Stir the liquid well during the test.

5.6 Record the temperature of the bath at which the indenting tip has penetrated into the test piece by 1 ± 0.01 mm relative to its starting position, and record the value as the VST of the test piece.

5.7 Record the arithmetic mean of the VST of the two test pieces as the VST of the pipe under test, and express the result in degree Celsius.

5.8 If the individual results differ by more than 2°C , report them in the test report and repeat the test using a new set of at least two test pieces.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 3 TEST FOR OPACITY

1 SCOPE

1.1 This standard (Part 3) specifies a method for the determination of the opacity of plastics pipes and fittings.

1.2 It lays down the maximum acceptable limit for light which may pass through the wall of the pipe or fitting, if the particular standard specifies that they be opaque.

2 TEST METHOD 1

2.1 Principle

Measurement of light flux passing through a test specimen cut from a pipe or fitting.

2.2 Apparatus

The apparatus shall comprise of the following:

- a) An adjustable power arc or incandescent lamp, the intensity of light of which is constant to ± 1 percent. When an arc lamp is used, a suitable filter shall be provided to limit the spectrum between 400 and 800 nm (nanometres);
- b) Diaphragm and optical lenses adjusted to obtain parallel and symmetrical incident beams. The diaphragm shall be circular;
- c) A support, arranged so that it maintains the surface of the test specimen to be examined perpendicular to the optical axis and at a fixed distance from the diaphragm cell; and
- d) A photoelectric cell sensitive to light of wave length specified in 2.2.4, used such that the response of the reading or the recording apparatus is a linear and uniform function of the light intensity, from maximum incidence I_0 up to at least $0.01 I_0$.

2.3 Test Specimens

Take a section of convenient length from the pipe or a sample of suitable dimensions and the original thickness from the fitting. Cut the sample into four strips equally spaced around the circumference.

2.4 Procedure

2.4.1 Calibration

2.4.1.1 Check that the equipment indicators are at

zero, in the absence of light. Ensure that the photoelectric cell is protected from incident daylight.

2.4.1.2 Check that the indicators reach 100 percent in the light emitted by the luminous source in the absence of the test specimen.

2.4.1.3 Check the precision of the reading using a standard gray glass filter with a calibrated standard absorption of about 0.2 percent.

NOTE — An accuracy of 0.02 percent in the range 0 to 0.2 percent is considered desirable.

2.4.1.4 Check the alignment of the installation.

2.4.2 Measurement

2.4.2.1 Adjust the apparatus to obtain a maximum reading, carefully arranging the light sensor in such a way that it receives the maximum light flux. Record the maximum deviation, D_M .

2.4.2.2 Place the test specimen on the support and position the whole, ensuring that the test specimen is centered and perpendicular to the light beam. The light beam shall be incident on the outer surface of the pipe specimen. The convex (outer) surface of the pipe or fitting shall face the light source.

2.4.2.3 Read the indicated maximum deviation (D), produced by the light beam. This deviation corresponds to the light flux which has passed through the wall of the test piece.

2.5 Calculation and Expression of Results

Calculate the percentage of light which has passed through the test specimen, using the formula:

$$\text{Percentage of Light} = \frac{D}{D_M} \times 100$$

where

- D = maximum deviation produced by the light flux from the source which has passed through the test specimen, and
- D_M = maximum deflection produced directly by the light from the source.

Take the mean of the three measurements of each test piece.

The highest of the four mean values is taken as the value of the opacity of the test specimen.

2.6 Test Report

The test report shall indicate the percentage of light that passed through the test specimen and whether or not the result complies with the requirement specified in 3.

3 SPECIFICATION

3.1 If the particular standard specifies that the pipe or fitting shall be opaque, the percentage of the light which passes the wall of the pipe or fitting, determined according to 2 of this Part, shall not exceed 0.2 percent.

4 TEST METHOD 2

4.1 Apparatus

4.1.1 The following apparatus is required:

- a) Source of light (halogen lamp 1 000 W),
- b) Photo-electric cell (with filter correction to match eye response), and
- c) Digital current meter.

4.2 Procedure

4.2.1 The light source and photo-electric cell shall be set at a distance to get maximum reading in the

galvanometer in the absence of the sample and also in the absence of daylight. Connect the galvanometer to the photoelectric cell and note the maximum deflection produced by the light flux of the source falling on the photo-electric cell.

4.2.2 Place the test specimen on the photo-electric cell in such a manner that one wall is touching the photo-electric cell surface between the light source and the cell (distance between source and cell remaining constant). The light beam shall be incident on the outer surface of the pipe specimen.

4.2.3 Read on the spot light galvanometer, the maximum deflection produced by the light flux of the source. The deflection corresponds to the light flux passing through the wall of the test specimen.

4.2.4 The second deflection expressed as a percentage of the first shall give the measure of visible light transmitted.

4.2.5 In case of dispute, the test shall be performed after flattening the test specimen by heating it in an air oven at 120°C. An oil bath shall not be used for this purpose as this can lead to discolouration of the specimen.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 4 DETERMINING THE DETRIMENTAL EFFECT ON THE COMPOSITION OF WATER

1 SCOPE

This standard (Part 4) specifies the methods of test for determining the detrimental effect on the composition of water flowing through plastics pipes manufactured according to IS 4985.

2 REFERENCES

The standard listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
1070 : 1992	Reagent grade water (<i>third revision</i>)
3025 : 1964	Methods of sampling and test (physical and chemical) for water used in industry
3025	Methods of sampling and test (physical and chemical) for water and waste water:
(Part 41) : 1992	Cadmium
(Part 47) : 1994	Lead
(Part 48) : 1994	Mercury
4985 : 2000	Specification for unplasticised PVC (PVC-U) pipes for potable water supplies (<i>third revision</i>)

3 PROCEDURE

3.1 Lead and Tin

3.1.1 Three pieces of pipe, as received, each of a length to contain, when stoppered, not less than the quantity of extractant required for subsequent analysis, are plugged at one end with a stopper of polyethylene (or some other non-interfering material), fitted with a glass cock and clamped to a stand with open end upwards. Tap water is poured into the pipes until it overflows slightly. Then the cock shall be opened sufficiently for a velocity of 3 m/min to be maintained inside the pipe. The pipe shall be kept continuously filled with water. After a period of 6 h, the pre-washing is discontinued, the stopper removed

and the interior of the pipe rinsed out with a little distilled water (*see* IS 1070) to remove any remnants of tap water. During pre-washing (but not subsequently), the pipe sample may be fitted with a non-interfering core so as to reduce the quantity of water required, provided the velocity of 3 m/min is maintained.

3.1.1.1 After the test specimens have been cleaned, as described above, close one end of each sample tightly with any material that does not contain any toxic substances and also does not interfere with the determination of such constituents in the aqueous samples.

3.1.1.2 Fill each pipe sample with distilled water (*see* IS 1070) containing added carbonic acid equivalent to 150 mg CO₂/l. A freshly made solution shall be used for each series of tests (*see* 3.1.6).

3.1.1.3 Close the other end of each pipe.

3.1.1.4 First extraction

Maintain the pipe and contents at room temperature for 48 h, then empty the water into suitable containers and retain for analysis. This is the sample for lead determination (first extraction).

3.1.1.5 Second extraction

Refill the pipes with the standard solution as in 3.1.2, close and allow to stand as above for 48 h and discard.

3.1.1.6 Third extraction

Refill the pipes a third time for a further period of 48 h and retain the solution for analysis. This is the sample for lead and tin determination (third extraction).

3.1.1.7 The water containing the desired quantity of carbon dioxide may conveniently be prepared by saturating a large bulk of water with carbon dioxide, determining the carbon dioxide content by a standard method, such as that given in IS 3025, (with suitable adjustment of quantities) and then mixing with the calculated quantity of carbon dioxide free water.

3.1.1.8 The metals present shall now be determined. Determine the contents of lead and organotin by the methods described in IS 3025 (Part 47) and (Part 10) of this standard or by any other suitable

method. The arithmetic mean of the triplicate determinations shall be reported in mg/l of the standard solution.

3.2 Cadmium and Mercury

3.2.1 Proceed as described in 3.1.1. However, terminate the pre-washing after a period of 60 ± 10 min.

3.2.1.1 After the test specimens have been cleaned, as described above, close one end of each sample tightly with any material that does not contain any toxic substances and also does not interfere with the determination of such constituents in the aqueous samples.

3.2.1.2 Fill each test specimen with distilled water, acidified to a pH of 4.5 ± 0.1 , by bubbling a current of carbon dioxide through it, and maintained at a temperature of approximately 27°C .

NOTE — For each series of tests, a freshly prepared solution of acidified water shall be used.

3.2.1.3 Close the other end of each test specimen by means of a stopper (see 3.1.1.1) and maintain the filled test specimens at $27 \pm 2^\circ\text{C}$ for 48 h.

3.2.1.4 First extraction

At the end of 48 h, empty the water from the test specimens into suitable stoppered containers and determine the quantity of cadmium and mercury in each.

3.2.1.5 Second extraction

Fill the same test specimens with the test water (see 3.2.1.2) and, having closed them again, maintain them at $20 \pm 2^\circ\text{C}$ for 48 h. At the end of this period, transfer the test water from the test specimens to suitable stoppered container and determine the quantity of cadmium and mercury in each in accordance with the method described in IS 3025 (Part 41) and IS 3025 (Part 48) respectively.

3.2.1.6 Third extraction

Fill the test specimens for a third time with test water (see 3.2.1.2) and having closed them again, maintain them at $27 \pm 2^\circ\text{C}$ for 48 h. At the end of this period, transfer the test water from the test specimens to suitable stoppered containers and determine the quantity of cadmium and mercury in each, in accordance with the method described in IS 3025 (Part 41) and IS 3025 (Part 48) respectively.

NOTE — The analytical test methods to be used for the determination of the quantity of material taken into solution are not defined. They shall, however, allow the analysis to be carried out with an accuracy of 0.005 mg/l for cadmium and 0.000 5 mg/l for mercury.

3.3 Assessment of Results

3.3.1 Lead

The specimens, when tested as above shall meet the requirements of the referring product standard.

3.3.2 Tin

The specimens, when tested as above shall meet the requirements of the referring product standard.

3.3.3 Cadmium

3.3.3.1 Calculate for the three test specimens the arithmetic mean of the quantities of cadmium determined in the extracts for the first, second and third extractions.

3.3.3.2 Express the results in mg/l with an accuracy of 0.005 mg/l.

3.3.4 Mercury

3.3.4.1 Calculate for the three test specimens the arithmetic mean of the quantities of mercury determined in the extracts for first, second and third extractions.

3.3.4.2 Express the results in mg/l with an accuracy of 0.000 5 mg/l.

4 TEST REPORT

4.1 The test report shall include the following information:

- a) Complete identification of pipe tested;
- b) Number of test specimens;
- c) Analytical method used for the determination of the quantity of lead in aqueous solution;
- d) Analytical method used for the determination of the quantity of tin in aqueous solution;
- e) Analytical method used for the determination of cadmium in aqueous solution;
- f) Analytical method used for the determination of the quantity of mercury in aqueous solution;
- g) Duration of pre-washing;
- h) Quantities of extracted lead found in the first and third extraction;
- j) Quantity of tin found in the third extraction;
- k) Arithmetic mean of the quantities of extracted cadmium found in the first, second and third extractions;
- m) Arithmetic mean of the quantities of mercury found in the first, second and third extractions; and
- n) Details of the procedure which have not been provided for by this test method and also any accidental circumstance which might have attached the results.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 5 LONGITUDINAL REVERSION

Section 1 Determination Methods

1 SCOPE

This standard (Part 5/Sec 1) specifies the method of test for reversion performed on thermoplastics pipes.

2 GENERAL

2.1 This test may be carried out either in an air oven or, alternatively, in a bath of mono or polyethylene glycol, glycerol or mineral oil free from aromatic hydrocarbons.

NOTE — Monoethylene glycol is toxic and constitutes a fire hazard. Refer to relevant literature before using. Poveethylene glycol, on the other hand, is high boiling and does not pose such hazards.

2.2 Preparation of Test Specimens

The test specimen shall consist of a length of pipe approximately 200 mm long. Two circumferential marks shall be scribed on the test specimen 100 mm apart and in such a way that one of these marks is approximately 15 mm from one end of the specimen. The instrument to be used shall be a pair of vernier calipers with an accuracy of at least 0.02 mm.

3 IMMERSION METHOD

3.1 Apparatus

The apparatus shall consist of a thermostatically controlled bath in which the heat transfer medium is mono- or polyethylene glycol, glycerol or mineral oil which is free from aromatic hydrocarbons. The bath is continuously stirred and maintained automatically at a temperature of $150 \pm 2^\circ\text{C}$.

3.2 Procedure

The test specimens shall be suspended in the heat transfer medium by the end further from the scribe marks, in such a way that both scribe marks are completely immersed and that there is a minimum distance of 30 mm between the upper boundary of the test area and the air/liquid interface. Care shall be taken to ensure that the specimen does not touch the sides or bottom of the bath. The test specimen shall be immersed in the bath for a time determined as follows:

- a) For a pipe of wall thickness not greater than 8.6 mm — 15 min,
- b) For a pipe of wall thickness greater than 8.6 mm but not greater than 14.1 mm — 30 min, and

- c) For pipe of wall thickness greater than 14.1 mm — 60 min.

After the specified immersion period, the specimen shall be removed from the bath, laid on its side and allowed to cool to room temperature. The distance between the two scribed marks shall be measured along the surface of the pipe using a pair of vernier calipers with an accuracy of at least 0.02 mm and the percentage change in length calculated.

4 AIR OVEN METHOD

4.1 Apparatus

An electrically heated air oven with internal circulation fan, the whole interior of which is maintained automatically at a temperature of $150 \pm 2^\circ\text{C}$.

4.2 Procedure

The specimen shall be placed on a tray with a smooth surface which has been covered with a uniform layer of talcum powder. The tray shall be kept in an oven and the time measured from the moment at which the oven regains a temperature of 150°C . The test specimens shall be kept in the oven for a time determined as follows:

- a) For a pipe of wall thickness not greater than 8.6 mm — 60 min,
- b) For a pipe of wall thickness greater than 8.6 mm but not greater than 14.1 mm — 120 min, and
- c) For a pipe of wall thickness greater than 14.1 mm — 240 min.

After the specified periods, the specimen shall be removed from the oven, laid on its side and allowed to cool to room temperature. The distance between the two scribed marks shall be measured along the surface of the pipe using a pair of vernier calipers with an accuracy of at least 0.02 mm and the percentage change in length calculated and the percentage change in length calculated.

5 ASSESSMENT OF RESULTS

The specimen, when treated as above, shall meet the requirements given in the applicable specification.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 5 LONGITUDINAL REVERSION

Section 2 Determination Parameters

1 SCOPE

This standard (Part 5/Sec 2) specifies the parameters for the determination of longitudinal reversion of thermoplastics pipes in accordance with methods specified under 3 and 4 of IS 12235 (Part 5/Sec 1).

This part of IS 12235 applies to all pipes of thermoplastics material given in 2 and 3.

Recommendations for maximum levels of reversion as a function of certain pipe materials are given in Annex A.

2 PARAMETERS FOR USING A LIQUID BATH

For the determination of longitudinal reversion in

accordance with the immersion method described in IS 12235 (Part 5/Sec 1), the parameters for the thermoplastics material shall be as given in Table 1.

NOTE — Abbreviations of materials are given in Annex B for information.

3 PARAMETERS FOR USING AN AIR OVEN

For the determination of longitudinal reversion in accordance with the air oven method described in IS 12235 (Part 5/Sec 1), the parameters for the thermoplastics material are given in Table 2.

Table 1 Parameters for the Determination Using a Liquid Bath
(Clause 2)

Sl No.	Thermoplastics Material ¹⁾	Temperature of Bath $T_R, ^\circ\text{C}$	Duration of Immersion min	Length of Test Specimen mm
(1)	(2)	(3)	(4)	(5)
i)	PVC-U	150 ± 2	15 for $e < 8.6$ ¹⁾ 30 for $8.6 < e \leq 14.1$ 60 for $e > 14.1$	
ii)	PVC-C	150 ± 2	15	
iii)	PE 32/40 ²⁾	100 ± 2		
iv)	PE 50/63 ²⁾	110 ± 2		
v)	PE 80/100 ²⁾	110 ± 2		
vi)	PE-X	120 ± 2		
vii)	PB	110 ± 2	30	200 ± 20
viii)	PP homopolymers and block copolymers of PP	150 ± 2		
ix)	PP random copolymers	135 ± 2		
x)	ABS and ASA	150 ± 2	15 for $e < 8$ 30 for $8 < e \leq 16$ 60 for $e > 16$	

¹⁾ e is the wall thickness in millimetres.

²⁾ Figures indicate MRS values.

Table 2 Parameters for the Determination Using an Air Oven
(Clause 3)

Sl No.	Thermoplastics Material	Temperature of Bath T_R °C	Duration of Exposure min	Length of Test Specimen mm
(1)	(2)	(3)	(4)	(5)
i)	PVC-U	150 ± 2	60 for $e \leq 8.6$ ¹⁾ 120 for $8.6 < e \leq 14.1$ 240 for $e > 14.1$	
ii)	PVC-C	170 ± 2	30	
iii)	PE 32/40 ²⁾	100 ± 2	60 for $e \leq 8$ 120 for $8 < e \leq 16$ 240 for $e > 16$	
iv)	PE 50/63 ²⁾	110 ± 2	60 for $e \leq 8$ 120 for $8 < e \leq 16$ 240 for $e > 16$	
v)	PE 80/100 ²⁾			
vi)	PE-X	120 ± 2	60 for $e < 8$ ¹⁾ 120 for $8 \leq e < 16$ 240 for $e \geq 16$	200 ± 20
vii)	PB	110 ± 2	60 for $e \leq 8$ 120 for $8 < e \leq 16$ 240 for $e > 16$	
viii)	PP homopolymers and block copolymers of PP	150 ± 2	60 for $e \leq 8$ 120 for $8 < e \leq 16$ 240 for $e > 16$	
ix)	PP random copolymers	135 ± 2	240 for $e > 16$	
x)	ABS and ABA	150 ± 2	15 for $e \leq 8$ 30 for $8 < e \leq 16$ 60 for $e > 16$	

¹⁾ e is the wall thickness in millimetres.

²⁾ Figures indicate MRS values.

ANNEX A*(Clause 1)***RECOMMENDED BASIC SPECIFICATIONS FOR LONGITUDINAL REVERSION**

A-1 Under the determination conditions in accordance longitudinal reversion shall comply with the value with either method, the calculated value of the given in Table 3.

Table 3 Basic Specifications for Longitudinal Reversion

Sl No. (1)	Thermoplastics Material (2)	Reversion Percent (3)	Thermoplastics Material (4)	Reversion Percent (5)
i)	PVC-U	≤ 5	PB	≤ 2
ii)	PVC-U	≤ 5	PP homopolymers and block copolymers of PP	≤ 2
iii)	PE	≤ 3	PP random copolymers	≤ 2
iv)	PE-X	≤ 3	ABS and ASA	≤ 5

NOTE — For applications requiring more stringent specifications, a value smaller than the applicable limit given in Table 3 may be adopted.

ANNEX B*(Clause 2)***INFORMATIVE ABBREVIATIONS**

ABS	Acrylonitrile/butadiene/styrene	PE-X	Cross linked polyethylene
ASA	Acrylonitrile/styrene/acrylate	PVC-C	Chlorinated polyvinyl chloride
PB	Bolybutylene	PVC-U	Unplasticised polyvinyl chloride
PE-32/40	Polyethylene MRS 32/40	PP	Polypropylene
PE-50/63	Polyethylene MRS 50/63	PE-80/100	Polyethylene MRS 80/100
PE-80/100	Polyethylene MRS 80/100		

*Indian Standard***THERMOPLASTICS PIPES AND FITTINGS —
METHODS OF TEST****PART 6 STRESS RELIEF TEST****1 SCOPE**

This standard (Part 6) specifies the method for the stress relief test performed on thermoplastics pipes and fittings.

2 GENERAL

This test may be carried out either in an air oven or, alternatively, in a bath of mono or polyethylene glycol, glycerol or mineral oil free from aromatic hydrocarbons.

NOTE — Monothylene glycol is toxic and constitutes a fire hazard. Refer to relevant literature before using. Polyethylene glycol, on the other hand, is high boiling and does not pose such hazards.

3 TEST SPECIMENS

3.1 In the case of pipes, the specimen shall consist of the full socketed portion of the pipe with at least 100 mm portion of plain pipe.

3.2 In the case of fittings, the specimen shall consist of the whole fitting.

4 IMMERSION METHOD**4.1 Apparatus**

The apparatus shall consist of a thermostatically controlled bath in which the heat transfer medium is mono- or polyethylene glycol, glycerol or mineral oil which is free from aromatic hydrocarbons. The bath is continuously stirred and maintained automatically at a temperature of $150 \pm 2^\circ\text{C}$.

4.2 Procedure

The test specimen shall be suspended in the heat transfer medium in such a way that it is completely

immersed at a depth of at least 30 mm and that the specimen does not touch the sides or bottom of the bath. The specimen shall be immersed in the bath for a period of 60 min, the duration being measured from the time the heat transfer medium regains the temperature of 150°C .

4.3 After 1 h, the specimen shall be removed from the bath and allowed to cool naturally to room temperature before examination.

5 AIR OVEN METHOD**5.1 Apparatus**

An electrically heated air oven with internal circulation fan, the whole interior of which is maintained automatically at a temperature of $150 \pm 2^\circ\text{C}$.

5.2 Procedure

In the case of a pipe, the specimen shall be placed in the oven standing on its socket. The specimen may be supported, if necessary, by a simple jig that has been pre-heated in the oven.

5.3 The specimen shall be kept in the oven for a period of 1 h, measured from the time the oven regains the stipulated temperature.

5.4 After 1 h, the specimen is removed from the oven and allowed to cool naturally to room temperature before examination.

6 ASSESSMENT OF RESULTS

The sample shall meet the requirements of the relevant specification.

Indian Standard

**THERMOPLASTICS PIPES AND FITTINGS —
METHODS OF TEST**

PART 7 RESISTANCE TO SULPHURIC ACID

1 SCOPE

This standard (Part 7) specifies the method of test for resistance to sulphuric acid of thermoplastics pipes and fittings, including those of unplasticized poly vinyl chloride (PVC-U).

2 FORM OF TEST SPECIMEN

This specimen shall be cut from the pipe and shall have a total surface area of $45 \pm 3 \text{ cm}^2$.

3 PROCEDURE

The test specimens shall be cleaned, wiped dry and weighed, then totally immersed in 93 ± 0.5 percent

(*m/m*) sulphuric acid for 14 days at $55 \pm 2^\circ\text{C}$. Care shall be taken to avoid gradual change in concentration of the acid due to evaporation losses, etc. After the specified time, the specimen shall be removed, washed in running water for 5 min, wiped dry with a clean cloth and reweighed immediately.

4 ASSESSMENT OF RESULTS

The average change in mass shall not exceed the value given in the appropriate standard.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 8 RESISTANCE TO INTERNAL HYDROSTATIC PRESSURE

Section 1 Resistance to Internal Hydrostatic Pressure at Constant Internal Water Pressure

1 SCOPE

This standard (Part 8/Sec 1) specifies the method for the determination of resistance of thermoplastics pipes, including unplasticized PVC pipes, intended for the conveyance of fluids, to constant internal water pressure at constant temperature.

2 REFERENCE

The standard listed below contains provision, which through references in this text constitutes provisions of this standard. At the time of publication the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
4985 : 2000	Specification for unplasticised PVC (PVC-U) pipes for potable water supplies (<i>third revision</i>)

3 APPARATUS

3.1 End Caps

3.1.1 Type A

Fixed to the ends of the pipe. The caps shall be rigidly connected to the test specimen but not to each other, hence transmitting the hydrostatic end thrust to the test specimen, (as shown in Fig. 1A). They may comprise of flanged plates on the ends of a large-diameter pipe, optionally welded when flanges, caps, plugs or plates are of a material compatible with that of the test specimens.

3.1.2 Type B

Sockets, made of metal, fitted with joints ensuring sealing on to the external surface of the test specimen and connected to one another, hence not transmitting the hydrostatic end thrust to the test specimen. They may comprise one or more metal rods, as shown in Fig. 1B, allowing sufficient longitudinal movement at the ends of the test specimen to avoid buckling due to thermal expansion.

NOTES

- Other than toothed grips, any sharp edges which would come

in contact with the outside surface of the test specimen shall be rounded off.

- The constituent material of the end cap shall not have any known adverse effect on the pipe under test.

- For evaluation of the pipe and/or fittings in accordance with IS 4985, Type A end caps shall be used, unless otherwise specified in a reference specification.

- In cases of dispute, Type A end caps shall be used.

3.2 Tank

A tank filled with water or other liquid, kept at a constant temperature, as specified in the referring standard, to within a mean of $\pm 1^\circ\text{C}$ and a maximum deviation of $\pm 2^\circ\text{C}$. Water, when used, shall not contain any impurities which could affect the results. When environments other than water is used, all necessary precautions shall be taken, in particular those concerning safety and any interaction between the medium and the material(s) of the test specimen.

When environments other than water are used, tests which are intended to be comparative shall be carried out in the same environment.

3.3 Supports or hangers enabling test specimens to be placed in the tank in such a way that there is no contact between them or the sides of the tank.

3.4 Pressurizing equipment capable of applying the required pressure gradually and smoothly in accordance with 7.1 and then keeping it constant to within $\begin{matrix} +2 \\ -1 \end{matrix}$ percent of the required pressure for the duration of the test.

As the results are strongly influenced by pressure, the tolerance on pressure shall be kept as small as possible.

NOTES

- The pressure should preferably be applied individually to each test specimen. However, the use of equipment enabling the pressure to be applied simultaneously to several pieces is also permitted, provided there is no danger of interference when failure occurs (for example, by the use of an isolation valve or a test based on the first failure in a batch).

- To maintain the pressure within the specified tolerance, it is recommended that a system be introduced which automatically resets the pressure if it drops slightly (for example, because of swelling of the test piece), to the specified value.

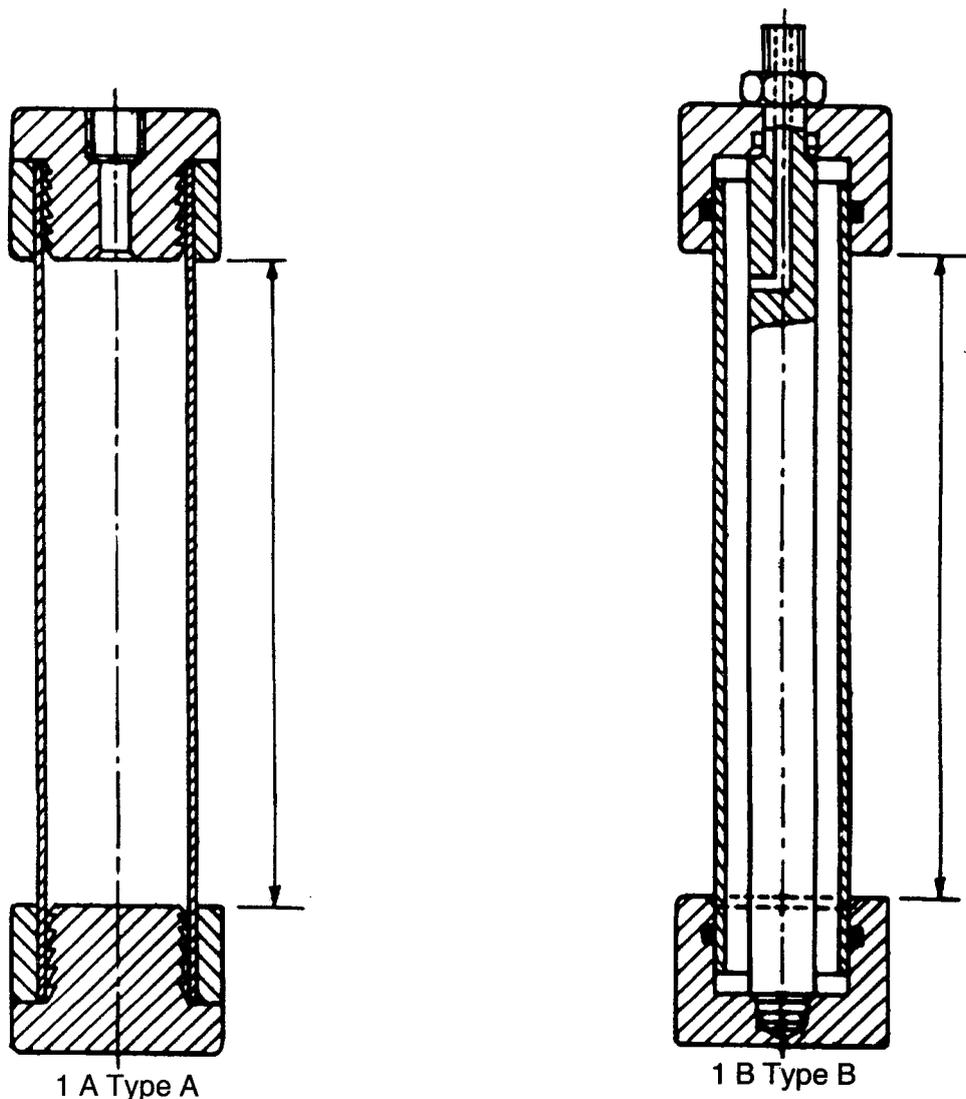


FIG. 1 EXAMPLES OF DEVICES FOR THE INTERNAL HYDROSTATIC PRESSURE TESTING OF PIPES

3.5 Pressure measurement devices capable of checking conformity to the specified test pressure (see 5.2.2), in the case of gauges or similar calibrated pressure measurement devices, the range of the gauge shall be such that the required pressure setting lies within the calibrated range of the device used (see 5.1).

3.5.1 The pressure measurement devices shall not contaminate the test fluid.

3.5.2 The use of master gauges for calibration of the apparatus is recommended.

3.6 Thermometer or other temperature-measuring device capable of checking conformity to the specified test temperature (see 3.2).

3.7 Timer capable of recording the duration of the pressure applications up to the moment of failure or leakage.

NOTE — It is recommended that equipment be used which is sensitive to pressure variations due to leaks or a failure and

which is capable of stopping the timer and, if necessary, closing the pressure circuit for the test specimen concerned.

3.8 Means of measuring the wall thickness conforming to Part 1 of this standard, with hemispherical tips and of such a design that measurements can be made along the whole length of the pipe.

NOTE — A suitable, calibrated ultrasonic measuring device may be used.

3.9 Means of measuring outside diameter of the pipe conforming to Part 1 of this standard, for example, a metal tape or π metal tape.

4 TEST SPECIMENS

4.1 Dimensions

4.1.1 Free Length

The free length, l_0 , of each test specimen between the end caps shall be at least ten times the outside diameter

of the pipe but not less than 250 mm or greater than 750 mm.

4.1.2 Total Length

For Type B end caps, the total length of the test specimen shall be such that the test specimen does not make contact with the end surface of the end caps during the test.

4.1.3 Number of Test Specimens

As specified in the referring standard.

5 CALIBRATION OF THE APPARATUS AND CALCULATION OF TEST PRESSURE

5.1 Calibration of the Apparatus

The temperature and pressure control systems, and the equipment for measuring temperature, pressure and time, shall be calibrated to an accuracy compatible with the scales used and at a frequency commensurate with the conditions of use.

5.2 Calculation of Test Pressure

5.2.1 Determine, in accordance with Parts 1 and 2 of this standard, the mean outside diameter and the minimum wall thickness of the test specimens.

5.2.2 Calculate the test pressure p , in MPa, to three significant decimal places, using the following equation:

$$p = \sigma 2e_{\text{Min}} / (d_{\text{em}} - e_{\text{Min}})$$

where

- σ = hoop stress, in MPa, to be induced by the applied pressure;
- d_{em} = measured mean outside diameter, in millimetres, of the test specimen; and
- e_{min} = measured minimum wall thickness, in millimetres, of the free length of the test specimen.

6 CONDITIONING OF THE TEST SPECIMENS

Clean and dry the test specimens to remove any traces of dirt, oil, wax or any other contamination, and fit them with the end caps chosen for the test. Fill the test specimens with water, which may be preheated to a temperature not more than 5°C above the test temperature.

After filling, immerse the test specimens in the water bath and condition for the time period specified in Table 1.

Table 1 Conditioning Periods

Sl No.	e_{Min} mm	Period min
(1)	(2)	(3)
i)	$e_{\text{min}} < 16$	60 ± 5
ii)	$16 \leq e_{\text{Min}} < 32$	120 ± 10
iii)	$32 \leq e_{\text{Min}}$	180 ± 15

The test specimens shall not be tested within a period of 24 h of production of the pipes, except for manufacturing checks.

7 PROCEDURE

7.1 Connect the conditioned test specimens to the pressurising equipment and bleed off the air. Progressively and smoothly apply the test pressure (calculated in accordance with 5.2.2) to ± 5 percent, in the shortest time practicable, preferably between 30 s and 1 h, depending upon the material, the size of the pipe and the capability of the pressurizing equipment.

Start the timer when the test pressure is reached.

7.2 Keep the test pieces suspended in the thermally controlled environment. Maintain a constant temperature in accordance with the referring standard, and keep within a mean of $\pm 1^\circ\text{C}$ and a maximum of $\pm 2^\circ\text{C}$ until testing is complete in accordance with 7.3 or 7.4 as applicable.

7.3 Stop the test either when the specified duration is reached, or when a failure or leak occurs in the test specimen, in which case record the time to failure.

7.4 In the event of equipment failure, tests which have been under way for more than 1 000 h may be continued provided the equipment is reinstated within 3 days. For tests which have been under way for more than 5 000 h, the test may be continued provided the equipment is reinstated within 5 days. Following equipment failure, if the test specimens are closed off at the test pressure by a solenoid valve or other means, the test may be continued in the event of periods of breakdown in excess of that stated above. It should be noted that in this situation, the pressure will gradually decrease due to continuing creep in the test specimen. The time while the equipment is not able to function normally shall not be included in the test time.

8 ASSESSMENT OF RESULTS

If a failure occurs, record the type of failure as brittle or ductile.

If a break occurs in a test specimen at a distance of less than that equal to the mean outside diameter, d_{em} , of the test specimen from an end cap, it does not constitute a failure. Disregard the result and repeat the test using another test specimen.

NOTE — A failure is brittle, if no plastic deformation has occurred in the failure zone. A failure is ductile if accompanied by plastic deformation (bulging, stretching), visible without magnification, in the failure zone.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 8 RESISTANCE TO INTERNAL HYDROSTATIC PRESSURE

Section 2 Leak-tightness of Elastomeric Sealing Ring Type Socket Joints Under Positive Internal Pressure and with Angular Deflection

1 SCOPE

This standard (Part 8/Sec 2) specifies a method of testing the leaktightness under positive pressure of assemblies of thermoplastics pipe, including unplasticized polyvinyl chloride (PVC-U), pipes with elastomeric sealing ring type socket joints including:

- a) Single sockets of pipes;
- b) Double sockets; and
- c) Sockets of fittings.

It also applies to elastomeric sealing ring type sockets made of ductile iron for use in combination with PVC-U pressure piping.

2 PRINCIPLE

A joint assembly as a test specimen consisting of a PVC-U pipe mounted into a PVC-U socket is exposed, within a specified temperature range, to a specified internal pressure regime for a specified time while the pipe is subject to an angular deflection in the socket. While under pressure the test piece is monitored for signs of leakage.

NOTE — It is assumed that the following test parameters are set by the standard making the reference to this standard:

- a) Test pressure, and
- b) Number of test specimens to be used.

3 APPARATUS

3.1 Framework comprising of at least two fixing devices, one of which is movable to allow angular deflection, vertical or horizontal, to be applied within the socket. A typical arrangement is shown in Fig. 1.

3.2 A pressure control device connected to the test specimen and capable of applying and maintaining a variable internal hydrostatic pressure of the PVC-U pipe section mounted into the socket of the component to be tested.

The assembly shall be carried out in accordance with the socket manufacturers instructions.

A pipe of the same nominal pressure as that of the socket shall be used for the test.

The length of the pipe section shall be such that the free length, L , between the socket and the end-seal is equal to five times the normal outside diameter, d_n , of the pipe with a minimum of 500 mm and a maximum of 1 500 mm.

NOTE — The mean outside diameter, d_{em} , of the pipe should preferably conform to the minimum specified value, and the socket dimensions (mean inside diameter, d_{im} , and the diameter of the groove for housing the sealing ring) should preferably conform to the maximum values stated by the manufacturer, in order to have dimensions as close to the extreme limits of the relevant tolerances.

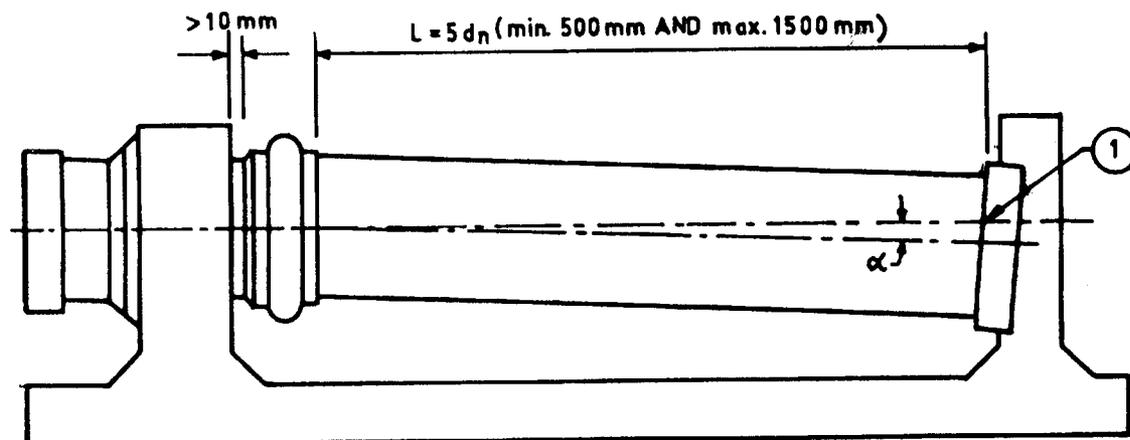


FIG. 1 TYPICAL ARRANGEMENT FOR TEST APPARATUS

3.3 Number of test specimens shall be as specified in the referring standard.

4 PROCEDURE

4.1 Secure the socket, without any deformation, to the solid framework and align the pipe section with the axis of the socket.

4.2 Incline the pipe in the test apparatus, determine the free angle of deflection, α , which the joint can tolerate without application of force.

If $\alpha \geq 2^\circ$ firmly anchor the pipe to maintain the deflected pipe in this position for the remainder of the test.

If $\alpha < 2^\circ$, carry out the test at a deflection of 2° by forcing the pipe to that degree of deflection.

4.3 Fill the test specimen with water at a temperature of $27 \pm 5^\circ\text{C}$ and release any trapped air.

4.4 Condition the test specimen assembly for a period of at least 20 min to ensure equalization of temperature.

4.5 While testing in accordance with 4.6:

- a) Maintain the ambient temperature within $\pm 5^\circ\text{C}$ of any temperature between 20°C and 32°C ; and
- b) Examine the joint during the whole test cycle and record any sign of leakage.

4.6 Apply the hydrostatic pressure according to the pressure regime shown in Fig. 2. Maintain the applied pressures at the specified static values with permitted deviations of $\begin{matrix} +5 \\ -0 \end{matrix}$ percent.

NOTE — Pressure changes need not necessarily be linear.

5 TEST REPORT

The test report shall include the following information:

- a) Reference to this standard and to the referring standard;
- b) Nominal pressure class of the PVC-U pipe and socket used for the test;
- c) Angle of deflection, α , used for the test;
- d) Ambient temperature during the test;
- e) Information of the leaktightness of the joint;
- f) Any factors which may have affected the results, such as any incidents or any operating details not specified in this standard; and
- g) Date of the test.

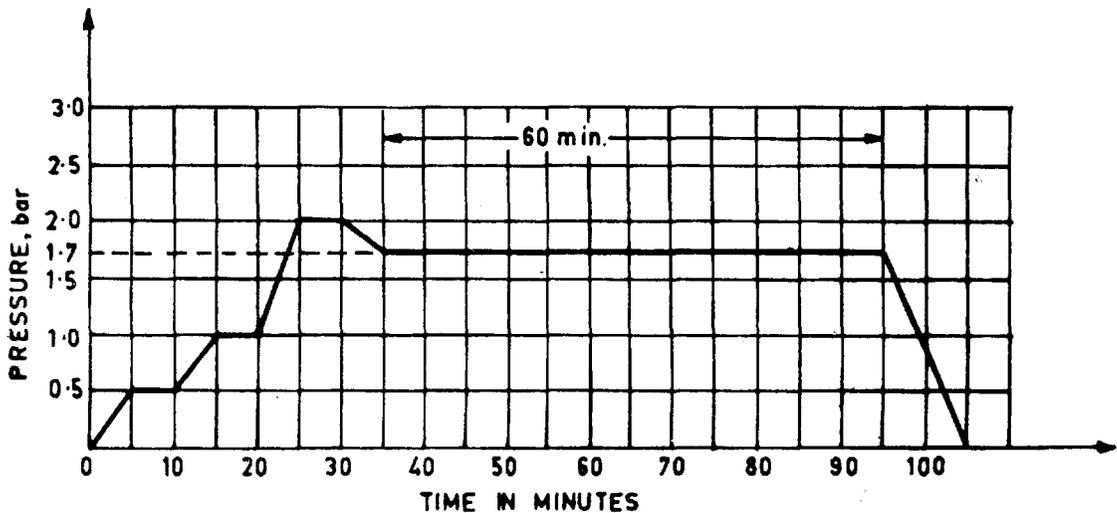


FIG. 2 HYDROSTATIC PRESSURE TEST REGIME

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 8 RESISTANCE TO INTERNAL HYDROSTATIC PRESSURE

Section 3 Leak-tightness of Elastomeric Sealing Ring Type Socket Joints Under Negative Internal Pressure and with Angular Deflection

1 SCOPE

This standard (Part 8/Sec 3) specifies a method of testing the leaktightness under negative pressure of assemblies of thermoplastics pipes, including unplasticized polyvinyl chloride (PVC-U) pipes, with elastomeric sealing ring type socket joints, including:

- a) Single sockets of pipes;
- b) Double sockets; and
- c) Sockets of fittings.

It also applies to elastomeric sealing ring type sockets made of ductile iron for use with thermoplastics pressure piping.

2 PRINCIPLE

A joint assembly as a test specimen consisting of a thermoplastics pipe mounted into a thermoplastics socket is exposed, within a specified temperature range, to a specified negative pressure for a specified time while the pipe is subject to an angular deflection in the socket. While under vacuum, the test piece is monitored for signs of leakage.

NOTE — It is assumed that the following test parameters are set by the standard making the reference to this standard:

- a) Test pressure, and
- b) Number of test specimens to be used.

3 APPARATUS

3.1 Framework comprising of at least two fixing devices, one of which is movable to allow angular deflection, vertical or horizontal. A typical arrangement is shown in Fig. 1 in Part 8, Section 2 of this standard.

3.2 Vacuum pump and control device connected to the test specimen, preferably at the immovable end of the apparatus, and capable of applying and maintaining two required levels of negative pressure of the pipe section mounted into the socket of the component to be tested.

3.3 An isolation valve between the test piece and the vacuum pump. A pipe of the same nominal pressure as that of the socket shall be used for the test. The

length of the pipe section shall be such that the free length, L , between the socket and the end-seal is equal to five times the nominal outside diameter, d_n , of the pipe with a minimum of 500 mm and a maximum of 1 500 mm.

NOTE — The mean outside diameter, d_{em} , of the pipe should preferably conform to the minimum specified value and the socket dimensions (mean inside diameter, d_{im} , and the diameter of the groove for housing the sealing ring) should preferably conform to the maximum values stated by the manufacturer, in order to have dimensions as close to the extreme limits of the relevant tolerances.

3.4 Number of test specimens shall be as specified in the referring standard.

4 PROCEDURE

4.1 Secure the socket without deformation, to the immovable portion of the framework and align the pipe section with the axis of the socket.

4.2 Incline the pipe in the test apparatus, determine the free angle of deflection, α which the joint can tolerate without application of force.

If $\alpha \geq 2^\circ$ firmly anchor the pipe to maintain the deflected pipe in this position for the remainder of the test.

If $\alpha < 2^\circ$ carry out the test at a deflection of $< 2^\circ$ by forcing the pipe to that degree of deflection.

4.3 While testing in accordance with 4.4, maintain the ambient temperature within $\pm 5^\circ\text{C}$ of any temperature between 20°C and 32°C .

4.4 Apply negative pressure to the test piece until a constant gauge pressure of -0.1 ± 0.02 bar (-0.01 ± 0.002 kPa) is achieved (see Fig. 1).

4.5 Isolate the vacuum pump from the test piece, but not from the control device. Record the change in the negative pressure for 15 min.

4.6 Unless the change in negative pressure was more than 0.05 bar (0.005 kPa), in which case stop the test, apply a further negative pressure to the test piece until a constant gauge pressure of -0.8 ± 0.02 bar (80 ± 2 kPa) is achieved.

4.7 Again isolate the vacuum pump from the test piece, monitor the pressure for a further period of 15 min and record any change in the negative pressure.

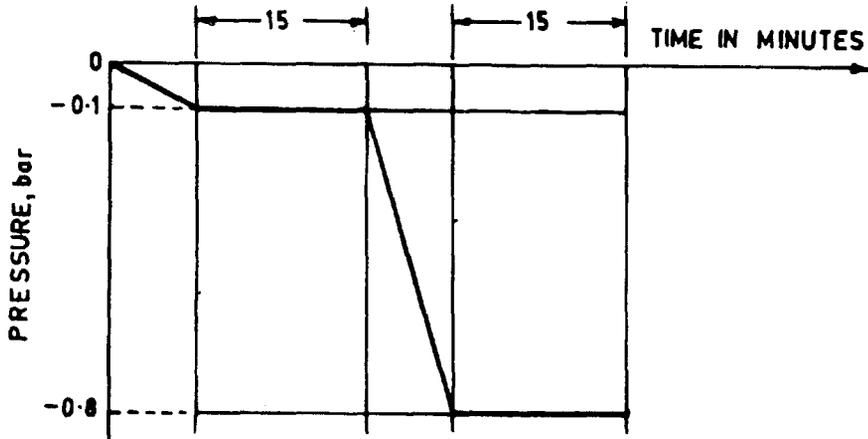
NOTE — The first negative pressure is approximately 0.9 bar absolute, the second negative pressure is approximately 0.2 bar absolute.

5 TEST REPORT

The test report shall include the following information:

- a) A reference to this standard and to the referring standard,

- b) Nominal pressure class of the pipe and the socket used for the test,
- c) Angle of deflection, α used for the test,
- d) Ambient temperature during the test,
- e) Information of the leaktightness of the joint, including any changes observed in the negative pressure,
- f) Any factors which may have affected the results, such as any incidents or any operating details not specified in this standard, and
- g) Date of the test.



NOTE — The pressure changes from one pressure level to the next do not necessarily have to take place at strictly linear rates.

FIG. 1 NEGATIVE PRESSURE TEST REGIME

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 8 RESISTANCE TO INTERNAL HYDROSTATIC PRESSURE

Section 4 Leak-tightness of Elastomeric Sealing Ring Type Socket Joints Under Positive Internal Pressure Without Angular Deflection

1 SCOPE

This standard (Part 8/Sec 4) specifies a method of testing the leaktightness under positive pressure of assemblies of thermoplastics pipe, including unplasticized polyvinyl chloride (PVC-U), pipes with elastomeric sealing ring type socket joints including:

- a) Single sockets of pipes;
- b) Double sockets; and
- c) Sockets of fittings.

It also applies to elastomeric sealing ring type sockets made of ductile iron for use in combination with PVC-U pressure piping.

2 APPARATUS

2.1 End Caps — Fixed to the ends of the pipe. The caps shall be rigidly connected to the test specimen but not to each other.

NOTES

- 1 Other than toothed grips, any sharp edges which would come in contact with the outside surface of the test specimen shall be rounded off.
- 2 The constituent material of the end cap shall not have any known adverse effect on the pipe under test.

2.2 End-Restraint Device — Since joints with elastomeric sealing rings are non-end-load-bearing, the joint assembly must be fixed between two end-restraining frames, connected to each other by length adjustable tie-rods, as shown in Fig. 1.

2.3 Pressurizing equipment capable of applying the required pressure gradually and smoothly in accordance with 5.2 and then keeping it constant to within ± 5 percent of the required pressure for the duration of the test.

As the results are strongly influenced by pressure, the tolerance on pressure shall be kept as small as possible.

NOTES

- 1 The pressure should preferably be applied individually to each test specimen. However, the use of equipment enabling the pressure to be applied simultaneously to several pieces is also permitted, provided there is no danger of interference when failure occurs (for example, by the use of an isolation valve or a test based on the first failure in a batch).
- 2 To maintain the pressure within the specified tolerance, it is

recommended that a system be introduced which automatically resets the pressure if it drops slightly (for example, because of swelling of the test piece), to the specified value.

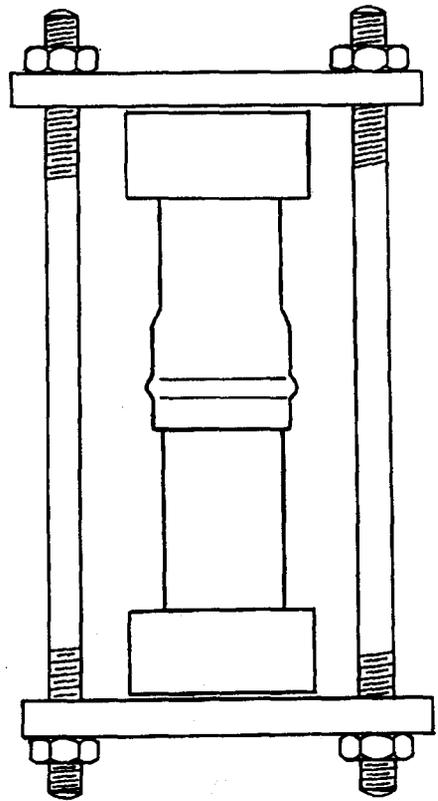


FIG. 1 SCHEMATIC ARRANGEMENT OF
TEST ASSEMBLY

2.4 Pressure measurement devices, capable of checking conformity to the specified test pressure (see 4.2.2), in the case of gauges or similar calibrated pressure measurement devices, the range of the gauge shall be such that the required pressure setting lies within the calibrated range of the device used.

2.4.1 The pressure measurement devices shall not contaminate the test fluid.

2.4.2 The use of master gauges for calibration of the apparatus is recommended.

2.5 Thermometer or other temperature-measuring device, capable of checking conformity to the specified test temperature.

2.6 Timer, capable of recording the duration of the pressure applications up to the moment of failure or leakage.

NOTE — It is recommended that such equipment be used which is sensitive to pressure variations due to leaks or a failure and which is capable of stopping the timer and, if necessary, closing the pressure circuit for the test specimen concerned.

3 TEST SPECIMENS

3.1 Dimensions

Suitable lengths of pipe with socket and spigot ends shall be used. A minimum free length equal to the diameter of the pipe should be allowed between the root of the socket and the end-cap on the socket portion and between the mouth of the socket and the end-cap on the spigot portion of the joint (*see* Fig. 1). Specimens shall not be tested within a period of 24 h of production of the pipes.

NOTE — It is advisable to choose spigots with mean outer diameters near the lower tolerance limit and sockets with groove diameters near the upper tolerance limits.

3.2 Number of Test Specimens

As specified in the referring standard.

4 CALIBRATION OF THE APPARATUS

The temperature and pressure control systems, and the equipment for measuring temperature, pressure and time, shall be calibrated to an accuracy compatible with the scales used and at a frequency commensurate with the conditions of use.

5 PROCEDURE

5.1 Specimens shall not be tested within a period of 24 h of production of the pipes. Assemble the joints in accordance with the instructions of the manufacturer.

5.2 Fix the assembled joint assembly between the frames of the end-restraint device.

5.3 Fill the assembly with water, which may be preheated to a temperature 5°C above the test temperature and release any entrapped air.

5.4 Condition the assembly for a period of at least 20 minutes.

5.5 Connect the conditioned test specimens to the pressurising equipment and wipe dry. Progressively and smoothly apply the required test pressure as specified in the referring standard to ± 5 percent, in the shortest time practicable, preferably between 30 s and 5 min, depending upon the material, the size of the pipe and the capability of the pressurizing equipment. Start the timer when the test pressure is reached.

5.6 Stop the test either when the specified duration is reached, or when water is seen to leak from the joint. Leakage from any other point, such as the end caps or pressure transmission hoses or connections, does not constitute a failure of the joint. In such a case the test has to be repeated after rectifying the fault.

5.7 In the event of equipment failure, tests which have been under way for more than 100 h can be continued provided the equipment is reinstated within 1 day. For tests that have been under way for more than 1 000 h, the test can be continued, provided the equipment is reinstated within 3 days. Following equipment failure, if the test specimens are closed off at the test pressure by a solenoid valve or other means, the test can be continued in the event of periods of breakdown in excess of that stated above. It should be noted that in this situation, the pressure will gradually decrease due to continuing creep in the test specimen. The time while the equipment is not able to function normally shall not be included in the test time.

6 ASSESSMENT OF RESULTS

The joint is deemed to have passed the test, if no leakage from the joint is observed for a period specified in the referring standard.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 9 RESISTANCE TO EXTERNAL BLOWS (IMPACT RESISTANCE) AT 0°C (ROUND-THE-CLOCK METHOD)

1 SCOPE

This standard (Part 9) specifies a method for the determination of the resistance to external blows of thermoplastics pipes, including unplasticized PVC pipes.

This method is applicable to isolated batches of pipe tested at 0°C.

2 DEFINITIONS

For the purposes of this standard, the following definitions shall apply.

2.1 True Impact Rate (TIR) — The total number of failures divided by the total number of blows, as a percentage, as if the whole batch had been tested.

NOTE — In practice, test specimens are drawn at random from the batch and the result is only an estimate of the TIR for that batch.

2.2 Failure — Shattering or any crack or split on the inside of the pipe that was caused by the impact and that can be seen by the naked eye (lighting devices may be used to assist in examining the specimens).

Indentation of the test specimen is not considered a failure.

3 PRINCIPLE

Test pieces are subjected to blows from a falling striker, of specified mass and shape, dropped from a known height onto specified positions around the circumference of the test specimen. The true impact rate (TIR) of the batch, or production run from an extruder, is estimated.

The severity of this test method can be adjusted by changing the mass of the striker and/or by changing the drop height. It is not technically correct to vary the severity of the test by choosing values of the TIR other than those specified below.

The maximum acceptable values for the TIR is taken to be 10 percent.

NOTE — It should be appreciated that a completely definitive result can be reached only by testing the whole batch. But in practice, a balance is necessary between the statistical possibility of a definitive result and the cost of further testing.

4 APPARATUS

4.1 Falling Weight Testing Machine — Incorporating the following basic components (*see* Fig. 1).

4.1.1 Main frame with guide rails or tube, which can be fixed in the true vertical position, to accommodate a striker and release mechanism to release the striker to fall vertically and freely.

4.1.2 Striker having a nose comprising all or part of a hemisphere, combined with a stem at least 10 mm long, and having dimensions conforming to Fig. 2 read with Table 1. The mass of the striker, including any associated weights, shall be selected from the values 0.5, 0.8, 1.0, 1.25, 1.6, 2.0, 2.5, 3.2, 4.0, 5.0, 6.3, 8.3, 10.0, 12.5 and 16.0 kg. The permissible tolerance on the mass of a striker shall be ± 0.5 percent. Below the stem, the nose shall be of solid steel, polished and free of flats, indentations or other imperfections which may influence the result.

Table 1 Dimensions for the Nose of the Striker

All dimensions in millimetres.

Sl No.	Type	R_s	d	d_s	α°
(1)	(2)	(3)	(4)	(5)	(6)
i)	d 25	50	25 ± 1	Free	Free
ii)	d 90	50	90 ± 1	Free	Free

4.1.3 Rigid specimen support, consisting of a 120° V-Block at least 200 mm long positioned so that the vertical projection of the point of impact of the falling striker is within 2.5 mm of the axis of the V-Block (*see* Fig. 1).

4.1.4 Release mechanism, such that the striker can fall from a variable height which can be adjusted to any height up to at least 2 m, measured from the top surface of the test specimen, with an accuracy of ± 10 mm.

5 TEST SPECIMENS

Test specimens of length 200 ± 10 mm shall be cut from pipe selected at random from the batch, or the production run from an extruder.

The cut ends shall be square to the axis of the pipe, clean and free from damage.

For pipes with outside diameters greater than 40 mm, a straight line shall be drawn along the length of each test specimen at a random position. Further lines shall be drawn at equal distances around the pipe piece so that each test specimen has a number of lines given in

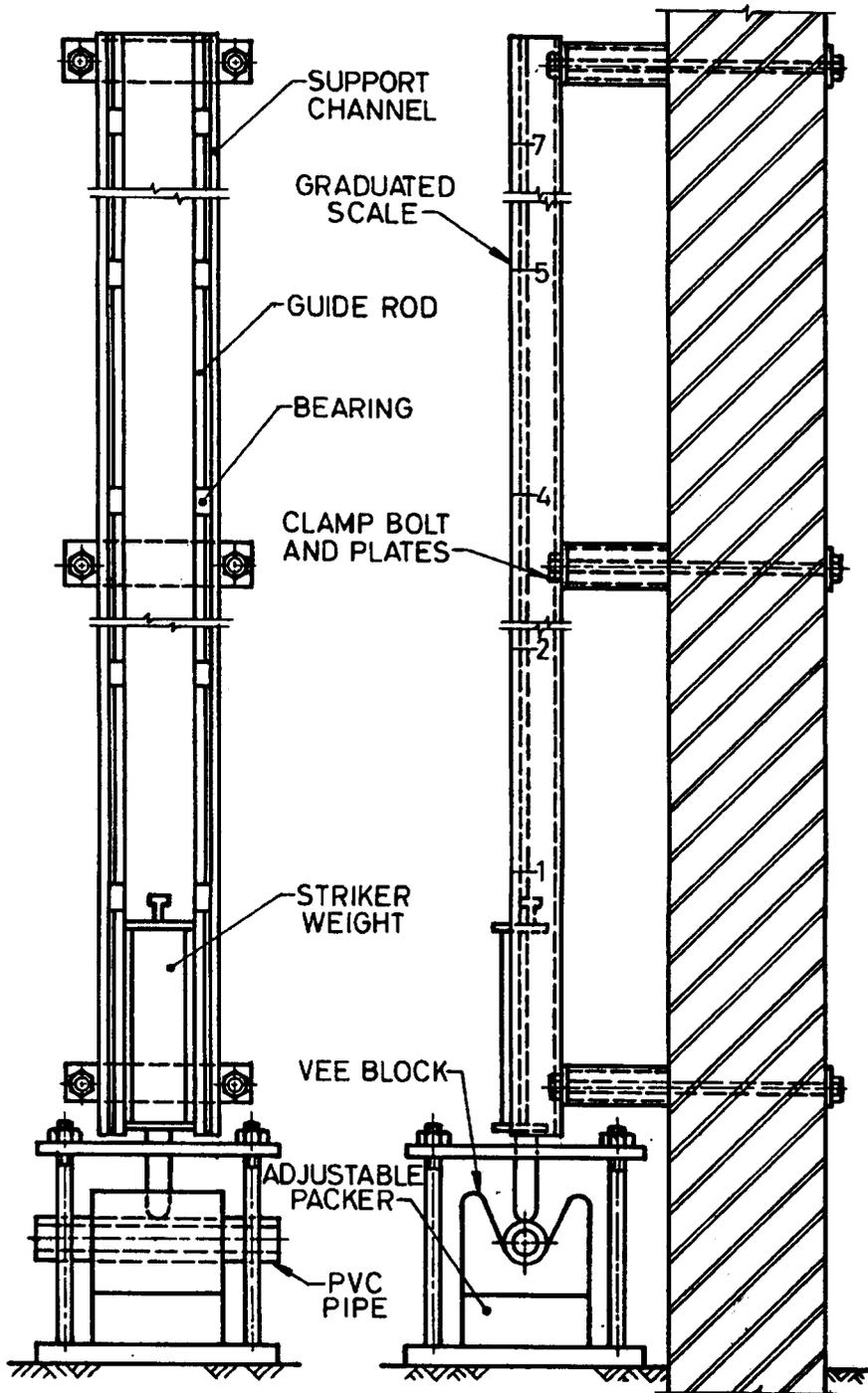


FIG. 1 IMPACT TESTING MACHINE

Table 2. The number of blows required is given in 6. For pipes with outside diameters less than or equal to 40 mm, only one blow per test specimen shall be made.

6 SAMPLING TO CONFIRM VALUE OF TIR ON ISOLATED BATCHES

6.1 If the number of failures from a sample falls into region A of Fig. 3 (for a TIR of less than or equal to 10 percent), then reasonable confirmation is obtained that

the batch has a TIR less than or equal to the specified level.

6.2 If the number of failures falls into the region C of Fig. 3, the batch can be judged to have a TIR greater than the specified value.

6.3 If the number of failures falls into the region B of Fig. 3, in general further test specimens should be taken so that a decision can be reached. However, attention is drawn to 10 for further details.

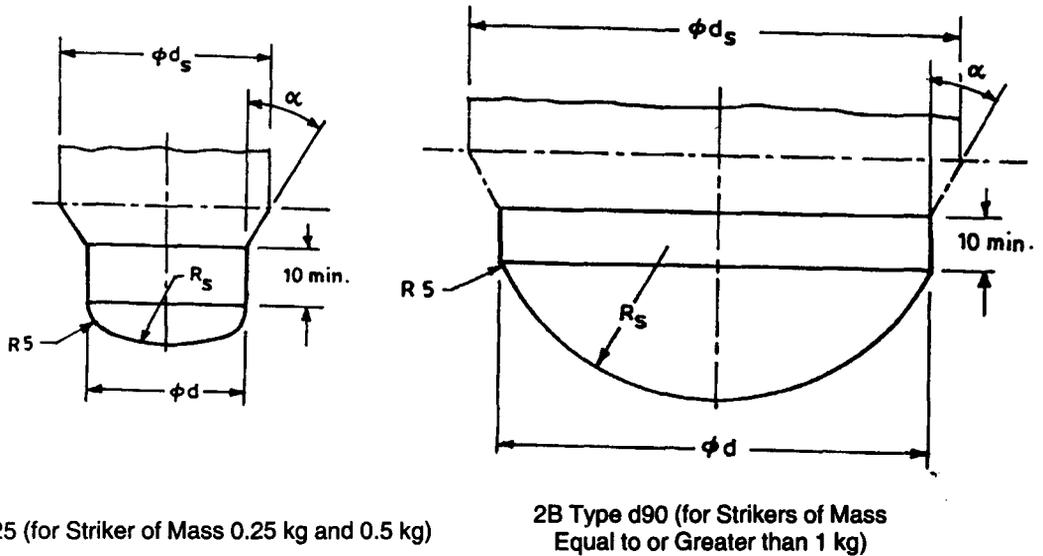
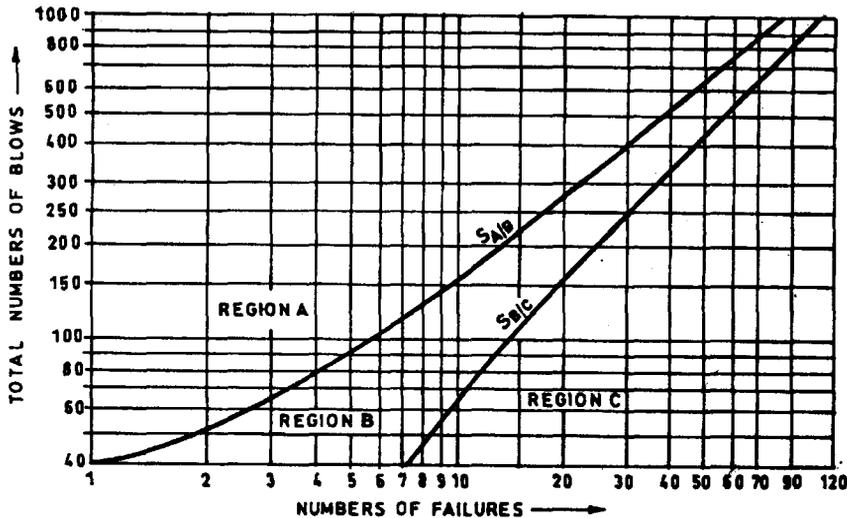


FIG. 2 NOSES OF THE STRIKERS

6.4 The decision shall be made by using the cumulative result of all the test specimens examined from the batch under consideration.

6.5 The graph is given only to indicate the principle

of the test method and is given only as a guideline. Evaluation of the test results shall be done based on Table 3. If the number of blows exceeds 124, refer to the graph for assessment of results.



Boundaries between regions are calculated using the following equations:

$$S_{A/B} = np - 0.55 - \mu \sqrt{np(1-p)}$$

$$S_{B/C} = np - 0.55 - \mu \sqrt{np(1-p)}$$

where

- μ = 1.282 (10 percent one sided),
- p = 0.10 (TIR), and
- n = number of blows.

NOTES

- 1 Initially a minimum of 25 blows shall be made. In case of no failure, the lot is deemed to have passed the test. In case of more than four failures, the lot is treated as rejected. The test shall be continued further if one or two or three failures occur till the results fall into either region A or region C of Table 3 to arrive at a decision for acceptance or rejection respectively.
- 2 It is necessary to have achieved at least 25 blows without failure before the test is discontinued.

FIG. 3 NUMBER OF TEST PIECES FOR 10 PERCENT TIR (AT 90 PERCENT CONFIDENCE LEVEL)

Table 2 Number of Equidistant Lines to be Drawn on Test Specimens
(Clause 5)

Sl No.	Nominal Outside Diameter of Pipe mm	Number of Equidistant Lines to be Drawn
(1)	(2)	(3)
i)	≤ 40	—
ii)	50	3
iii)	63	3
iv)	75	4
v)	90	4
vi)	110	6
vii)	125	6
viii)	140	8
ix)	160	8
x)	180	8
xi)	200	12
xii)	225	12
xiii)	250	12
xiv)	280	16
xv)	≥ 315	16

Table 3 Number of Blows and Failures
(Clause 6.5)

Number of Blows (1)	Number of Failures		
	Accept (2)	Continue (3)	Reject (4)
25	0	1 to 3	4
26	0	1 to 4	5
27	0	1 to 4	5
28	0	1 to 4	5
29	0	1 to 4	5
30	0	1 to 4	5
31	0	1 to 4	5
32	0	1 to 4	5
33	0	1 to 5	6
34	0	1 to 5	6
35	0	1 to 5	6
36	0	1 to 5	6
37	0	1 to 5	6
38	0	1 to 5	6
39	0	1 to 5	6
40	1	2 to 6	7
41	1	2 to 6	7
42	1	2 to 6	7
43	1	2 to 6	7
44	1	2 to 6	7
45	1	2 to 6	7
46	1	2 to 6	7
47	1	2 to 6	7
48	1	2 to 6	7
49	1	2 to 7	8
50	1	2 to 7	8
51	1	2 to 7	8
52	1	2 to 7	8
53	2	3 to 7	8
54	2	3 to 7	8
55	2	3 to 7	8
56	2	3 to 7	8

Table 3 (Concluded)

(1)	(2)	(3)	(4)
57	2	3 to 8	9
58	2	3 to 8	9
59	2	3 to 8	9
60	2	3 to 8	9
61	2	3 to 8	9
62	2	3 to 8	9
63	2	3 to 8	9
64	2	3 to 8	9
65	2	3 to 9	10
66	2	3 to 9	10
67	3	4 to 9	10
68	3	4 to 9	10
69	3	4 to 9	10
70	3	4 to 9	10
71	3	4 to 9	10
72	3	4 to 9	10
73	3	4 to 10	11
74	3	4 to 10	11
75	3	4 to 10	11
76	3	4 to 10	11
77	3	4 to 10	11
78	3	4 to 10	11
79	3	4 to 10	11
80	4	5 to 10	11
81	4	5 to 11	12
82	4	5 to 11	12
83	4	5 to 11	12
84	4	5 to 11	12
85	4	5 to 11	12
86	4	5 to 11	12
87	4	5 to 11	12
88	4	5 to 11	12
89	4	5 to 12	13
90	4	5 to 12	13
91	4	5 to 12	13
92	5	6 to 12	13
93	5	6 to 12	13
94	5	6 to 12	13
95	5	6 to 12	13
96	5	6 to 12	13
97	5	6 to 12	13
98	5	6 to 13	14
99	5	6 to 13	14
100	5	6 to 13	14
101	5	6 to 13	14
102	5	6 to 13	14
103	5	6 to 13	14
104	5	6 to 13	14
105	6	7 to 13	14
106	6	7 to 14	15
107	6	7 to 14	15
108	6	7 to 14	15
109	6	7 to 14	15
110	6	7 to 14	15
111	6	7 to 14	15
112	6	7 to 14	15
113	6	7 to 14	15
114	6	7 to 15	16
115	6	7 to 15	16
116	6	7 to 15	16
117	7	8 to 15	16
118	7	8 to 15	16
119	7	8 to 15	16
120	7	8 to 15	16
121	7	8 to 15	16
122	7	8 to 15	16
123	7	8 to 16	17
124	7	8 to 16	17

7 CONDITIONING

7.1 The test specimens shall be conditioned in a liquid bath or in air at a temperature of $0 \pm 1^\circ\text{C}$ for at least the period given in Table 4.

7.1.1 In case of disputes over the results, a liquid bath shall be used.

7.2 Test specimens with wall thickness up to 8.6 mm shall be tested within 10 s of their removal from air conditioning, or within 20 s of their removal from liquid conditioning, as applicable.

7.3 Test specimens with wall thickness greater than 8.6 mm shall be tested within 20 s of their removal from air conditioning or within 30 s of their removal from liquid conditioning, as applicable.

7.4 If this interval is exceeded, the test specimen shall be returned immediately to the unit for re-conditioning for a minimum of 5 min.

Table 4 Conditioning Period
(Clause 7.1)

Sl No.	Wall Thickness <i>e</i> mm (2)	Conditioning Period	
		Liquid Bath min (3)	Air min (4)
i)	< 8.6	15	60
ii)	8.6 to 14.1	30	120
iii)	> 14.1	60	240

NOTE — For pipes with smooth inside and outside surfaces, the wall thickness of the pipe to be tested shall be the total wall through the pipe section and for pipes which are corrugated or ribbed externally, the wall thickness is the thickest wall of the pipe cross-section.

8 PROCEDURE

The mass of the falling striker and the drop height appropriate to the pipe shall be as specified in the referring product standard.

For pipes of outside diameter 40 mm or less subject the test specimen to only a single blow.

For pipes of outside diameter greater than 40 mm, subject the test specimen to a blow by allowing the striker to fall on one of the marked lines. If the test specimen passes the test, rotate it in the V-block to the next marked line and again subject it to a blow from the falling striker, after re-conditioning if necessary (see 7).

In case of corrugated or ribbed pipes, when the pitch of the pipe is over 0.25 times the shaft diameter *d*, ensure that the test specimen is struck on the top of the corrugation or rib.

Continue this procedure until the test specimen fails the test, or until all the marked lines have been struck one blow.

If required, carry out the test on subsequent test specimens, subjecting each one to the required number of blows.

9 EXPRESSION OF RESULTS

The result shall be expressed as A, B or C for the batch or the production run from an extruder, as follows:

- a) If the TIR is below 10 percent;
- b) If no decision can be made on the basis of the number of test specimens used (see 10.3); and
- c) If the TIR is greater than 10 percent.

NOTE — The number of failed test specimens, as compared to the total number of blows, should not be expressed as a percentage, to avoid confusion with the TIR, of which the percentage is only an estimate.

10 EVALUATION OF RESULTS FROM ISOLATED BATCHES (INFORMATIVE)

10.1 Scope

This clause provides information on the evaluation of results from isolated batches of pipe and on the use of Fig. 3. It also suggests a procedure for sampling and testing from continuous production.

10.2 Reliability of Claims of TIR

The decision on the number of test pieces to be taken as a sample from an isolated batch should be made with the following consideration kept in mind. In general, the precision and accuracy of the test method is poor according to statistical laws.

This is illustrated by the following examples:

If, on testing to confirm a claim of 10 percent TIR on a sample taken at random from a batch, one test piece fails out of 100 blows, this result can only be interpreted as meaning that the batch has a TIR of between 0.1 percent and 3.9 percent (with 90 percent confidence):

- a) If 5 test pieces fail out of 100 blows, this indicates that the batch has a TIR of between 2.5 percent and 9.1 percent (with 90 percent confidence);
- b) If 9 test pieces fail out of 100 blows, this indicates that the batch has a TIR of between 5.5 percent and 13.8 percent (with 90 percent confidence).

10.3 Isolated Batches with a Third-Party Quality Mark

10.3.1 Procedure given in 10.3.2 is applicable in the case where independent certification and monitoring are applied.

10.3.2 If an isolated batch is claimed to have a TIR of 10 percent or less and this claim is supported by a quality mark, this can be confirmed as follows:

- a) If the number of failures from a sample falls into region *A* of Fig. 3, then reasonable confirmation is obtained that the batch does not have a TIR of less than 10 percent;
- b) If the number of failures falls into region *B*, subsequent measurements must fall into region *A* for the TIR to be confirmed; and
- c) If the number of failures falls into region *C*, the claim given by the quality mark is not confirmed.

10.3.3 Example

A test is made on a sample to confirm a claim to TIR of less than or equal to 10 percent:

- a) If after 100 blows there are 13 or fewer failures, reasonable confirmation is obtained that the batch has a TIR of less than or equal to 10 percent. and
- b) If 14 or more failures occur, the claim made by the quality mark is not confirmed.

10.4 Isolated Batches Without a Third-Party Quality Mark

10.4.1 If an isolated batch is claimed to have a TIR of 10 percent or less; but has no quality mark, this claim may be confirmed as follows:

- a) If the number of failures from a sample falls into region *A* of Fig. 3, than reasonable confirmation is obtained that the batch has a TIR of less than or equal to 10 percent;
- b) If the number of failures falls into region *C*, the batch can be judged to have a TIR of greater than 10 percent; and
- c) If the number of failures falls into region *B*, further test pieces should be taken so that a decision can be reached; this decision is made

by considering the cumulative result of all the test pieces which were impact tested.

10.4.2 Example

A test is made on a sample to confirm a claim of TIR of less than or equal to 10 percent:

- a) If after 100 blows, there are not more than 5 failures, reasonable confirmation is obtained that the batch has a TIR of less than or equal to 10 percent;
- b) If 14 or more failures occur, the batch can be judged to have a TIR of greater than 10 percent; and
- c) If 6 to 13 failures occur, further blows have to be made so that a decision can be reached (for example, if after a further 50 blows there have been a total of 20 failures, the batch can be judged to have a TIR of greater than 10 percent.

10.5 Suggested Sampling Procedure for Continuous Production

10.5.1 At the commencement of a production run sufficient test pieces should be impact tested to demonstrate that the pipe has a TIR of equal to or less than 10 percent.

10.5.2 Thereafter, at intervals, not exceeding 8 h, sufficient test pieces should be taken to ensure that 25 impacts may be made.

10.5.3 If no failures occur in the sample taken in accordance with **10.5.2** production may proceed.

10.5.4 In the event of a failure occurring in the sample taken in accordance with **10.5.2**, further test pieces should be tested until a positive pass or fail decision is reached (that is, the number of failures is in either region *A* or *C*).

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 10 DETERMINATION OF ORGANOTIN AS TIN AQUEOUS SOLUTION

1 SCOPE

This standard (Part 10) specifies the method for the determination of organotin as tin aqueous solution of thermoplastics pipe, including unplasticized PVC pipes.

2 REFERENCE

The standard listed below contains provisions which, through references in this text, constitutes provisions of this standard. At the time of publication the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

IS No.	Title
1070 : 1992	Reagent grade water (third revision)

3 PRINCIPLE

3.1 Toluene-3,4-dithiol (dithiol) forms a coloured complex with an acid solution of divalent tin. This colloiddally dispersed red compound is used for the determination of tin by a spectrophotometric method.

3.2 The lower limit of the determination is about 2 µg of tin.

4 APPARATUS

Spectrophotometer — Suitable for use in the visible range of the electromagnetic spectrum (400 to 800 nm), with 1 and 4 cm cells.

5 REAGENTS

The reagents used shall be of recognized analytical reagents quality. Water conforming to IS 1070 shall be used throughout.

- a) *Concentrated nitric acid* — relative density 1.42.
- b) *Perchloric acid* — 600g/litre solution.
- c) *Thioglycolic acid* — approximately 98 percent.
- d) *Dilute sulphuric acid* — 25 percent (v/v) solution.
- e) *Dodecyl sodium sulphate* — 20 g/litre solution. Dissolve 2 g of dodecyl sodium sulphate

(sodium lauryl sulphate) in 100 ml of warm water. The solution may lose its clarity on cooling; gentle warming will restore it.

- f) *Toluene-3,4-dithiol* — 2 g/litre solution. Dissolve 2 g of toluene-3,4-dithiol (dithiol) or 0.28 g of zinc toluene-3,4-dithiol in 5 ml of 5 N sodium hydroxide. Add 1 ml of thioglycolic acid and dilute to 100 ml with water. Filter, if necessary. This solution should be prepared fresh daily.

NOTE — The life of this solution may be extended to about one week if it is stored under refrigerated conditions.

- g) *Standard tin solution* — 0.2 mg Sn/ml. Dissolve 0.200 g of tin in 100 ml of 50 percent (v/v) hydrochloric acid and dilute with the same acid to 1 000 ml.
- h) *Standard tin solution* — 0.02 mg Sn/ml. Prepare by diluting the solution prepared under (g) above appropriately using 25 percent (v/v) hydrochloric acid.
- j) *Standard tin solution* — 0.004 mg Sn/ml. Prepare by diluting the solution prepared under (g) above appropriately using 25 percent (v/v) hydrochloric acid.

6 PROCEDURE

6.1 Preparation of the Colour Standards

- a) *High Range (100-500 µg tin per test)* — Into six 25 ml standard one-mark volumetric flasks, transfer volumes of the 0.004 mg/ml standard tin solution [5 (j)] from 0 to 5.0 ml, increasing in stages of 1.0 ml. Treat each in the following manner:

Dilute with water to about 6 ml, add 2 drops of thioglycolic acid [5 (c)] followed by 2 ml of sulphuric acid [5 (d)] and mix thoroughly. Cautiously add 0.4 ml of the dodecyl sodium sulphate solution [5 (e)] with constant swirling; avoid shaking which creates foam. Continue to swirl the contents of the flask while adding 0.2 ml of toluene-3,4-dithiol solution [5 (f)]. Dilute to 25 ml, stopper the flask and shake thoroughly. Fifteen minutes after the addition of toluene-3,4-dithiol solution, measure the optical density of each solution in

a 1 cm cell at a wavelength of 535 nm (nanometres) using water as the comparative standard blank. Prepare a graph of the optical density readings against micrograms of tin present.

- b) *Low Range (up to 100 µg tin per test)* — Into six 50 ml standard one-mark volumetric flasks, transfer volumes of the 0.02 mg/ml standard tin solution [5 (h)], from 0 to 10.0 ml in stages of 2 ml each. Treat each in the following manner:

Dilute with water to about 15 ml, add 2 drops of thioglycollic acid [5 (c)] followed by 10 ml of the dilute sulphuric acid [5 (d)] and mix thoroughly. Cautiously add 2.0 ml of dodecyl sodium sulphate solution [5 (e)] with constant swirling; avoid shaking which creates foam. Continue to swirl the contents of the flask while adding 1.0 ml of toluene-3,4-dithiol solution [5 (f)]. Dilute to 25 ml, stopper the flask and shake thoroughly. Fifteen min after the addition of toluene-3,4-dithiol solution, measure the optical density of each solution in a 4 cm cell at a wavelength of 535 nm (nanometers) using water as the comparative

standard blank. Prepare a graph of the optical density readings against micrograms of tin present.

6.2 Determination

Evaporate a suitable volume of the test solution to dryness, add 2 ml of dilute sulphuric acid [5 (d)] and evaporate until fumes of sulphur trioxide appear. Add concentrated nitric acid [5 (a)] followed by 0.2 ml of perchloric acid [5 (b)] and evaporate until fumes of sulphur trioxide appear.

Cool and transfer the contents of the beaker quantitatively into a 10 ml standard volumetric flask and dilute to about 8 ml with water.

Add two drops of thioglycollic acid [5 (c)] and, with constant swirling, 0.4 ml of dodecyl sodium sulphate solution [5 (e)]. Add 0.2 ml of toluene-3,4-dithiol solution [5 (f)]; dilute to the mark, stopper the flask and shake thoroughly. Transfer a quantity to a suitable cell and 15 min after the addition of toluene-3,4-dithiol solution, measure its optical density at a wave length of 535 nm (nanometres), using water as the comparative standard blank. Read off the amount of tin present from the appropriate calibration graph.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 11 RESISTANCE TO DICHLOROMETHANE AT SPECIFIED TEMPERATURE

1 SCOPE

This standard (Part 11) specifies a method of test for determining the resistance of unplasticised PVC pipes to dichloromethane at a temperature specified in the relevant standard.

2 PRINCIPLE

A piece of PVC-U pipe of specified length, chamfered at one end to an angle dependent on its thickness, is immersed for a fixed period of time in a thermo-controlled dichloromethane bath in order to verify that the PVC-U is not attacked at the temperature specified in the standard.

NOTES

1 If the PVC has not been sufficiently gelled, whitening of the surface will occur and, in the worst case, a powdery precipitate will be produced.

2 The maximum temperature at which the PVC is not attacked gives an indication of the degree and homogeneity of gelatin of the PVC-U of which the pipe is made. This characteristic is related to the mechanical properties, and in particular the long-term pressure resistance of the pipe.

3 The minimum permitted bath temperature at which attack by the dichloromethane shall not take place is specified.

3 REAGENT

3.1 Dichloromethane, Analytical Grade

NOTE — Dichloromethane can be toxic by absorption through the skin and eyes. It is, therefore, necessary to take precautions when handling dichloromethane or test specimens which have been immersed in it. Furthermore, the boiling point of dichloromethane is low, 40°C. Consequently, it has a high vapour pressure at ambient temperatures, the vapour is also toxic, the threshold limit value corresponding to the maximum admissible concentration being 500 ml/m³ (ppm). Ventilation of the room or area in which the container is kept and where the test specimens are dried is therefore essential.

4 APPARATUS

4.1 Chamfering Machine

4.2 Glass or stainless-steel container of suitable dimensions to accommodate one or more test specimens under the specified conditions (*see* 7.4). A mark on the inside surface to indicate a suitable dichloromethane level is useful.

4.3 Grating so fitted that it is approximately 1 cm above the bottom of the container.

4.4 Lid to limit the evaporation of the dichloromethane.

4.5 Thermostat, to maintain the temperature of the dichloromethane at $15 \pm 0.5^\circ\text{C}$.

4.6 Cooling device to cool the dichloromethane to the specified temperature.

4.7 Stirrer to homogenize the temperature of the bath.

4.8 Hood fitted with a fume extraction system.

5 USE OF THE DICHLOROMETHANE BATH

5.1 Maintain the dichloromethane at a suitable level in the container

5.2 The consistency of colour, and hence purity of the dichloromethane in the bath shall be checked regularly by measuring the refractive index, which shall not vary in use by more than ± 0.002 from the original value.

Whenever the value of the refractive index changes by more than ± 0.002 from the original value, it shall be changed.

NOTE — In practice, the refractive index will change by 0.000 5 over a period of 3 months, if some 700 or 800 tests are carried out per month.

Checking the quality of the dichloromethane in the bath every 3 months should suffice.

6 PREPARATION OF THE TEST SPECIMENS

Cut from the pipe to be tested, pieces 160 mm in length. The cut shall be square to the axis of the pipe.

If necessary, cool the test specimens to ambient temperature.

Chamfer by machining one of the ends of each test specimen over its complete wall thickness, the angle of chamfer depending on the wall thickness e of the pipe (*see* Table 1). The test specimens shall not be allowed to reach a temperature greater than 60°C during the machining operation.

Table 1 Details of Chamfer

Sl No.	e mm	α degree
(1)	(2)	(3)
i)	$e < 8$	10
ii)	$8 \leq e \leq 16$	20
iii)	$e > 16$	30

7 PROCEDURE

7.1 Fill the container (see 4.2) with dichloromethane (see 3.1) to a depth sufficient to cover the chamfered zone of the test specimens introduced in accordance with 7.4.

7.2 Cover the dichloromethane with a layer of demineralized water approximately 20 mm deep.

NOTE — The purpose of the water layer is to reduce the evaporation (normally 0.6 l/m².h) of the dichloromethane and to protect the operator from any harmful effects of the vapour.

7.3 Set the thermostat (see 4.5) at 15 ± 0.5°C. Start the cooling device and the stirrer.

7.4 When the temperature of the bath has reached the set temperature, place the test specimens on the grating (see 4.3) so that the chamfered zone is completely immersed in the dichloromethane. Cover the container with the lid.

7.5 Leave the test specimens for 30 min in the dichloromethane, ensuring that the temperature is maintained at the specified value.

7.6 Remove the test specimens from the container with a pair of pincers (see 3.1) or use gloves.

7.7 Leave the test specimens to dry in air for at least 15 min under the hood.

7.8 Examine the test specimens in accordance with 8.

8 EXPRESSION OF RESULTS

8.1 If the test specimen shows no sign of attack : 'no attack'.

8.2 If the test specimen shows signs of attack, describe the appearance and location of the attack.

NOTE — When the attack is on the chamfer, express the result as a percentage of the total chamfer area (see Fig. 1).

a) Percentage attack calculated across the chamfer =

$$\frac{d}{c} \times 100$$

b) Percentage of attack calculated round the chamfer =

$$\frac{b}{\pi D} \times 100$$

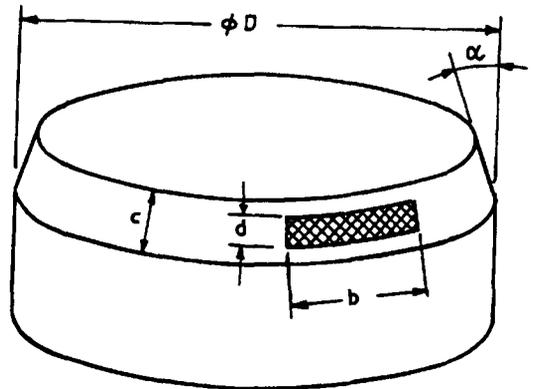


FIG. 1 CALCULATION OF PERCENTAGE ATTACK

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 12 DETERMINATION OF TITANIUM DIOXIDE CONTENT

1 SCOPE

This standard (Part 12) specifies a method of test for determining the titanium dioxide content in the unplasticized polyvinyl chloride pipes and fittings.

2 PRINCIPLE

A sample of PVC-U pipe or fitting is ignited in a furnace and the resulting ash is boiled with sodium sulphate and sulphuric acid. This solution is diluted with distilled water and the concentration of titanium dioxide determined by spectrophotometry.

3 REFERENCE

The standard listed below contains provisions which through references in this text, constitutes provisions of this standard. At the time of publication the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
1070 : 1992	Reagent grade water — Specification

4 REAGENTS AND APPARATUS

4.1 Reagents

Except where otherwise specified, only reagents of recognized analytical grade and only water conforming to IS 1070 shall be used.

4.1.1 Sulphuric Acid (Density 1 840 kg/m³)

4.1.2 Anhydrous Sodium Sulphate

4.1.3 Hydrogen Peroxide (30 percent)

4.1.4 Sulphuric Acid—10 percent solution (1 part concentrated sulphuric acid added to 9 parts of distilled water).

4.1.5 Rutile titanium dioxide of average assay 97 percent TiO₂.

4.2 Apparatus

4.2.1 Ultra violet/visible range spectrophotometer set to read at 408.0 ± 0.2 mm.

4.2.2 Muffle furnace capable of being maintained at 850 ± 10°C.

4.2.3 Analytical balance with 0.1 mg accuracy.

4.2.4 Hotplate

4.2.5 Porcelain or Silica Crucibles — 50 ml volume.

4.2.6 Thermometers capable of indicating the required temperatures to an accuracy of ± 2°C.

4.2.7 Standard laboratory glassware.

5 PREPARATION OF THE TEST SAMPLE

The bulk sample shall be prepared by finely milling a suitable length of pipe or section of fitting and then mixing it uniformly. No preconditioning of the test samples is required.

Test portions for analysis are randomly selected from this bulk sample.

NOTE — Fragments or pieces obtained from an impact test may be used.

6 PROCEDURE

6.1 Standards Preparation

6.1.1 Weigh out approximately 100 mg of titanium dioxide commercial grade of approx 97 percent purity to the nearest 0.1 mg and record the mass determined. Transfer the TiO₂ to a 250 ml beaker and add 1.5 g of anhydrous sodium sulphate and 50 ml of concentrated sulphuric acid. Add boiling chips, cover the beaker with a watch glass, and heat to boiling point on a hotplate until the solid material has dissolved.

6.1.2 When the solution has cooled, add to it approximately 100 ml of distilled water, stirring continuously. After cooling transfer the solution to a 500 ml volumetric flask containing approximately 200 ml of distilled water, and make up to the mark with distilled water.

6.2 Preparation of the Standard Curve

6.2.1 Prepare standard TiO₂ solutions in the following concentrations:

0.00, 0.02, 0.04, 0.06, 0.08 and 0.10 mg/ml by transferring 0, 5.0, 10.0, 15.0, 20.0 and 25.0 ml of the standard solution into separate 50 ml volumetric

flasks and dilute almost to volume with 10 percent sulphuric acid solution. Add 2.0 ml of 30 percent hydrogen peroxide solution to each of the volumetric flasks, dilute to volume with 10 percent sulphuric acid solution, shake and leave in a dark cupboard for approximately 30 min, with occasional further shaking.

6.2.2 Using the spectrophotometer, determine the absorbance of each solution at a wave length of 408 nm using 1.0 cm cells with a blank of 2.0 ml 30 percent hydrogen peroxide in 50 ml 10 percent sulphuric acid solution.

6.2.3 From these results plot a standard curve (absorbance *versus* concentration in mg/ml).

6.3 Sample Preparation

6.3.1 For samples containing in the region of 5 percent TiO₂, weigh out approximately 1.5 g of the test portion.

6.3.2 For samples containing in the region of 0.6 percent TiO₂, weigh out approximately 3.0 g of the test portion.

6.3.3 Weigh the appropriate amount of sample to the nearest 0.1 mg into a 50 ml porcelain or silica crucible and record the mass (*M*).

6.3.4 Heat the crucible, gently at first, with a bunsen burner until charring is complete and the evolution of copious white fumes has ceased.

6.3.5 Transfer the crucible to a muffle furnace maintained at 850 ± 10°C and ignite to a white or pale gray ash. (This takes approximately 4 h.)

6.3.6 Allow the crucible to cool, then add 1.5 g of anhydrous ammonium sulphate and 25 ml of concentrated sulphuric acid, followed by boiling chips. Cover the crucible with a watch glass and bring the contents to a boil on the hot plate (take care to avoid spattering or spillage). A clear solution should result.

NOTE— Sometimes the solution is slightly cloudy, but this has no effect on the final result.

6.3.7 Allow the crucible to cool and then carefully transfer the contents of the beaker containing 200 ml of distilled water. Thoroughly wash the crucible with further aliquots of distilled water.

6.3.8 After cooling, transfer the solution to a 500 ml volumetric flask and make up the volume (*V*₁) with distilled water.

6.4 Determination of Titanium Dioxide in the Sample Solution

6.4.1 Transfer 20 ml (*V*₃) of the sample solution prepared in **6.3.8** to a 50 ml volumetric flask and dilute almost to volume with 10 percent sulphuric acid solution. Add 2.0 ml of 30 percent hydrogen peroxide, make up to volume (*V*₂) with 10 percent sulphuric acid solution, shake and leave in a dark cupboard for 30 min, with occasional further shaking.

6.4.2 Determine the absorbance of the sample as in **6.2.2**. Should the absorbance fall outside the calibration range, repeat the determination using a suitable aliquot of sample solution.

6.4.3 Determine the concentration *C*, in mg/ml, of TiO₂ in the final solution, from the standard curve.

7 CALCULATIONS

Titanium dioxide content shall be calculated as follows:

$$\text{TiO}_2 \text{ content in percent by mass of pipe or fitting} = \frac{C V_1 V_2}{M V_3} \times 100$$

where

- C* = concentration of TiO₂ in the final solution, in mg/ml;
- M* = mass of test portion sample, in mg;
- V*₁ = total volume of sample solution, in ml;
- V*₂ = volume of solution prepared, in ml; and
- V*₃ = volume of solution transferred out of total volume of sample solution, in ml.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 13 DETERMINATION OF TENSILE STRENGTH AND ELONGATION

1 SCOPE

This standard (Part 13) specifies a method for determining the tensile properties, including elongation, of thermoplastic pipes, including PVC-U pipes.

2 REFERENCE

The standard listed below contains provisions, which, through references in this text constitutes provisions of this standard. At the time of publication the editions indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
8543 (Part 4/ Sec 1) : 1984	Methods of testing plastics: Part 4 Short term mechanical properties, Section 1 Determination of tensile properties

3 APPARATUS

3.1 Tensile Testing Machine — Testing machine with grips that can be separated at one or more (as required) of the rates given below:

Speed A :	1 mm/min \pm 50 percent
Speed B :	5 mm/min \pm 20 percent
Speed C :	50 mm/min \pm 10 percent
Speed D :	100 mm/min \pm 10 percent
Speed E :	500 mm/min \pm 10 percent

3.1.1 Speed of Separation — The speed of separation is the rate at which the two grips are separated from each other. Unless otherwise agreed the speed of separation shall be maintained at 50 mm/min \pm 10 percent.

3.1.2 Grips — Grips for holding the test specimen, one being attached to a fixed or essentially stationary member of the machine and the other a movable member. The grips are self-aligning; that is, they are attached to the fixed and movable member respectively in such a manner that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the centre

line of the grip assembly. The test specimen is held in such a way that slip relative to the grips is prevented as far as possible. The grips may be of a type that tighten automatically under load.

3.1.3 Load Indicator — Suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism is essentially free from inertia lag at the specified rate of testing and indicates the load with an accuracy of \pm 1 percent of the indicated value, or better.

3.1.4 Extension Indicator — A suitable instrument for determining, at any time during the test, the distance between two fixed points located within the middle parallel-sided part of the test specimen. It is desirable, but not essential, that this instrument should automatically record this distance (or any change in it) as a function of the load on the test specimen, or of the elapsed time from the start of the test, or both. If only distance as a function of elapsed time is recorded, load-time data are also taken. The instrument is essentially free of inertia lag at the specified speed of testing and is accurate to \pm 1 percent of strain, or better. For the measurement of modulus of elasticity, the instrument is capable of measuring the distance between the lines to an accuracy of \pm 0.1 mm.

3.2 Micrometers — Screw micrometer reading to at least 0.02 mm for measuring the width and thickness of the specimen.

4 PREPARATION OF TEST SPECIMENS

4.1 Dimensions of test specimens shall be as given in Fig. 1.

4.1.1 The specimens shall be cut or machined from lengths of pipe in the longitudinal direction, that is, along the pipe axis.

4.1.2 If for any reason, it is not possible to use the standard test specimen shown in Fig. 1, a test specimen of similar form and with dimensions having a constant ratio to those of Fig. 1 may be used, in which case the rate of separation of grips should be adjusted so that the middle parallel part of the specimen is strained at the rate that is appropriate to the standard test specimen.

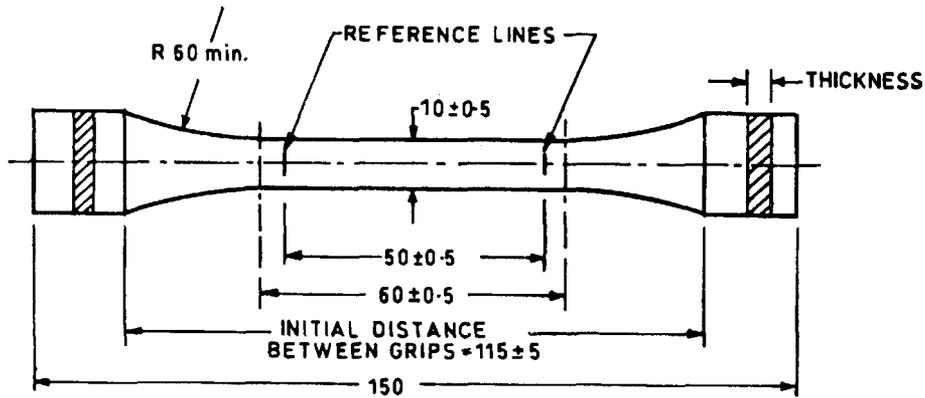


FIG. 1 DIMENSIONS OF TEST SPECIMEN

4.1.3 When reference lines are marked on test specimens, this is done with ink or other suitable medium that will not affect the material being tested. Reference lines should not be scratched, punched or impressed upon the specimens.

5 NUMBER OF TEST SPECIMENS

5.1 At least five test specimens are tested.

5.2 The specimens that do not break within the parallel portion are discarded and further test specimens are tested.

6 CONDITIONING OF THE SPECIMENS

Test specimens are conditioned as specified in the relevant material specification. In the absence of any such directive, the test specimens shall be conditioned in an atmosphere with a temperature of $27 \pm 2^\circ\text{C}$ and 65 ± 5 percent relative humidity for 24 h.

7 PROCEDURE

7.1 Measure the width and thickness of the specimen at five equally spaced points on the parallel sided portion to the nearest 1 percent with a micrometer prescribed in 3.2. Place the test specimen in the grips of the testing machine, taking care to align the long axis of the specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. Tighten the grips of the testing machine to a degree necessary to prevent the test specimen from slipping during the test, but not to the point where the specimen would be crushed.

7.2 Set the speed of the machine and start the machine. Note the following:

- Load at yield point,
- Distance between the reference lines at the yield point,
- Load at break or maximum load, and
- Distance between the reference lines at break.

The above information may be obtained from an autographically recorded stress-strain curve or may be directly observed.

8 CALCULATION AND EXPRESSION OF RESULTS

8.1 Tensile Stress at Yield, Tensile Stress at Maximum Load and Tensile Stress at Break

The load in kilograms-force at yield or the maximum load, or the load at break, as appropriate, is divided by the original minimum cross-sectional area of the test specimen (average of five values of the cross-section obtained in 7.1) in cm^2 . The results are expressed in kgf/cm^2 and reported to three significant figures.

8.2 Percentage Elongation at Yield and Percentage Elongation at Break

The extension at the yield point (*see* Fig. 2) or the extension at the moment of break, as appropriate, is divided by the original distance between the reference lines and multiplied by 100. The percentage elongation at yield or at break is reported to two significant places.

8.3 For each of the results of the five test specimens, the arithmetic mean of all values is calculated to three significant figures (except for elongation, which is calculated to two significant figures) and reported as the average value for the particular property in question.

8.4 If the standard deviation is required, it is calculated as follows and is reported to two significant figures:

$$s = \sqrt{(\sum x^2 - nx_{\text{bar}}^2)/(n-1)}$$

where

- s = estimated standard deviation;
 x = value of single observation;
 n = number of observations; and
 x_{bar} = arithmetic mean of the set of observations.

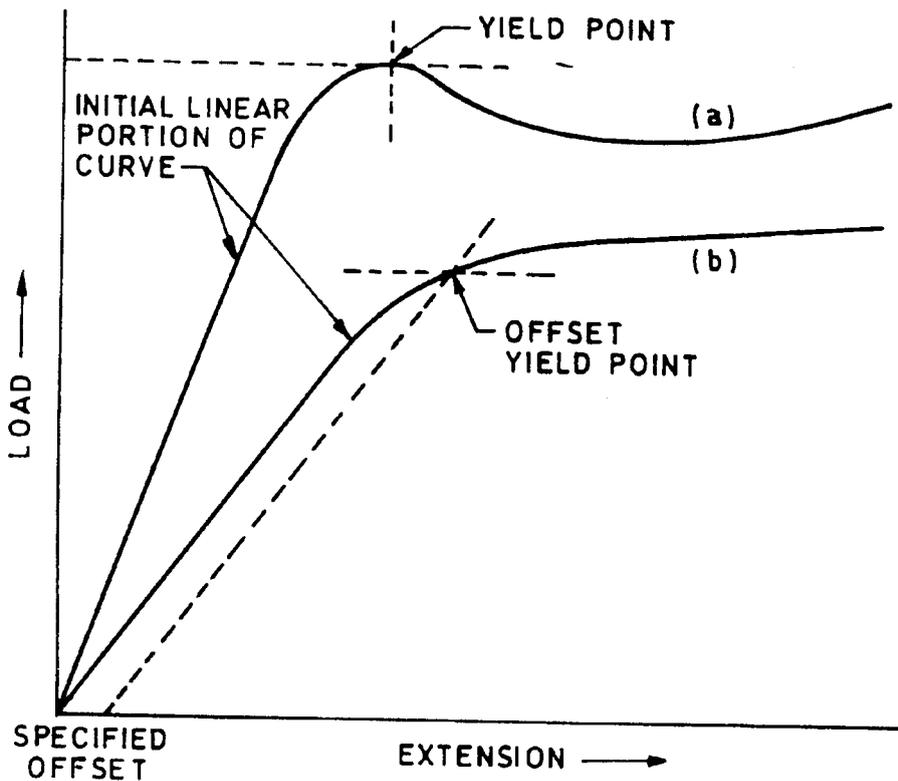


FIG. 2 LOAD/EXTENSION DIAGRAM

9 TEST REPORT

The test report shall include the following as appropriate:

- | | |
|--|--|
| <ul style="list-style-type: none"> a) Complete identification of the material tested, including type, source, manufacturer's name; form, principle dimension; b) Conditioning procedure used; c) Method of preparation of test specimen; d) Atmospheric conditions in the test room; | <ul style="list-style-type: none"> e) Number of test specimens tested; f) Speed of testing; g) Tensile stress at yield, average value; h) Tensile stress at maximum load or at break, average value; j) Percentage elongation at yield or at break, or both, average values; k) Standard deviations of the test results; and m) Date of test. |
|--|--|

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 14 DETERMINATION OF DENSITY/RELATIVE DENSITY (SPECIFIC GRAVITY)

1 SCOPE

This standard (Part 14) specifies a method of test for the determination of density or relative density (specific gravity) of non-cellular plastics pipes and fittings.

2 PRINCIPLE

Relative density is determined by applying the displacement principle, which involves weighing of the specimen in air and subsequently in water.

3 REFERENCES

The standard listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
196 : 1966	Atmospheric conditions for testing
13360 (Part 3/ Sec 1) : 1995	Plastics — Methods of testing: Part 3 Physical and dimensional properties, Section 1 Determination of density and relative density of non-cellular plastics

4 DEFINITIONS

4.1 Density ρ — The ratio of the mass of the sample to its volume V_t (at the temperature t), expressed in kg/m^3 , g/cm^3 or g/ml .

4.2 Relative Density — The ratio of the mass of a given volume of material at the temperature t_1 to that of an equal volume of a reference material at the temperature t_2 is expressed as relative density, at t_1 and t_2 where t is the temperature in degrees Celsius. Relative density may also be defined as the ratio of a substance to the density of a reference substance under conditions that are specific for both substances.

5 APPARATUS AND MATERIAL

5.1 Analytical balance with a precision of 0.1 mg.

5.2 Corrosion resistant wire of very fine gauge for suspending the specimen. A strand from standard household electrical copper cabling is adequate.

5.3 A beaker or other wide-mouthed vessel for holding the water and immersed specimen.

5.4 Supporting bridge for the vessel such that it can be placed over the pan, and the pan is free to move without any hindrance.

5.5 Thermometer with an accuracy of $\pm 1^\circ\text{C}$.

5.6 Substantially air-free distilled or demineralised water.

6 TEST SPECIMENS

6.1 The test specimen shall be a single piece, weighing between 2 g and 20 g, but optimally around 4 g, cut from a portion of pipe to any size and shape that can be conveniently tested, provided that its volume shall not be less than 1 cm^3 . The surface and edges of the test specimen shall be smooth. Care should be taken while cutting the specimen to avoid changes in density resulting from compressive stresses or frictional heating.

6.2 The specimen shall be free of oil, grease, dust and other foreign matter.

7 PROCEDURE

7.1 Weigh the specimen in air to the nearest 0.1 mg.

7.2 Attach to the balance a piece of fine wire sufficiently long to reach from the hook above the pan to the support for the immersion vessel. Attach the specimen to the wire such that it is suspended about 2.5 cm above the support for the immersion vessel.

NOTE — The specimen may be weighed in air after hanging from the wire. In this case, record the mass of the specimen, $a = (\text{mass of specimen} + \text{wire, in air}) - (\text{mass of wire in air})$.

7.3 Mount the immersion vessel on the support, and completely immerse the suspended specimen in the water at a temperature of $27 \pm 2^\circ\text{C}$. The vessel shall not touch the wire or specimen. Remove any bubbles adhering to the specimen and wire, paying particular attention to the holes in the specimen. Usually, these bubbles can be removed by rubbing them with another piece of wire. If it is not possible to remove bubbles by this method or if bubbles are continuously being formed due to gases dissolved in the water, the use of

vacuum is recommended (*see* Note under 7.2). Weigh the suspended specimen to the required precision (*see* Note). Record this mass as *b* (mass of the specimen and partially immersed wire in water). Unless otherwise specified, weigh rapidly in order to avoid absorption of water by the specimen.

NOTE — It may be necessary to change the sensitivity adjustment of the balance to overcome the damping effect of the immersed specimen.

7.4 Weigh the wire in water with immersion to the same depth as used in 7.3. Record this mass as *m* (mass of the wire in liquid).

8 CALCULATIONS

Calculate the density of the specimen as follows:

$$\rho_r = 0.9965 a / (a + m - b)$$

where

- a* = apparent mass of the specimen, without wire, in air;
- b* = apparent mass of specimen completely immersed in water and wire partially immersed in water; and
- m* = apparent mass of partially immersed wire.

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 15 DETERMINATION OF VINYL CHLORIDE MONOMER CONTENT

1 SCOPE

This standard (Part 15) specifies a method for determining the concentration of vinyl chloride monomer in PVC-U pipes and fittings.

2 PRINCIPLE

A solution of the PVC-U pipe or fitting in NN-dimethylacetamide (DMA) contained in a sealed glass vial is equilibrated at 45°C. The vinyl chloride monomer (VCM) content of the sample is determined by the gas chromatographic analysis of a sample of the head space vapour.

3 APPARATUS

3.1 Gas Chromatograph — For manual or automated head space injections and flame ionization detector.

3.2 Gas Chromatography Columns — (See Annex A for suitable columns) 2 m × 2 mm stainless steel packed with porapak Q80/100.

The column shall be capable of completely separating the air peak, the vinyl chloride peak from the standard solution and the internal standard peak, if used.

The signal obtained with a solution containing 0.02 mg/l of vinyl chloride shall be at least five times that of the background noise.

NOTE — A carbowax or modified porapak type column is recommended for the rare instances when porapak Q shows unsatisfactory resolution of VCM from interfering substances.

3.3 Digital Integrator

3.4 Glass Vials — Nominal 25 ml capacity equipped with butyl rubber septa and aluminium sealing caps, together with a manual crimping tool for sealing the vials.

NOTE — The dimensions of the vials are unimportant, but it is necessary to select containers of equivalent volume.

3.5 Gas Tight Syringe — 0.5 ml capacity.

3.6 Graduated Borosilicate Glass Flasks, 50 ml capacity.

3.7 Glassware — Borosilicate glass, as appropriate.

4 REAGENTS

4.1 NN-dimethylacetamide (DMA) — analytical grade.

NOTE — In practice, new batches of DMA are screened for potential interferences. If DMA is of inferior purity, usually a single distillation (collect cut 163 to 166°C at 760 mm) is acceptable.

4.2 Vinyl chloride monomer, of purity greater than 99.5 percent, stored in a stainless steel sample cylinder of 500 ml, approximate capacity, fitted with needle valves. From this pure VCM, ± 2 percent accurately certified 100 µ l/l to 1 000 µ l/l VCM in air or nitrogen samples are made for the preparation of calibration standards.

NOTE — VCM is a gas at ambient temperatures and is flammable and carcinogenic; special care should be taken to avoid the inhalation of VCM vapours. Preparations must be carried out under a well ventilated hood.

5 PROCEDURE

5.1 Sample Preparation

Weigh 0.500 ± 0.005 g cut from the pipe or fitting into a glass vial, add 5.0 ml DMA, seal the vial and equilibrate at $45 \pm 2^\circ\text{C}$ overnight. In the initial hour or two of heating, gently agitate the contents to ensure all of the sample has dissolved or disintegrated.

5.2 Standards Preparation

Prepare an approximate 20 mg/ml solution of VCM in DMA as follows:

- a) Fill a 50 ml graduated flask with DMA to within approximately 10 ml of the graduation,
- b) Stopper the flask with a rubber septum,
- c) Slowly bubble VCM into the DMA through a syringe barrel and needle. Vent the flask with a second syringe needle,
- d) After several minutes, remove both the needles and re-weigh, and
- e) Using a syringe, make up to the volume with DMA and calculate the actual VCM concentration of the standard solution. Alternately, a gas sampling bulb (at least 20 ml capacity), which is quantitatively filled at atmospheric pressure with a certified VCM gas standard, may be used. No more than 5 percent of the capacity of the bulb is removed for the preparation of standards.

NOTE — After preparation, liquid standards must be stored under refrigerated conditions. When this is done, the standards are stable for up to one month.

5.3 Control Preparation

Select a control sample of PVC-U so that the VCM content is below the detection limit (*see* 6). Prepare a set of samples of this control as described in 5.1. Use one of these samples for the blank determination. Prepare calibration standards over an appropriate VCM concentration range, by spiking the remainder of the set of solutions with varying amounts of the standard VCM mixture. Equilibrate, overnight at $45 \pm 2^\circ\text{C}$.

5.4 Calibration

The calibration standards shall be prepared as follows:

5.4.1 After equilibration, inject 0.5 ml of the head space vapour (*see* Note 1) from each calibration standard straight into the gas chromatograph using the following parameters:

- a) Column temperature : approx. 130°C
(*see* Note 2)
- b) Injection port temperature : $150 \pm 2^\circ\text{C}$
- c) Detector temperature : $150 \pm 2^\circ\text{C}$
- d) Carrier : N_2 at approx.
30 ml/min
(*see* Note 2)

NOTES

1 For automatic injections, an injection time is selected to give as near as possible to the prescribed injection volume. If sensitivity is a problem for samples containing less than 0.05 mg/kg VCM, the injection time may be increased. However, larger injection volumes lead to larger air packs and other volatile compounds which may be present and which may cause some interference problems. Therefore, it is important to check that the blank does not show any interference in the VCM region of the chromatogram.

2 Column temperature and the carrier rate may be altered slightly to give a VCM retention time of 3 ± 1 min.

5.4.2 Determine and record the mean response factor (amount per area or amount per peak height) for the whole set of standards.

If the blank contains major interfering peaks or gives poor resolution between VCM and other peaks, the column is unsuitable and one of different polarity may be chosen.

5.5 Sample Determination

5.5.1 Take a sample volume of head space vapour, as selected in 5.4 of the sample which was prepared as in 5.1 and inject into the gas chromatograph. A maximum of two aliquots may be taken from any one vial.

5.5.2 Measure the peak heights and determine the level of the VCM present by comparison with the response factors in 5.4.2 (b).

NOTE— The presence of VCM should be confirmed on at least one sample of a set of determinations of each specific commodity. The recommended method for the identification of VCM is by means of mass spectrometry.

6 DETECTION LIMIT

The detection limit is arbitrarily defined as the equivalent of 3 percent to 4 percent full scale deflection with the gas chromatograph set at maximum sensitivity.

The detection limit depends on the partition coefficient of VCM between the air in the head space and the sample in the vial.

The estimated detection limits using the standard conditions is 0.3 mg/kg for pipe wall sections.

7 ACCURACY

The estimated possible error varies according to the VCM level being determined. Below a level of 0.05 mg/kg the possible error is of the order of ± 25 percent, whereas above 0.05 mg/kg it is approximately ± 6 to 10 percent. These estimates presuppose no systematic error on the part of the operator on the preparation of calibration standards.

8 REPORT

The following information shall be reported:

- a) Type and/or class, size and configuration of pipe or fitting tested, and
- b) VCM content reported to the nearest 0.5 mg/kg.

ANNEX A

(Clause 3.2)

SUITABLE COLUMNS FOR THE DETERMINATION OF VINYL CHLORIDE MONOMER IN
HOMOPOLYMER AND COPOLYMER RESINS

<i>Sl No.</i>	<i>Column</i>	<i>Length, m</i>	<i>Diameter, mm</i>	<i>Stationary Phase</i>	<i>Support</i>	<i>Operating Temperature Range ±C</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	1	2.00	2	Carbowax 1 500 20 percent (<i>m/m</i>)	Carbopack B 180 to 150 µm	50 to 70
ii)	2 ¹⁾	1.00	2		Porapak Q or QS 180 to 150 µm	120 to 140
iii)	3	3.00	2	D-isodecylphthalate 25 percent (<i>m/m</i>)	Chromosorb WHP 180 to 150 µm	50 to 70
iv)	4	3.00	3	1,2,3-Tri (2-cyanoethoxy) propane 20 percent (<i>m/m</i>)	Chromosorb W.AW-DMCS 180 to 150 µm	35 to 55
v)	5	3.60	2	Polypropylene-glycol 3 000 15 percent (<i>m/m</i>)	Kieselguhr 250 to 180 µm	40 to 60

¹⁾This column may not be suitable for determinations on copolymers of vinyl chloride and vinyl acetate, VC/VAC

Indian Standard

**THERMOPLASTICS PIPES AND FITTINGS —
METHODS OF TEST**

PART 16 HIGH TEMPERATURE TEST

1 SCOPE

This standard (Part 16) specifies a method of test for the matrix of thermoplastics pipes and fittings, including those made of unplasticized PVC, using high temperatures.

2 PRINCIPLE

This test indicates the presence of volatiles and gas bubbles resulting from incorrect processing conditions or thermal decomposition. The test also provides an indication of gelatin levels in extruded PVC-U pipes. A pipe section is heated in an oven, then sliced into segments, which are examined for splits, delamination or porosity.

3 APPARATUS

3.1 An electrically heated air oven with internal circulation fan, the whole interior of which is maintained automatically at a temperature of $180 \pm 4^\circ\text{C}$.

3.2 Thermometer capable of indicating the required temperature to an accuracy of $\pm 2^\circ\text{C}$

4 TEST SPECIMENS

The test specimen shall consist of a complete section of pipe of 200 mm minimum length. The ends shall be cut reasonably square.

5 PROCEDURE

5.1 Pre-heat the oven to $180 \pm 4^\circ\text{C}$ and allow to stabilize for at least 15 min.

5.2 Place the test specimen in the oven, standing it vertically on one end.

5.3 Allow the specimen to remain in the oven for a period of $60 \begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$ min at the prescribed temperature.

5.4 Remove the test specimen from the oven and place it on a cutting board. Slice the test specimen with a stainless steel knife in the axial direction into pieces not larger than 50 mm in width.

5.5 Examine the pieces visually and record the existence of any splits, delamination bubbles or porosity.

6 REPORT

Report shall contain the following:

- a) Type, class, size and configuration of pipe tested, and
- b) Any splits, delaminations, bubbles or porosity.

*Indian Standard***THERMOPLASTICS PIPES AND FITTINGS —
METHODS OF TEST****PART 17 DETERMINATION OF ASH CONTENT AND SULPHATED ASH CONTENT****1 SCOPE**

This standard (Part 17) specifies methods of determination of the ash content of pipes and fittings made of unplasticized polyvinyl chloride (PVC-U). These methods can also be used for PVC resins and compounds.

NOTE — Polyvinyl chloride evolves hydrogen chloride on thermal decomposition, and precautions should be taken to avoid inhalation of fumes.

2 PRINCIPLE**2.1 Method A**

Direct calcination that is by burning the organic matter and heating the residue at 850°C until constant mass is reached.

2.2 Method B

Calcination, with sulphuric acid treatment after combustion, that is by burning the substance and transforming the residue into sulphates using concentrated sulphuric acid, and finally, heating the residue at 850°C until constant mass is reached. Should lead compounds be present, method B is recommended.

3 REAGENTS

(For Method B only). Sulphuric acid (density 184.0 kg/m³) of recognized analytical grade.

4 APPARATUS

4.1 Crucible of silica or platinum, inert to the material tested. The size shall be sufficient that the crucible is not more than half filled by the sample.

4.2 Bunsen Burner, with silica triangle and tripod, or other suitable heating device.

4.3 Muffle Furnace, capable of being controlled thermostatically at 850 ± 50°C.

4.4 Pipette, of appropriate capacity (For Method B only).

4.5 Dessicator, containing an effective drying agent that does not react chemically with the ash components.

NOTE — In some cases, the affinity of the ash for water may be greater than that of the drying agents commonly used.

4.6 Analytical Balance, accurate to 0.1 mg.

5 PROCEDURE**5.1 Method A**

5.1.1 Prepare the crucible by heating in the muffle furnace at 850 ± 50°C until constant mass is reached. Allow to cool in the dessicator to room temperature, but for at least 1 h, and weigh to the nearest 0.1 mg.

5.1.2 Introduce into the crucible 2 g to 5 g of the sample and reweigh. Heat the crucible directly on the heating device so that the sample burns slowly and loss of ash is avoided. Continue this operation until no more smoke is evolved.

5.1.3 Place the crucible at the entrance of the muffle furnace maintained at 850 ± 50°C (the temperature in the entrance zone is about 300°C to 400°C), then advance the crucible slowly into the furnace. Calcine slowly (to prevent loss of ash particles) for 30 min at 850 ± 50°C.

5.1.4 Remove the crucible from the furnace. Place it in the dessicator, allow to cool to room temperature, but for at least 1 h, and weigh to the nearest 0.1 mg.

5.1.5 Calcine again, under the same conditions, until constant mass is reached, that is, until the results of two consecutive weighings do not differ by more than 0.5 mg. The duration of the heating in the furnace shall not, however, exceed 3 h; if constant mass is not attained after this time, the mass after 3 h shall be used for calculating the result.

5.2 Method B

5.2.1 Proceed as in 5.1.1 and 5.1.2.

5.2.2 After allowing the crucible and its contents to cool, add sulphuric acid dropwise by means of a pipette of suitable capacity until the residue is soaked completely. Heat carefully on a suitable heating device until the evolution of smoke ceases, taking care to avoid spattering of the contents of the crucible.

5.2.3 If, after allowing the crucible to cool, carbon is still evident, add 1 to 5 drops of sulphuric acid and reheat until evolution of white fumes has ceased.

5.2.4 Place the crucible at the entrance of the muffle furnace maintained at 850 ± 50°C and proceed as detailed in 5.1.3, 5.1.4 and 5.1.5. The residue, after calcination, shall be white.

6 NUMBER OF DETERMINATIONS

Carry out two determinations. Calculate the arithmetical mean of the results. If the individual test results differ from each other by more than 10 percent of their mean, repeat the procedure until two successive results satisfy this requirement.

7 EXPRESSION OF RESULTS

The ash or sulphated ash content, expressed in grams per 100 g of sample, is given by the formula:

$$(m_1 / m_0) \times 100$$

where

m_0 = mass, in grams, of the test portion, and

m_1 = mass, in grams, of ash obtained.

8 TEST REPORT

The test report shall contain the following particulars:

- a) A reference to this standard,
- b) Complete identification of the sample, including type, manufacturer's code number, source, trade name, etc.,
- c) Method used, that is,
Method A — ash at 850°C and
Method B — sulphated ash at 850°C,
- d) Mass of each of the two test portions used,
- e) Individual results of the two determinations and the mean ash content, and
- f) If constant mass is not attained after 3 h, report that fact (*see 5.1.5*).

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 18 DETERMINATION OF RING STIFFNESS

1 SCOPE

This standard (Part 18) specifies the method for the determination of the ring stiffness of thermoplastics pipes, including unplasticized polyvinyl chloride (PVC-U) pipes having a circular cross-section, under parallel-plate loading.

2 PRINCIPLE

The ring stiffness is determined by measuring the force and the deflection while deflecting the pipe at a constant rate. A length of pipe supported horizontally is compressed vertically between two parallel plates moved at a constant speed which is dependent of the diameter of the pipe. A plot of force *versus* deflection is generated. The ring stiffness is calculated as a function of the force necessary to produce a deflection of 3 percent diametrically across the pipe.

3 DEFINITIONS

3.1 Initial Internal Diameter (d_i) — The average of the inside diameters of the test specimen expressed in metres.

3.2 Vertical Deflection (y) — Measured change of the inside diameter in the direction of the load application expressed in metres.

3.3 Percentage Deflection (P) — The ratio of the reduction in pipe inside diameter to the pipe initial diameter expressed as a percentage of the initial inside diameter.

3.4 Load (F) — The load applied to the pipe to produce a given percentage deflection, expressed in kN.

3.5 Length (L) — The average length of the test specimen expressed in metres.

3.6 Ring Stiffness (S) — The value obtained by dividing the force per unit length of specimen by the resulting deflection in the same units at the prescribed percentage deflection and multiplied by a factor, expressed in kN/m^2 .

4 APPARATUS

4.1 Testing Machine — A properly calibrated compression testing machine of the

constant-rate-of-crosshead-movement type, shall be used for the tests. The rate of head movement shall be in accordance with Table 1, with sufficient force and travel to produce the specified deflection through the parallel plates.

Table 1 Deflection Speeds

SI No.	Nominal Diameter d_n of Pipe mm	Deflection Speed mm/min
(1)	(2)	(3)
i)	$d_n \leq 100$	2 ± 0.4
ii)	$100 < d_n \leq 200$	5 ± 1
iii)	$200 < d_n \leq 400$	10 ± 2
iv)	$400 < d_n \leq 1\,000$	20 ± 2
v)	$d_n > 1\,000$	50 ± 5

4.2 Loading Plates — The load shall be applied to the specimens through two parallel steel bearing plates. The plates shall be flat, smooth and clean. The thickness of the plates shall be sufficient so that no bending or deformation occurs during the test, but it shall not be less than 6.0 mm. The plate length shall equal or exceed the specimen length and the plate width shall not be less than the pipe contact width at maximum pipe deflection plus 25 mm.

4.3 Deformation (Deflection) Indicator — The change in the inside diameter or deformation parallel to the direction of loading, shall be measured with a suitable instrument accurate to the nearest 0.25 mm. The instrument shall not support the pipe test specimen or the plate, or in any way affect the load deflection measurements. Changes in diameter may be measured during loading by continuously recording plate travel.

4.4 Measuring devices, capable of measuring:

- a) Length of the test specimen to within 1 mm,
- b) Internal diameter of the test specimen to within 0.5 percent, and
- c) Change in inside diameter of the test specimen in the direction of loading with an accuracy of 0.1 mm or 1 percent of the deflection, which ever is greater.

4.5 Force-measuring device, capable of determining to within 2 percent the force necessary to produce

1 percent to 4 percent deflection of the test specimen diametrically across the test specimen.

5 TEST SPECIMENS

5.1 Marking

The pipe from which the specimens are to be cut shall be marked on the outside along its full length with a line parallel to the pipe axis. Three test specimens, marked a, b, and c, shall be tested for each sample of pipe. The ends of the test specimens shall be reasonably square to the axis of the pipe, free of burrs and jagged ends and the lengths shall conform to 5.2.

5.2 Length

5.2.1 The length of the test specimen shall be determined by calculating the arithmetic mean of *n* length measurements, made to within 1 mm, equally spaced around the circumference of the pipe in conformation with Table 2. For each individual test specimen, the smallest of the length measurements shall not be less than 0.9 times the largest.

Table 2 Number of Length Measurements
(Clause 5.2.1)

Sl No.	Nominal Diameter d_n of Pipe mm	Number of Length Measurements, <i>n</i>
(1)	(2)	(3)
i)	$d_n \leq 200$	3
ii)	$200 < d_n < 500$	4
iii)	$d_n \geq 500$	6

5.2.2 For pipes with nominal diameter less than or equal to 1 500 mm, the average length of each test specimen shall 300 ± 10 mm.

5.2.3 For pipes that have a nominal diameter, d_n , greater than 1 500 mm, the average length of each test specimen shall be $0.2 d_n$.

5.2.4 Structured-wall pipes with perpendicular ribs or corrugations or other regular structures shall be cut such that each test specimen contains the minimum whole number of ribs, corrugations or other structures necessary to conform to 5.2.2 and 5.2.3 (see Fig. 1). The cuts shall be made at the mid point between the ribs, corrugations or other structures.

5.2.5 Hellically wound pipes shall be cut such that each piece contains the minimum whole number of hellical windings necessary to conform to 5.2.2 and 5.2.3 (see Fig. 2).

5.3 Inside Diameter

Determine inside diameter, d_{ia} , d_{ib} , d_{ic} , of each test specimen as the arithmetic mean of four measurements made at 45° intervals along one cross-section of the test specimen. Finally, calculate the

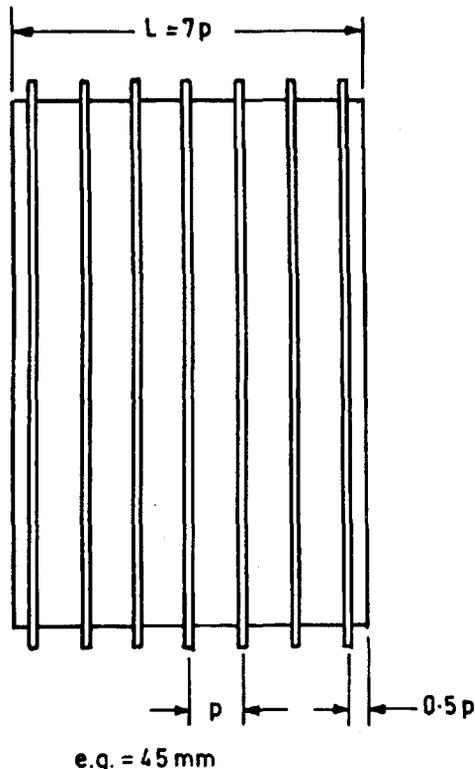


FIG. 1 TEST PIECE CUT OUT OF A PERPENDICULARLY RIBBED PIPE

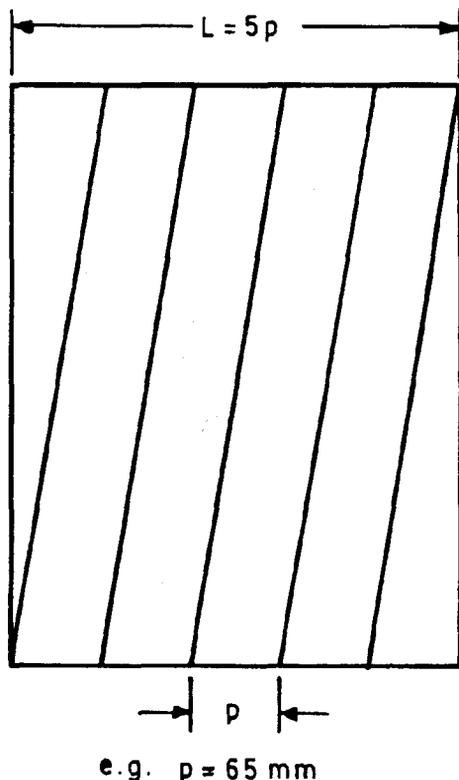


FIG. 2 TEST PIECE CUT OUT OF A HELICALLY WOUND PIPE

average internal diameter, d_i , of all three test specimens as

$$d_i = (d_{ia} + d_{ib} + d_{ic})/3$$

An example of a device for measuring the inside diameter of corrugated pipes is shown in Fig. 3.

5.4 Average Outside Diameter

Measure the average outside diameter of each test specimen in accordance with Part 1 of this standard.

5.5 Wall Thickness

Measure the wall thickness in accordance with Part 1 of this standard evenly spaced points along the perimeter of each test specimen. Note the maximum and minimum values and calculate the average. Mark the point of minimum wall thickness, if any, on each test specimen.

6 CONDITIONING

The test specimens shall be at least 24 h old. For type testing and in cases of dispute, the age of the test shall be 21 ± 2 days.

6.1 Condition the pipe samples for at least 24 h in air, at a temperature of $27 \pm 2^\circ\text{C}$, and conduct the test at the same temperature.

6.2 In case of dispute, the specimens shall be conditioned at a temperature of $23 \pm 2^\circ\text{C}$ and a relative

humidity of 50 ± 5 percent for 40 h and the test conducted under the same conditions.

7 PROCEDURE

7.1 Locate the pipe specimen with its longitudinal axis parallel to the bearing plates and centre it laterally in the testing machine.

7.2 If an orientation of minimum wall thickness has been found, place the first specimen with the thinnest portion on top. Rotate each successive specimen 35° and 70° . If no minimum wall thickness has been found, use any base line.

7.3 With the deflection indicator in place, bring the upper plate in contact with the specimen with no more load than necessary to hold it in place. This establishes the beginning point for the measurement of subsequent deflections.

7.4 Compress the specimen at a constant speed specified in Table 1, while continuously recording the force and deflection.

7.5 Typically, the force and deflection measurements are generated continuously by measuring the displacement of one of the plates, but if, during the test, the pipe-wall height e_c (see Fig. 4) changes by more than 10 percent, generate force/deflection plot by measuring the change in the inside diameter of the test specimen.

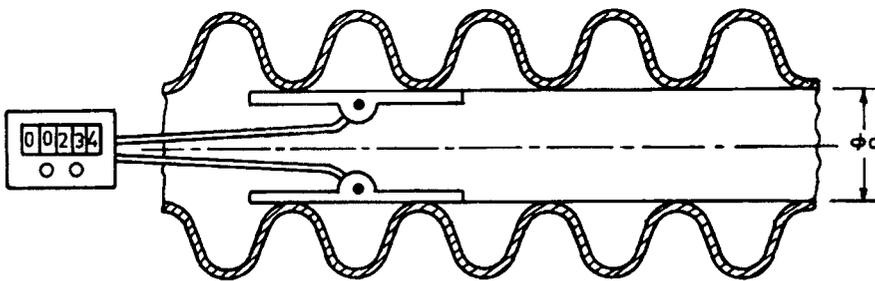


FIG. 3 EXAMPLE OF A DEVICE FOR MEASURING THE INSIDE DIAMETER OF A CORRUGATED PIPE

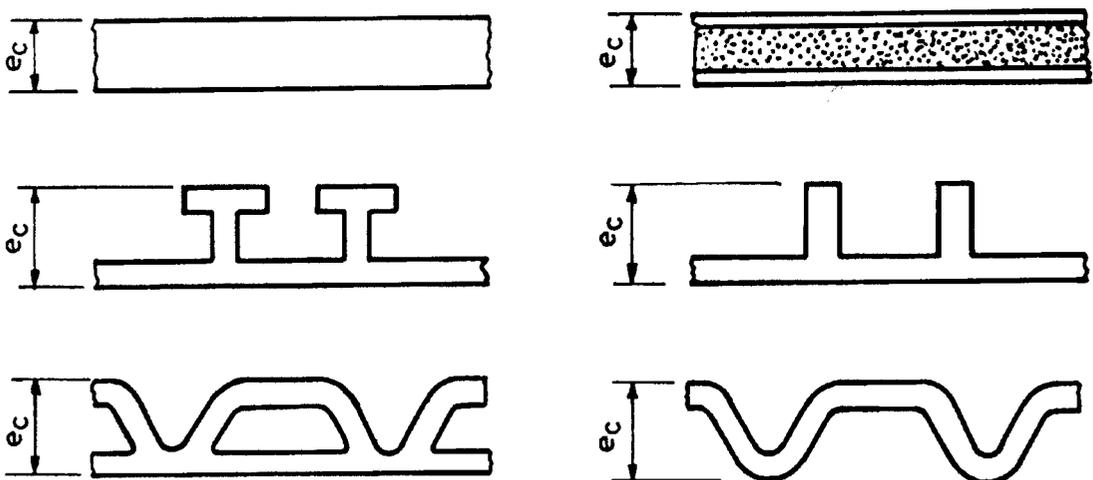


FIG. 4 EXAMPLES OF THE PIPE-WALL HEIGHT, e_c

7.6 If the force/deflection plot, which is typically a smooth curve, indicates that the zero point may be incorrect (see Fig. 5), extrapolate back the initial straight-line portion of the curve and use the intersect with the horizontal axis as the (0,0) point (origin).

NOTE — Procedure for plotting load *versus* deflection is given in Annex A for information.

8 CALCULATIONS

Calculate the ring stiffness, S_a , S_b , S_c , of each of the three test specimens using the following equations:

$$S_a = \{0.0186 + 0.025 (y_a/d_i)\} (F_a / L_a y_a)$$

$$S_b = \{0.0186 + 0.025 (y_b/d_i)\} (F_b / L_b y_b)$$

$$S_c = \{0.0186 + 0.025 (y_c/d_i)\} (F_c / L_c y_c)$$

where

- F = force, in kN, corresponding to 3.0 percent pipe deflection;
- L = length, in metres, of the test specimen; and
- y = deflection in metres, corresponding to 3.0 percent deflection, that is, $y/d_i = 0.03$

Calculate the ring stiffness of the pipe, in kN/m^2 , as the mean of these three values, using the following equation:

$$S = (S_a + S_b + S_c) / 3$$

9 TEST REPORT

Report the following information:

- a) Complete identification of the samples tested;
- b) All dimensions of each specimen;
- c) Conditioning time, temperature and environment;
- d) Testing temperature and environment;
- e) The calculated values of S_a , S_b and S_c of the ring stiffness of each test specimen, to three decimal places;
- f) The calculated value of the ring stiffness S , to two decimal places;
- g) If required, a force/deflection plot for each test specimen;
- h) Any factors which may affect the results; and
- j) Date of report.

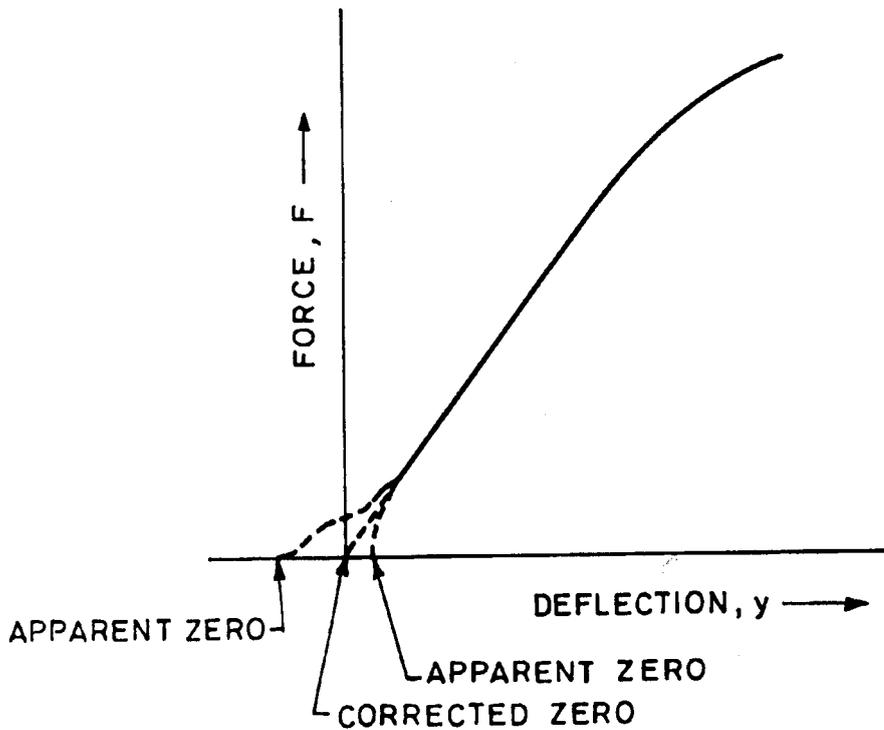


FIG. 5 METHOD OF CORRECTING THE ORIGIN

ANNEX A

(Clause 7.6)

PLOTTING LOAD *VERSUS* DEFLECTION

A-1 The load *versus* deflection plot is typically a smooth curve. In some cases, for example, when the curve is generated automatically, the zero point may be in error (*see* Fig. 6). In such cases, the initial straight line portion of the curve shall be extrapolate back, and this intercept be used as the (0,0) point.

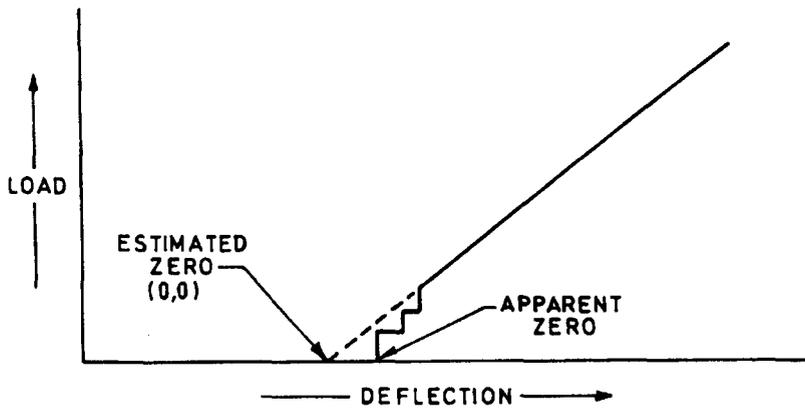


FIG. 6 METHOD OF ESTIMATING THE ORIGIN

Indian Standard

THERMOPLASTICS PIPES AND FITTINGS — METHODS OF TEST

PART 19 FLATTENING TEST

1 SCOPE

This standard (Part 19) specifies a method for the determination of resistance to damage on flattening under load, of thermoplastics pipe, including unplasticized polyvinyl chloride (PVC-U) pipe.

2 APPARATUS

2.1 Testing Machine — A properly calibrated compression testing machine of the constant-rate-of-crosshead-movement type, shall be used for the tests. The rate of head movement shall be in accordance with Table 1, with sufficient force and travel to produce the specified deflection through the parallel plates.

2.2 Loading Plates — The load shall be applied to the plates through two parallel steel bearing plates. The plates shall be flat, smooth and clean. The thickness of the plates shall be sufficient so that no bending or deformation occurs during the test, but it shall not be less than 6.0 mm. The plate length shall equal or exceed the specimen length and the plate width shall not be less than the pipe contact width at maximum pipe deflection plus 25 mm.

2.3 Deformation (Deflection) Indicator — The change in the inside diameter or deformation parallel to the direction of loading, shall be measured with a suitable instrument accurate to the nearest 0.25 mm. The instrument shall not support the pipe test specimen or the plate, or in any way affect the load deflection measurements. Changes in diameter may be measured during loading by continuously recording plate travel.

2.4 Measuring devices, capable of measuring:

- a) Length of the test specimen to within 1 mm,
- b) Internal diameter of the test specimen to within 0.5 percent, and

- c) Change in inside diameter of the test specimen in the direction of loading with an accuracy of 0.1 mm, or 1 percent of the deflection, whichever is greater.

3 PROCEDURE

3.1 Cut three samples, each 50 mm long, from the pipe to be tested. The ends shall be square, smooth and free from cracks, chips or other imperfections.

3.2 Place the samples, one at a time, between two parallel plates of a suitable press and flatten the samples until the distance between the plates is 40 percent of the outside diameter of the pipe or the inner walls of the sample touch, whichever occurs first. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 min.

NOTE — The plates of the press should be made of steel at least 6 mm thick and they should be wider than the width of contact of the compressed pipe sample and longer than the length of the same sample under test.

3.3 Remove the load and examine the samples for evidence of splitting, cracking or breaking.

Table 1 Deflection Speeds
(Clause 2.1)

SI No.	Nominal Diameter, d_n , mm	Deflection Speed mm/min
(1)	(2)	(3)
i)	$d_n \leq 100$	2 ± 0.4
ii)	$100 < d_n \leq 200$	5 ± 1
iii)	$200 < d_n \leq 400$	10 ± 2
iv)	$400 < d_n \leq 1\ 000$	20 ± 2
v)	$d_n > 1\ 000$	50 ± 5

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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