

**BRITISH STANDARD**

**Methods of test for**

# **Petroleum and its products**

**Part 71. Section 1. Petroleum products -  
Transparent and opaque liquids -  
Determination of kinematic viscosity and  
calculation of dynamic viscosity**

**(Identical with IP 71 Section 1/96)**

**BS EN ISO  
3104 : 1996  
BS 2000 :  
Part 71 :  
Section 1 :1996  
ISO 3104 : 1994**

The European Standard EN ISO 3104 : 1996 has the status of a British Standard

## National foreword

This British Standard was published under the authority of the Materials and Chemicals Sector Board and comes into effect on 29 July 1996. It is the English language version of EN ISO 3104 : 1996 Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity, published by the European Committee for Standardization (CEN), which endorses ISO 3104 : 1994, published by the International Organization for Standardization (ISO).

This British Standard supersedes BS 2000 : Part 71 : Section 1 : 1995 which is withdrawn.

There are no technical differences between this British Standard and the previous edition of BS 2000 : Part 71 : Section 1. A new edition has been made available to fulfil BSI's obligation to publish all approved European Standards.

BS 2000 comprises a series of test methods for petroleum and its products that are published by the Institute of Petroleum (IP) and have been accorded the status of a British Standard. Each method should be read in conjunction with the preliminary pages of 'IP Standard methods for analysis and testing of petroleum and related products' which gives details of the BSI/IP agreement for publication of the series, provides general information on safety precautions, sampling and other matters, and lists the methods published as Parts of BS 2000.

The numbering of the Parts of BS 2000 follows that of the corresponding methods published in 'IP Standard methods for analysis and testing of petroleum and related products'. Under the terms of the agreement between BSI and the Institute of Petroleum, BS 2000 : Part 71 : Section 1/BS EN ISO 3104 will be published by the IP (in 'Standard methods for analysis and testing of petroleum and related products' and as a separate publication). BS 2000 : Part 71 : Section 1 : 1996 is thus identical with IP 71 Section 1/96.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

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The following BSI references  
relate to the work of this  
standard:  
Committee reference PTI/13  
Announcement in *BSI News*  
July 1995

EUROPEAN STANDARD

EN ISO 3104

NORME EUROPÉENNE

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ICS 75.080

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English version

**Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity (ISO 3104:1994)**

Produits pétroliers - Liquides opaques et transparents - Détermination de la viscosité cinématique et calcul de la viscosité dynamique (ISO 3104:1994)

Mineralölerzeugnisse - Durchsichtige und undurchsichtige Flüssigkeiten - Bestimmung der kinematischen Viskosität und Berechnung der dynamischen Viskosität (ISO 3104:1994)

This European Standard was approved by CEN on 1996-01-18. 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.

The European Standards exist 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.

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**CEN**

European Committee for Standardization  
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## Foreword

The text of the International Standard from ISO/TC 28 "Petroleum products and lubricants" of the International Organization for Standardization (ISO) has been taken over as a European Standard by the Technical Committee CEN/TC 19 "Petroleum products, lubricants and related products".

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 August 1996, and conflicting national standards shall be withdrawn at the latest by August 1996.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

## Endorsement notice

The text of the International Standard ISO 3104:1994 has been approved by CEN as a European Standard without any modification.



# Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity

**WARNING** — The use of this International Standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

## 1 Scope

This International Standard specifies a procedure for the determination of the kinematic viscosity,  $\nu$ , of liquid petroleum products, both transparent and opaque, by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer. The dynamic viscosity,  $\eta$ , can be obtained by multiplying the measured kinematic viscosity by the density,  $\rho$ , of the liquid.

**NOTE 1** The result obtained from this International Standard is dependent upon the behaviour of the sample and is intended for application to liquids for which primarily the shear stress and shear rates are proportional (Newtonian flow behaviour). If, however, the viscosity varies significantly with the rate of shear, different results may be obtained from viscometers of different capillary diameters. The procedure and precision values for residual fuel oils, which under some conditions exhibit non-Newtonian behaviour, have been included.

## 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 re-

cent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3105:—<sup>1)</sup>, *Glass capillary kinematic viscometers — Specifications and operating instructions*.

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*.

## 3 Definitions

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

**3.1 kinematic viscosity,  $\nu$ :** Resistance to flow of a fluid under gravity.

**NOTE 2** For gravity flow under a given hydrostatic head, the pressure head of a liquid is proportional to its density,  $\rho$ . For any particular viscometer, the time of flow of a fixed volume of fluid is directly proportional to its kinematic viscosity,  $\nu$ , where  $\nu = \eta/\rho$ , and where  $\eta$  is the dynamic viscosity coefficient.

**3.2 density,  $\rho$ :** Mass per unit volume of a substance at a given temperature.

**3.3 dynamic viscosity,  $\eta$ :** Ratio between the applied shear stress and rate of shear of a liquid. It is sometimes called the coefficient of dynamic viscosity, or simply viscosity. Thus dynamic viscosity is a

1) To be published. (Revision of ISO 3105:1976)

measure of the resistance to flow or deformation of a liquid.

NOTE 3 The term dynamic viscosity can also be used in a different context to denote a frequency-dependent quantity in which shear stress and shear rate have a sinusoidal time dependence.

## 4 Principle

The time is measured for a fixed volume of liquid to flow under gravity through the capillary of a calibrated viscometer under a reproducible driving head and at a known and closely controlled temperature. The kinematic viscosity is the product of the measured flow time and the calibration constant of the viscometer.

## 5 Reagents and materials

**5.1 Chromic acid cleaning solution**, or a nonchromium-containing, strongly-oxidizing acid cleaning solution.

**WARNING — Chromic acid is a health hazard. It is toxic, a recognized carcinogen, highly corrosive and potentially hazardous in contact with organic materials. If used, wear a full face-shield and full-length protective clothing including suitable gloves. Avoid breathing vapour. Dispose of used chromic acid carefully as it remains hazardous. Nonchromium-containing, strongly oxidizing acid cleaning solutions are also highly corrosive and potentially hazardous in contact with organic materials, but do not contain chromium which has special disposal problems.**

**5.2 Sample solvent**, completely miscible with the sample. Filter before use.

NOTE 4 For most samples a volatile petroleum spirit or naphtha is suitable. For residual fuels, a prewash with an aromatic solvent such as toluene or xylene may be necessary to remove asphaltenic material.

**5.3 Drying solvent**, volatile and miscible with both the sample solvent (5.2) and water (5.4). Filter before use.

NOTE 5 Acetone is suitable.

**5.4 Water**, deionized or distilled, conforming to Grade 3 of ISO 3696. Filter before use.

**5.5 Certified viscosity reference standards**, for use as confirmatory checks on the procedure in the laboratory.

## 6 Apparatus

**6.1 Viscometer**, calibrated, of the glass capillary type, capable of measuring kinematic viscosity within the limits of precision given in clause 14 (see annex A).

NOTE 6 Viscometers listed in table A.1, whose specifications meet those given in ISO 3105, meet these requirements. It is not intended to restrict this test method to the use of only those viscometers listed in table A.1; annex A gives further guidance.

Automated viscometers, which have been shown to measure kinematic viscosity within the limits of precision given in clause 14, are acceptable alternatives. Apply a kinetic energy correction (see ISO 3105) to kinematic viscosities less than  $10 \text{ mm}^2/\text{s}$  and flow times less than 200 s.

**6.2 Viscometer holder**, enabling all viscometers which have the upper meniscus directly above the lower meniscus to be suspended vertically within  $1^\circ$  in all directions. Those viscometers whose upper meniscus is offset from directly above the lower meniscus shall be suspended vertically within  $0,3^\circ$  in all directions (see ISO 3105).

NOTE 7 The proper alignment of vertical parts may be confirmed by using a plumb line, but for rectangular baths with opaque ends this may not be wholly satisfactory.

**6.3 Temperature-controlled bath**, containing a transparent liquid of sufficient depth such that at no time during the measurement is any portion of the sample in the viscometer less than 20 mm below the surface of the bath liquid or less than 20 mm above the bottom of the bath.

Temperature control of the bath liquid shall be such that, for each series of flow-time measurements, within the range of  $15^\circ\text{C}$  to  $100^\circ\text{C}$  the temperature of the bath medium does not vary by more than  $\pm 0,02^\circ\text{C}$  from the selected temperature over the length of the viscometer, or between the position of each viscometer, or at the location of the thermometer. For temperatures outside this range, the deviation from the desired temperature shall not exceed  $\pm 0,05^\circ\text{C}$ .