

Paints and varnishes — Determination of viscosity using rotary viscometers —

Part 1: Cone-and-plate viscometer operated at a high rate of shear

The European Standard EN ISO 2884-1:2006 has the status of a
British Standard

ICS 87.040

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National foreword

This British Standard was published by BSI. It is the UK implementation of EN ISO 2884-1:2006. It is identical with ISO 2884-1:1999.

The UK participation in its preparation was entrusted to Technical Committee STI/10, Test methods for paints.

A list of organizations represented on STI/10 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Sector Committee for Materials and Chemicals, was published under the authority of the Standards Committee and comes into effect on January 2000

Amendments issued since publication

| Amd. No. | Date | Comments |
|----------|------------------|---|
| 16865 | 28 February 2007 | Renumbers the BS as BS EN ISO 2884-1:2006 |
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ICS 87.040

English Version

Paints and varnishes - Determination of viscosity using rotary viscometers - Part 1: Cone-and-plate viscometer operated at a high rate of shear (ISO 2884-1:1999)

Peintures et vernis - Détermination de la viscosité au moyen de viscosimètres rotatifs - Partie 1: Viscosimètre à cône et plateau fonctionnant à gradient de vitesse de cisaillement élevé (ISO 2884-1:1999)

Beschichtungsstoffe - Bestimmung der Viskosität mit Rotationsviskosimetern - Teil 1: Kegel-Platte-Viskosimeter bei hohem Geschwindigkeitsgefälle (ISO 2884-1:1999)

This European Standard was approved by CEN on 18 May 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Foreword

The text of ISO 2884-1:1999 has been prepared by Technical Committee ISO/TC 35 "Paints and varnishes" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 2884-1:2006 by Technical Committee CEN/TC 139 "Paints and varnishes", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 2884-1:1999 has been approved by CEN as EN ISO 2884-1:2006 without any modifications.

INTERNATIONAL STANDARD

ISO 2884-1

First edition
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Paints and varnishes — Determination of viscosity using rotary viscometers —

Part 1:

Cone-and-plate viscometer operated at a high
rate of shear

*Peintures et vernis — Détermination de la viscosité au moyen de
viscosimètres rotatifs —*

Partie 1: Viscosimètre à cône et plateau à gradient de vitesse élevé



Foreword

(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 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 3.

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 2884-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Together with the other parts (see below), this part of ISO 2884 cancels and replaces ISO 2884:1974, which has been technically revised. The main changes are:

- only a cone-and-plate viscometer is now specified;
- the shear rate is within a narrower range.

2884 consists of the following parts, under the general title *Paints and varnishes — Determination of viscosity using rotary viscometers*:

- *Part 1: Cone-and-plate viscometer operated at a high rate of shear*
- *Part 2: Disc or ball viscometer operated at a single specified speed*
- *Part 3: Disc and spindle viscometer operated at different speeds*
- *Part 4: Paddle viscometer operated at a single specified speed*

Annex A of this part of ISO 2884 is for information only.

Paints and varnishes — Determination of viscosity using rotary viscometers —

Part 1:

Cone-and-plate viscometer operated at a high rate of shear

1 Scope

This part of ISO 2884 is one of a series dealing with the sampling and testing of paints, varnishes and related products.

It supplements ISO 2431:1993, *Paints and varnishes — Determination of flow time by use of flow cups*.

It specifies the general procedure to be followed in determining the dynamic viscosity of paints, varnishes and related products at a rate of shear between $9\,000\text{ s}^{-1}$ and $12\,000\text{ s}^{-1}$.

The value obtained gives information about the resistance offered by the material to brushing, spraying and roller coating during application.

The method specified in this part of ISO 2884 is suitable for all paints and varnishes whether they are Newtonian in behaviour or not. Materials containing dispersions of large particles will produce spurious results.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 2884. For dated references, subsequent amendments to, or revisions of, any of these publications, do not apply. However, parties to agreements based on this part of ISO 2884 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 15528:—¹⁾, *Paints and varnishes — Sampling*.

3 Apparatus

3.1 Viscometer, with cone-and-plate geometry, working at a rate of shear between $9\,000\text{ s}^{-1}$ and $12\,000\text{ s}^{-1}$. The actual apparatus used shall be agreed between the interested parties, and the details given in the test report. A simple apparatus for routine use is described in annex A.

1) To be published. (Revision of ISO 842:1984 and ISO 1512:1991)

4 Sampling

Take a representative sample of the product to be tested, as described in ISO 15528. Then examine the sample prepare it for testing, as described in ISO 1513. If the sample has a tendency to sediment or separate on standing, stir it until it is homogeneous, taking care not to incorporate air bubbles. The sample shall be free of any foreign matter or lumps. The volume of the sample shall be sufficient to fill the gap between the cone and plate.

E Samples containing large particles will produce anomalous results and can cause damage to the instrument. For cone-and-plate viscometers with truncated cones, the larger particles in the sample should be less than a tenth the size of the gap between the cone and the plate.

Checking the apparatus

Check the apparatus on a regular basis in accordance with the manufacturer's recommendations and from experience gained in the use of the instrument, comparing the results against those from previous checks and hence establishing the frequency of checking required. Check by carrying out the determination as outlined in clause 7, using standard refined mineral oils having Newtonian characteristics and known viscosities (use three mineral oils with viscosities certified by an approved laboratory and lying between 0,05 Pa·s and 0,5 Pa·s). Check the cones regularly for wear and replace them if they show signs of scoring or, for cones that are not truncated, signs of flattening.

If the readings obtained differ from the known viscosities of the standard oils by more than 5 %, the apparatus shall be checked by a competent instrument engineer or returned to the manufacturer for adjustment.

E Silicone oils should preferably be avoided because of their tendency to contaminate instruments and because of the possibility of shear-thinning behaviour at high shear rates.

Checking the temperature control

To check that the temperature does not change during the determination, carry out the determination as outlined in clause 7 with the standard oil of the highest viscosity as indicated by the scale reading.

Allow the viscometer to run with this oil for 5 min, after which the reading shall not have decreased by more than 10 %. If the decrease is more than 10 %, the apparatus is unsuitable, as set up, for the determination of viscosities at high rates of shear in accordance with this part of ISO 2884.

7 Procedure

Carry out the following sequence of operations in duplicate immediately after the preparation of the sample in accordance with clause 4, first allowing the apparatus to warm up in accordance with the manufacturer's instructions.

When the viscosities of products are being compared, the rate of shear shall be the same. The determination shall be carried out at $(23 \pm 0,2)$ °C unless otherwise agreed.

Adjust the temperature of the stationary part of the viscometer to $(23 \pm 0,2)$ °C or to an alternatively agreed temperature. Transfer a suitable amount of the product to be tested to the appropriate part of the viscometer, taking care to avoid the inclusion of air bubbles, and adjust the other part to the correct position. Wait for the prescribed time, dependent on the apparatus used, to allow the sample to attain the agreed temperature.

Start the rotor and record the reading on the scale when the reading becomes steady. If the reading does not become steady after 15 s, the reading at 15 s shall be recorded and the lack of a constant reading shall be mentioned in the test report.

If the reading does not directly indicate the viscosity, multiply the reading by the appropriate conversion factor or use an appropriate calibration curve to obtain the viscosity.

8 Cleaning the apparatus

Clean the stator and rotor carefully after each determination, employing a suitable solvent. The procedure to be used will depend on the apparatus, but care shall be taken to remove all of the test material and cleaning solvent. Cleaning utensils which may damage the apparatus shall not be used. Metal cleaning tools shall never be used.

9 Precision

The results of two determinations with the same apparatus taken shortly after one other in the same laboratory by the same operator shall not differ by more than 5 % of their mean.

10 Test report

The test report shall contain at least the following information:

- a) all details necessary to identify the product tested;
- b) a reference to this part of ISO 2884 (ISO 2884-1);
- c) the type of apparatus used, stating the angle and diameter of the cone;
- d) the shear rate used;
- e) the temperature used;
- f) the test results in Pa·s or mPa·s;
- g) any deviation from the test procedure described, and whether agreed or not;
- h) the date of the test.

Annex A (informative)

Cone-and-plate viscometers

A.1 Description of a simple cone-and-plate viscometer for routine use

Cone-and-plate viscometers comprise a suitable electric motor that drives, at a constant rotational speed, a cone whose vertex touches a rigid temperature-controlled plate. The torque is measured either electronically or mechanically. Cone-and-plate viscometers are widely used for routine high-shear viscosity measurements. The geometry is shown in Figure A.1.

The instrument is designed so that the cone and motor assembly can be easily raised, first while the test liquid is being placed on the plate and later to permit thorough cleaning after each measurement.

In use, the liquid just fills the narrow gap between the plate and the cone.

The main characteristics are described in Table A.1.

Dimensions in millimetres

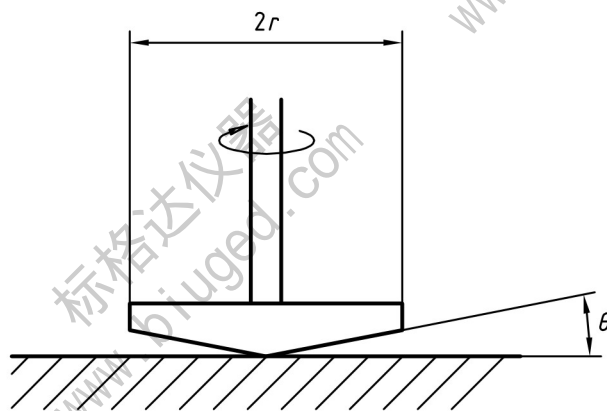


Figure A.1 — Cone and plate geometry

Table A.1 — Viscometer characteristics

| Characteristic | |
|-------------------------|---|
| Viscosity range | 0 to 1 Pa·s (0 to 10 P) |
| Rotational speed | (750 ± 10) rpm |
| Cone diameter | Dependent on speed, angle and torque selected (typically 24 mm) |
| Cone angle | 0,5° ± 2' produces a shear rate of 9 000 s ⁻¹ |
| Shear rate (calculated) | 9 000 s ⁻¹ |

A.2 Viscometric formulae

The equations governing the shear stress and shear rate for a cone-and-plate instrument are given below:

$$\text{Shear rate (s}^{-1}\text{)} = \frac{\omega}{\tan\theta}$$

$$\text{Shear stress (Pa)} = \frac{3T}{2\pi r^3}$$

$$\text{Viscosity (Pa}\cdot\text{s)} = \frac{3T \tan\theta}{2\pi \omega r^3}$$

where

T is the torque, in newton metres;

ω is the angular velocity, in radians per second;

r is the radius of the cone, in metres;

θ is the cone angle, in radians.

Bibliography

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- [2] MONK, C.J.H.: "Routine measurement of the viscosity of paint samples", *JOCCA*, **49** (1966), pp. 543-550.