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Unplasticized polyvinyl chloride (PVC) pipes — Determination of Vicat softening temperature

Tubes en polychlorure de vinyle (PVC) non plastifié — Détermination de la température de ramollissement Vicat

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard 2507 was drawn up by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids,* and circulated to the Member Bodies in June 1974.

It has been approved by the Member Bodies of the following countries :

Australia	Germany	Romania
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The Member Body of the following country expressed disapproval of the document on technical grounds :

Netherlands

Printed in Switzerland

Unplasticized polyvinyl chloride (PVC) pipes — Determination of Vicat softening temperature

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for the determination of the Vicat softening temperature of unplasticized polyvinyl chloride (PVC) pipes, and includes the adaptation, for this purpose, of method B described in ISO 306, using a force of 49,05 N (5 kgf).

2 REFERENCE

ISO 306, *Plastics — Determination of the Vicat softening temperature of thermoplastics.*

3 PRINCIPLE

Determination of the temperature at which a standard indenter, under a force of 49,05 N, penetrates 1 mm into a test piece cut from the wall of the pipe, the temperature increasing linearly as a function of time during the period of the test.

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

4 APPARATUS

The apparatus consists essentially of :

4.1 A **rod** provided with a load-carrying plate, 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 piece under the indenting tip at the end of the rod (see figure).

4.2 An **indenting tip,** preferably of hardened steel, 3 mm long, of circular cross-section, and area 1,000 ± 0,015 mm^2, fixed at the bottom of the rod. The lower surface of the indenting tip shall be plane and perpendicular to the axis of the rod and free from burrs.

4.3 A **micrometer dial gauge** (or other suitable measuring instrument), graduated in divisions of 0,01 mm, to measure the penetration of the indenting tip into the test piece. The thrust of the dial gauge, which contributes to the thrust on the test piece, must be known and shall comply with the requirements of 4.4.

4.4 A **load-carrying plate,** fitted to the rod (4.1), and suitable weights adjusted centrally so that the total thrust applied to the test piece can be made up to between 49,05 N (5 000 gf) and 49,54 N (5 050 gf). The combined masses of the rod, indenting tip and load-carrying plate shall not exceed 100 g.

NOTE — The construction of the apparatus shall be such that the micrometer dial gauge reading caused by differential thermal expansion over the intended temperature range does not exceed 0,02 mm when the test piece is replaced by a piece of borosilicate glass or low thermal expansion alloy steel.

It is recommended that the apparatus be constructed of low thermal expansion alloy.

4.5 A **heating bath,** containing a suitable liquid (see note 1 below), in which the apparatus is placed so that the test piece 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 can be raised at a uniform rate of 50 ± 5 °C/h (see note 2 below). This heating rate shall be considered to be met if, over every 5 min interval during the test, the temperature change is within the specified limits.

4.6 A **mercury-in-glass thermometer** (or 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.

NOTES

1 Water, liquid paraffin, transformer oil, glycerol and silicone oils may be suitable 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 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 variable transformer.

3 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 the rate of temperature rise.

5 TEST PIECES

5.1 The test pieces shall consist of segments of rings cut from pipes, with the following dimensions :

- length : approximately 50 mm;
- width : between 10 and 20 mm;
- thickness : between 2,4 and 6 mm.

5.2 If the wall thickness of the pipe is greater than 6 mm, it shall be reduced to 4 mm by machining the outer surface of the pipe only, by a suitable process.

5.3 If the wall thickness of the pipe is less than 2,4 mm, each test piece shall consist of two ring segments from the pipe superimposed so as to give a total thickness of at least 2,4 mm. The lower segment, which will serve as a base, shall be flattened. For this, heat it to 140 °C for 15 min, while resting on it a thin metal plate. The upper segment shall be left as such.

5.4 Use two test pieces for each test, but anticipate the need for additional test pieces in case the difference between the results is too great (see clause 8).

6 CONDITIONING

Condition the test pieces for 5 min, at a temperature at least 50 °C lower than the expected softening temperature.

7 PROCEDURE

For each test piece :

7.1 Raise the heating bath to a temperature about 50 °C lower than that anticipated for the softening temperature of the material under test (see note 3, clause 4). Maintain this temperature constant.

7.2 Mount the test piece horizontally under the indenting tip (4.2) of the unloaded rod (4.1), which shall rest on the concave surface of the test piece. For pipes 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. The indenting tip shall at no point be nearer to the edges of the test piece than 3 mm.

7.3 Immerse the assembly in the heating bath (4.5). The bulb of the thermometer (4.6) shall be at the same level as, and as close as possible to, the test piece.

7.4 After 5 min, with the indenting tip still in position, note the reading of the micrometer dial gauge (4.3) or set the micrometer to zero. Then add the weight to the load-carrying plate (4.4) so that the total thrust on the test piece is between 49,05 N (5 000 gf) and 49,54 N (5 050 gf).

7.5 Increase the temperature of the heating bath at a uniform rate of 50 ± 5 °C/h; stir the liquid well during the test.

7.6 Note the temperature of the bath at which the indenting tip has penetrated into the test piece by 1,00 mm beyond its starting position defined in 7.4 and record it as the Vicat softening temperature (VST) of the test piece.

8 EXPRESSION OF RESULTS

Express the Vicat softening temperature (VST) of the pipe examined as the arithmetic mean of the VST's of the two test pieces. Express the result in degrees Celsius. If the individual results differ by more than 2 °C, the test is invalid and a repeat test must be carried out.

9 TEST REPORT

The test report shall include the following particulars :

a) reference to this International Standard;

b) the complete identification of the pipe in question;

c) the thickness of the test pieces and, if applicable, if they consisted of two parts;

d) the nature of the immersion medium;

e) the conditioning and annealing methods used, if any;

f) the Vicat softening temperatures (VST) obtained for each of the two test pieces;

g) any alterations in the appearance of the test pieces during the test or after their immersion;

h) the results expressed in accordance with the instructions given in clause 8;

i) all operational details not included in this International Standard, and any occurrences capable of having influenced the results.

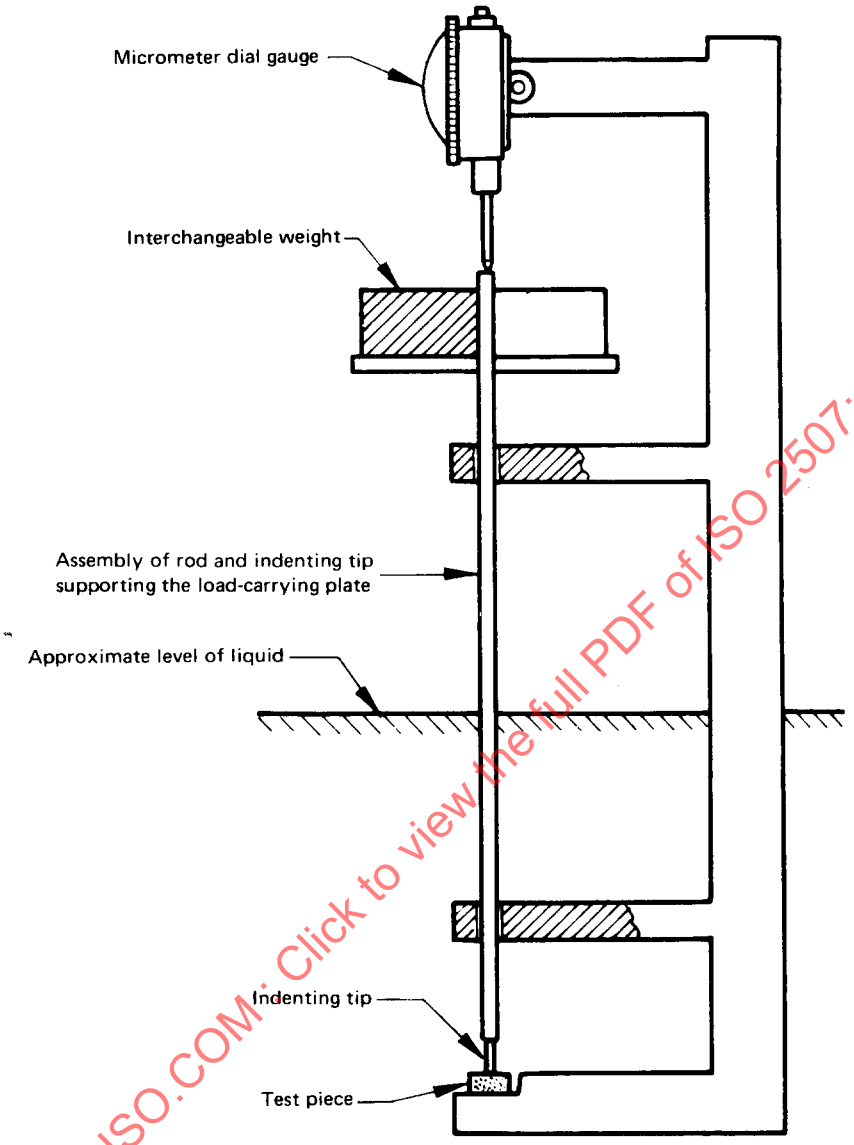

FIGURE – **Schematic diagram of apparatus for the determination of the Vicat softening temperature**