INTERNATIONAL STANDARD

ISO 2431

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Paints and varnishes — Determination of flow time by use of flow cups

Peintures et vernis — Détermination du temps d'écoulement au moyen de coupes d'écoulement

Reference number
ISO 2431:1993(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2431 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Sub-Committee SC 9, *General test methods for paints and varnishes*.

This fourth edition cancels and replaces the third edition (ISO 2431:1984), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Introduction

The first edition of this International Standard, published in 1972, specified only one flow cup of orifice diameter 4 mm. The second edition specified three flow cups of orifice diameter 3 mm, 4 mm and 6 mm. The third edition corrected errors in figures 2 and 4 and the equations for those figures. This fourth edition specifies four flow cups of orifice diameter 3 mm, 4 mm, 5 mm and 6 mm.

As is well known, many countries over the years have developed their own standard flow cups and the difficulty in correlation between them has led to considerable confusion in comparing values. The standardization of an improved design of flow cup has been recommended after careful consideration, by an expert working group, of the role of flow cups for the measurement of flow time of paints, varnishes and related products.

It is recognized that the flow times are reproducible only for products of Newtonian or near-Newtonian flow properties. This effectively limits their practical use. Nevertheless, for checking purposes, these flow cups do serve a useful purpose. Furthermore, the measurement of flow time is often used to confirm the application consistency.

Paints often contain flow-arresting agents to confer increased viscosity. Such paints exhibit anomalous flow properties. Their viscosity during application can only be properly assessed using viscometers operating at high velocity gradients, such as that described in ISO 2884.

Resins and varnishes may exhibit Newtonian or near-Newtonian flow at much higher viscosities than most paints and, where this applies, flow cups can provide a useful means of controlling the consistency. To meet this requirement, this International Standard provides flow cups suitable for viscosities up to about 700 mm^2/s.

Recommendations for the use of flow cups for the adjustment of paint consistency are given in annex A.

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Paints and varnishes — Determination of flow time by use of flow cups

1 Scope

1.1 This International Standard is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products.

1.2 This International Standard specifies a method for determining the flow time of paints, varnishes and related products that may be used to control consistency. A method for the adjustment of paints to the correct application consistency at the application temperature is described in annex A.

1.3 Four flow cups of similar dimensions, but having orifice diameters of 3 mm, 4 mm, 5 mm and 6 mm, are specified. The method for their calibration is given.

1.4 The method is limited to testing materials for which the breakpoint of the flow from the orifice of the flow cup can be determined with certainty. This point is difficult to determine and reproduce for materials with flow times in excess of 100 s due to slowing-down effects.

2 Normative references

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

ISO 1512:1991, *Paints and varnishes — Sampling of products in liquid or paste form.*

ISO 1513:1992, *Paints and varnishes — Examination and preparation of samples for testing.*

ISO 2884:1974, *Paints and varnishes — Determination of viscosity at a high rate of shear.*

3 Definitions

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

3.1 flow time: Time that elapses from the moment when the material under test starts to flow from the orifice of the filled cup to the moment when the flow stream of material first breaks close to the orifice.

3.2 Newtonian flow: Type of flow exhibited by a material in which the ratio of the shear stress to the velocity gradient does not vary either with time or with the velocity gradient. When variations in this ratio are small, the effect on viscosity of mechanical disturbance, such as stirring, is negligible and the material is said to have near-Newtonian flow.

3.3 anomalous flow: Type of flow exhibited by a material in which, at a constant temperature, the ratio of the shear stress to the velocity gradient varies either with time or with rate of shear. For example, with so-called thixotropic materials, stirring or other such mechanical disturbance immediately before test will reduce the flow time below that for an unstirred sample. With such materials, uncertain and variable values for flow time are obtained in all flow cups.

3.4 dynamic viscosity: Ratio of the applied shear stress to the velocity gradient.

NOTE 1 The SI unit for dynamic viscosity is the pascal second (Pa·s). The traditional unit is the centipoise (cP); 1 cP = 1 mPa·s.

3.5 kinematic viscosity: Ratio of the dynamic viscosity to the density of the liquid.

NOTE 2 The SI unit for kinematic viscosity is the square metre per second (m^2/s). The traditional unit is the centistokes (cSt); 1 cSt = 1 mm^2/s.

4 Temperature considerations

The effect of temperature on flow time is highly significant with respect to application properties and varies with the type of product.

For international reference purposes, it is essential to standardize one test temperature and (23 ± 0,5) °C is specified in this International Standard. However, it may be more convenient to carry out comparative testing at some other agreed temperature (for example, 25 °C) because of prevailing temperature conditions.

For control by flow time, the test sample and flow cup shall be conditioned to an agreed or specified temperature and it shall be ensured that the temperature variation does not exceed 0,5 °C during testing.

5 Apparatus

5.1 Flow cups

5.1.1 Dimensions

The dimensions of the ISO flow cups and the tolerances allowed in manufacture shall be as shown in figure 1.

NOTE 3 The most critical tolerance is the internal diameter of the jet of the cup, because the flow time is inversely proportional to the fourth power of this dimension.

The jet of the cup shall be made of stainless steel or sintered carbide, unless otherwise specified, and the body of the cup shall be made of a material which is corrosion resistant and is not affected by the products to be tested.

5.1.2 Construction

The dimensions not specified, such as wall thickness, shall be such that no distortion of the cup can occur in use. The external shape shown in figure 1 is recommended, but may be modified for convenience of use, or manufacture, provided that the protruding jet of the cup is protected from accidental damage as far as possible by an external protective sleeve. Such a protective sleeve shall not be immediately adjacent to the jet, so as to prevent a capillary action when the material under test flows out.

NOTE 4 Flow cups having a casing for temperature control are preferred.

5.1.3 Finish

The interior surfaces of the cups, including the orifice, shall be smooth and free from turning marks, crevices, ledges and burrs which may cause random flow or trap sample or cleaning material.

NOTE 5 The standard of finish required is equivalent to a maximum roughness[1)] of not more than 0,5 µm.

5.1.4 Calibration

Dimensionally similar cups will give, with Newtonian liquids, similar flow times, provided that the temperature of testing is precisely the same. The use of such liquids to calibrate cups provides a useful means of initially checking that dimensionally similar cups are within the accepted tolerances of performance and also for checking from time to time whether any wear or damage has taken place sufficient to bring a cup outside the accepted tolerances.

For calibration of any particular cup, use a standard oil[2)] of known kinematic viscosity and draw a graph of kinematic viscosity versus temperature from the data given by the supplier for the oil.

Using the procedure described in clause 7, determine the flow time of the oil at a known temperature within the range 20 °C to 30 °C, measured to the nearest 0,1 °C.

Record this flow time, which should be in the range 30 s to 100 s and preferably near the mid-point of this range, to an accuracy of 0,2 s.

From the prepared graph, read the kinematic viscosity at the test temperature.

Using the appropriate equation, calculate the flow time corresponding to this kinematic viscosity.

1) In the sense defined in ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements*; i.e. the arithmetical mean deviation R_a from the mean line of the profile.

2) Information on suppliers of suitable oils can be obtained from national standards organizations.

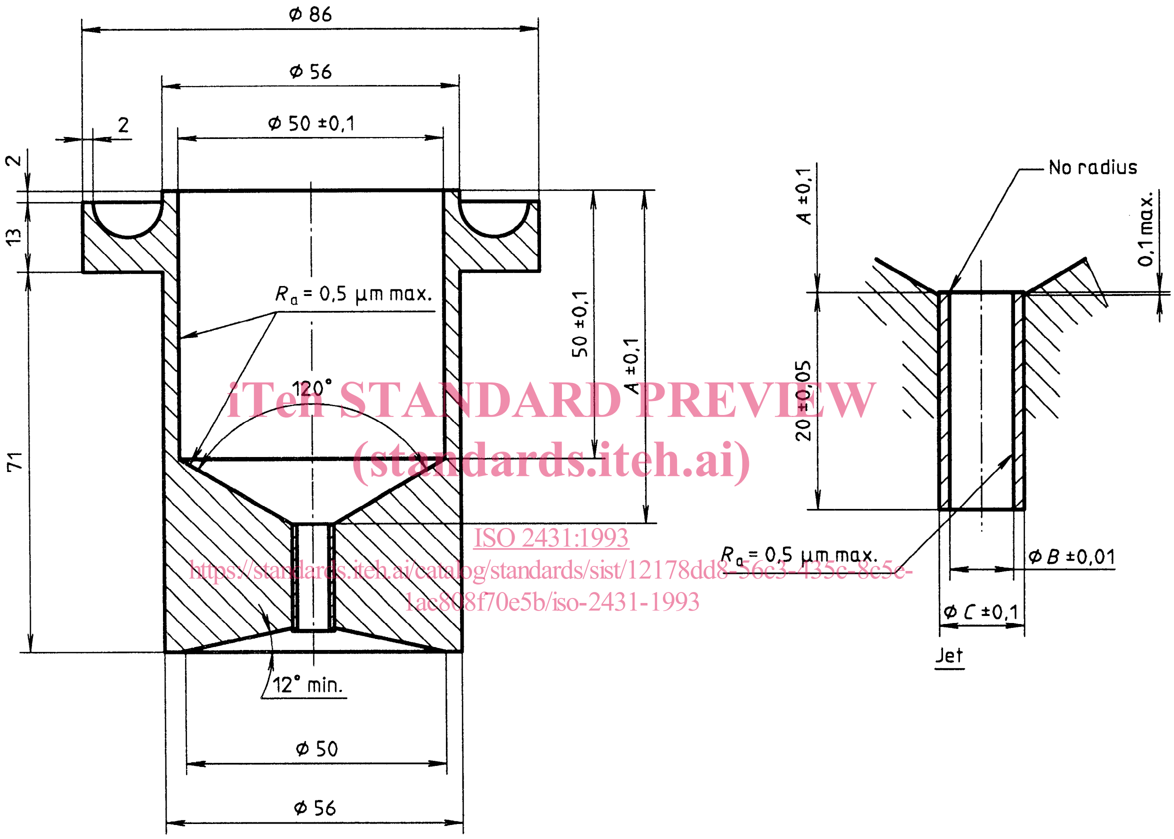
These calibration equations are as follows:

3-mm cup	$v = 0{,}443t - (200/t)$
4-mm cup	$v = 1{,}37t - (200/t)$
5-mm cup	$v = 3{,}28t - (220/t)$
6-mm cup	$v = 6{,}90t - (570/t)$

NOTE 6 The calibration curves plotted in figures 2 to 5 for these equations are given for information only.

If the two values of flow time obtained do not differ by more than 3 %, the cup is deemed satisfactory for use.

Dimensions in millimetres, unless otherwise indicated



Dimension	**Values1) for the given flow cups**			
	3-mm cup	4-mm cup	5-mm cup	6-mm cup
A	63	62,7	62,4	62,1
B	3	4	5	6
C	5	6	7	8

1) For tolerances, see the enlarged section of the jet.

Figure 1 — Flow cup

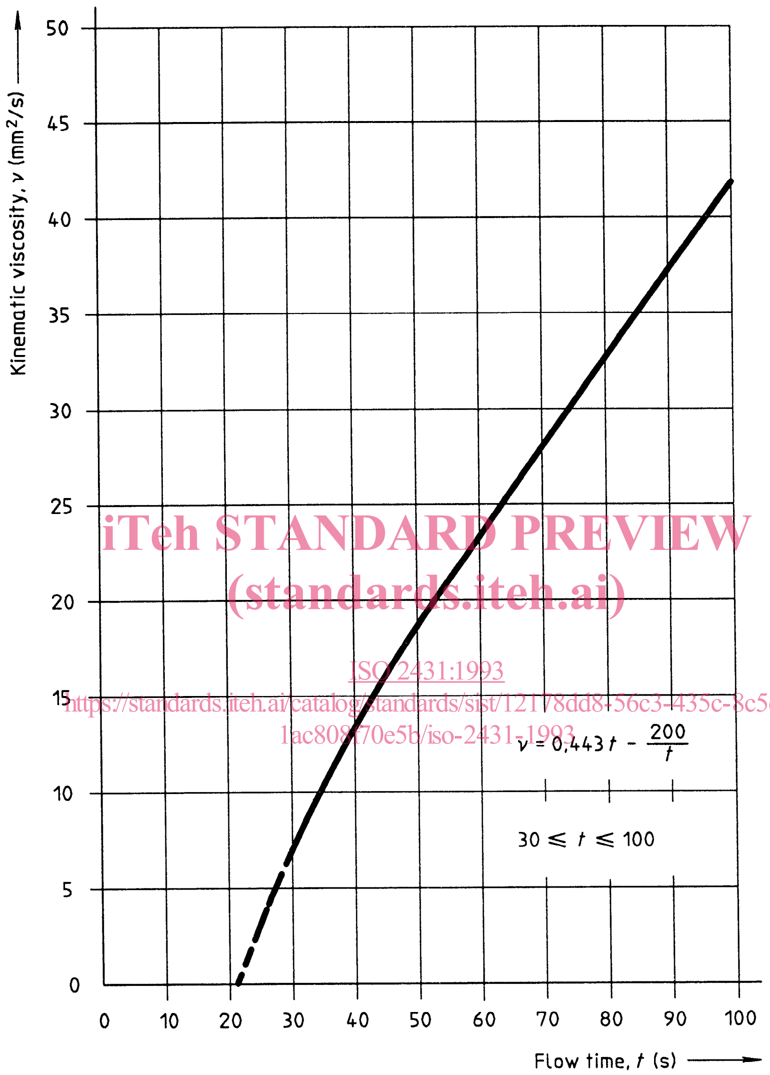


Figure 2 — Calibration curve for 3-mm cup

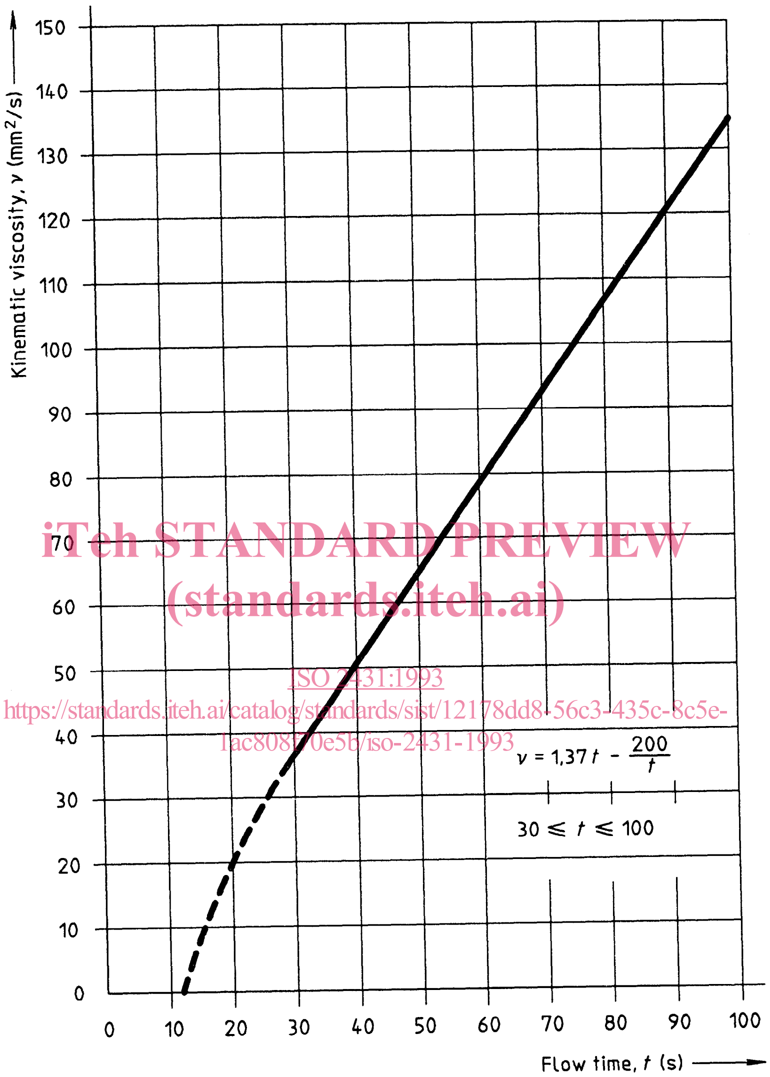


Figure 3 — Calibration curve for 4-mm cup