INTERNATIONAL STANDARD

ISO 2431

Fifth edition
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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
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fifth edition cancels and replaces the fourth edition (ISO 2431:1993), which has been technically revised. It also incorporates the Technical Corrigenda ISO 2431:1993/Cor.1:1994 and ISO 2431:1993/Cor.2:1999.

The main technical changes are as follows:

a) the curves in Figures 2 to 5 have been placed in a single figure (Figure 2) and the equations for the conversion of flow time to kinematic viscosity and *vice versa* represented by the curves in these figures have been moved from the figures to a table (Table 1);

b) the accuracy of the stopwatch used is no longer specified;

c) a clause has been added describing the marking of products tested to indicate the results of the test;

d) the procedure for checking the flow cups for wear and tear has been revised to include two alternative methods (one using a certified reference material or secondary working standard, the other using a certified flow cup) and has been moved to an informative annex;

e) the former Annex A on the use of flow cups for the adjustment of paint consistency has been deleted;

f) a new annex describing the conversion of flow times from one temperature to another has been added.

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. The fourth edition specified four flow cups of orifice diameter 3 mm, 4 mm, 5 mm and 6 mm. The main changes made in this fifth edition are given in the foreword.

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 the flow time of paints, varnishes and related products.

It is recognized that 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 non-Newtonian flow properties. Their viscosity during application can only be properly assessed using viscometers such as that described in ISO 3219.

Resins and varnishes can 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.

With thixotropic materials, stirring or other such mechanical disturbance immediately before testing will reduce the flow time compared with that for an unstirred sample. With such materials, uncertain and variable flow time values are obtained with all the flow cups. The repeatability and reproducibility limits given in Clause 9 cannot be achieved in the determination of the flow time of such materials.

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

1 Scope

1.1 This International Standard specifies a method for determining the flow time of paints, varnishes and related products that can be used to control consistency.

1.2 Four flow cups of similar dimensions, but having orifice diameters of 3 mm, 4 mm, 5 mm and 6 mm, are specified. Two methods for checking the flow cups for wear and tear are given (see Annex A).

Flow cups with a replaceable jet are not covered by this International Standard as the close tolerances on the supply of the material under test to the jet are not met.

Commonly used dipping flow cups are also not covered by this International Standard. In general, the fabrication tolerances for such flow cups are greater than those of the flow cups specified in this International Standard. Therefore flow time determinations with dipping flow cups give a precision which is lower than that obtained with the flow cups specified in this International Standard (see Clause 9).

1.3 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 near the upper limit of the measurement range (100 s) due to slowing-down effects.

2 Normative references

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

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

3.2
Newtonian flow
type of flow exhibited by a material in which, at a constant temperature, the ratio of the shear stress to the shear rate does not vary either with time or with the shear rate

NOTE 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
non-Newtonian flow
type of flow exhibited by a material in which, at a constant temperature, the ratio of the shear stress to the shear rate varies either with time or with shear rate

3.4
kinematic viscosity
ν
ratio of the dynamic viscosity to the density of the liquid

NOTE The SI base unit for kinematic viscosity is metres squared per second (m^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 reference purposes, (23,0 ± 0,5) °C is specified as the test temperature in this International Standard. However, it might be more convenient to carry out comparative testing at some other agreed temperature (for example, 25 °C) because of prevailing temperature conditions (see also Annex B).

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. The flow cup shall be in a place which is free from draughts.

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

5.1.2 Material

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

5.1.3 Construction

The dimensions not specified, such as wall thickness, shall be such that no distortion of the flow cup can occur in use. The external shape should preferably be as shown in Figure 1, but may be modified for convenience of use, or manufacture, provided that the protruding jet of the flow 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 any capillary action when the material under test flows out.

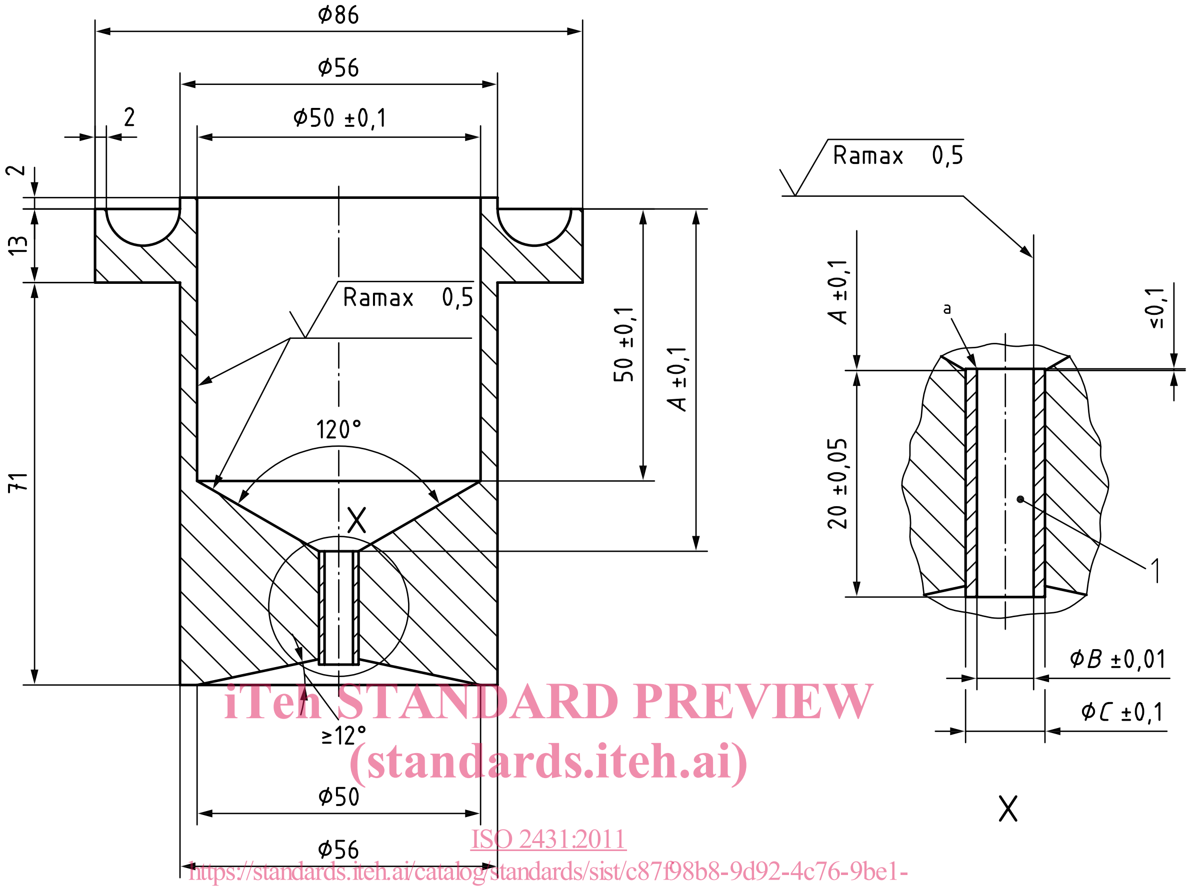
Flow cups having an additional jacket for temperature control are preferred.

5.1.4 Finish

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

NOTE The standard of finish required is equivalent to a maximum roughness Ra (as defined in ISO 4287) of not more than 0,5 µm.

Dimensions in millimetres,
roughness in micrometres



Key

1 jet

a Sharp edge (not rounded).

Dimension	Values[a] for the flow cups given			
	3-mm (No 3) flow cup	4-mm (No 4) flow cup	5-mm (No 5) flow cup	6-mm (No 6) flow cup
A	63	62,7	62,4	62,1
B	3	4	5	6
C	5	6	7	8

a For tolerances, see the enlarged section of the jet.

Figure 1 — Flow cup

5.1.5 Measurement range

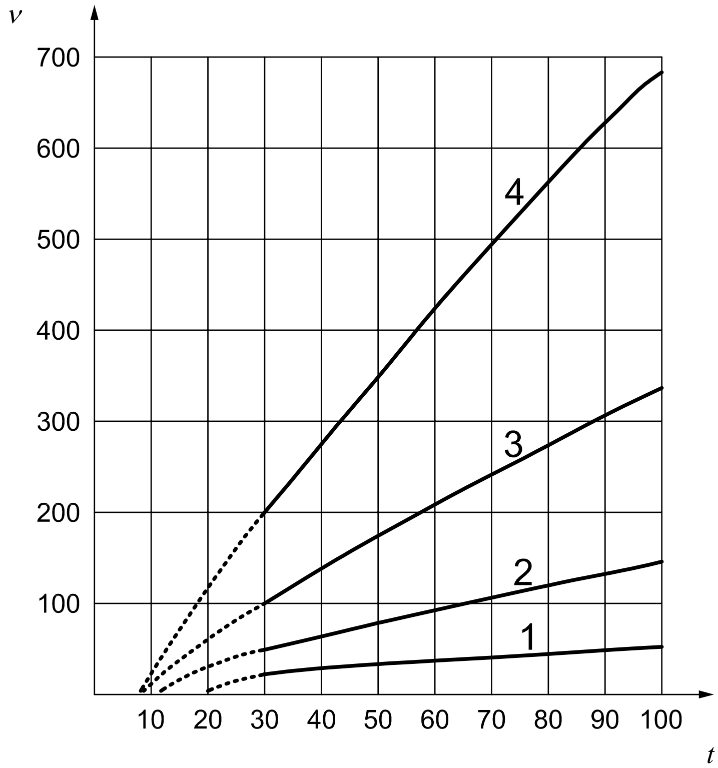
Flow cups shall be used within the measurement range given in Table 1. Only in this range can meaningful data be obtained. In addition, the conversion of flow time to kinematic viscosity and *vice versa*, shall be carried out using the equations given in Table 1.

Table 1 — Measurement range of flow cups and conversion of flow time to kinematic viscosity and *vice versa*

Flow cup	Flow time, t s	Kinematic viscosity, ν mm²/s	Measurement range s
No 3	$t = \frac{\nu}{0{,}89} + \sqrt{451{,}5 + \left(\frac{\nu}{0{,}89}\right)^2}$	$\nu = 0{,}443 \times t - \frac{200}{t}$	$30 \leq t \leq 100$
No 4	$t = \frac{\nu}{2{,}74} + \sqrt{146{,}0 + \left(\frac{\nu}{2{,}74}\right)^2}$	$\nu = 1{,}37 \times t - \frac{200}{t}$	$30 \leq t \leq 100$
No 5	$t = \frac{\nu}{6{,}56} + \sqrt{67{,}1 + \left(\frac{\nu}{6{,}56}\right)^2}$	$\nu = 3{,}28 \times t - \frac{220}{t}$	$30 \leq t \leq 100$
No 6	$t = \frac{\nu}{13{,}8} + \sqrt{82{,}6 + \left(\frac{\nu}{13{,}8}\right)^2}$	$\nu = 6{,}90 \times t - \frac{570}{t}$	$30 \leq t \leq 100$

The curves corresponding to the equations given in Table 1 are plotted in Figure 2.

NOTE These curves are given for information only.



Key

1 3-mm flow cup
2 4-mm flow cup
3 5-mm flow cup
4 6-mm flow cup
t flow time, in seconds
v kinematic viscosity, in millimetres squared per second

Figure 2 — Conversion curves for 3-mm, 4-mm, 5-mm and 6-mm flow cups

5.1.6 Marking

Each flow cup shall have the following inscriptions permanently and legibly marked on it:

a) designation of flow cup: ISO 2431, No 3, No 4, No 5 or No 6;

b) manufacturer's identification number;

c) manufacturer's name or trade mark.

5.1.7 Care and checking of flow cups

Clean the flow cup immediately after use and before the sample starts to dry, using a suitable solvent. Never use metal tools or a wire scourer for cleaning purposes. If the orifice becomes contaminated with dried deposits, soften these with a suitable solvent and clean carefully, for example with a soft cloth pulled through the orifice.

Check the flow cups periodically for wear and tear by one of the procedures specified in Annex A.

5.2 Supplementary apparatus

5.2.1 Thermometer, graduated at intervals of 0,2 °C or finer.