SLOVENSKI STANDARD
SIST ISO 3104:1995

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Naftni proizvodi - Prozorne in neprozorne tekočine - Določanje kinematične viskoznosti in izračun dinamične viskoznosti

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

Produits pétroliers -- Liquides opaques et transparents -- Détermination de la viscosité cinématique et calcul de la viscosité dynamique

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INTERNATIONAL STANDARD

ISO 3104

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

Produits pétroliers — Liquides opaques et transparents — Détermination de la viscosité cinématique et calcul de la viscosité dynamique

Reference number
ISO 3104:1994(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 3104 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

This second edition cancels and replaces the first edition (ISO 3104:1976), of which it constitutes a technical revision.

Annexes A, B and C form an integral part of this International Standard.

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Introduction

Many petroleum products, and some non-petroleum materials, are used as lubricants, and the correct operation of equipment depends upon the appropriate viscosity of the liquid being used. In addition, the viscosity of many petroleum fuels is important for the estimation of optimum storage, handling and operational conditions. Thus the accurate measurement of viscosity is essential to many product specifications.

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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, ν, 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, η, can be obtained by multiplying the measured kinematic viscosity by the density, ρ, 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 recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3105:—[1], *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, ν: 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, ρ. For any particular viscometer, the time of flow of a fixed volume of fluid is directly proportional to its kinematic viscosity, ν, where $\nu = \eta/\rho$, and where η is the dynamic viscosity coefficient.

3.2 density, ρ: Mass per unit volume of a substance at a given temperature.

3.3 dynamic viscosity, η: 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 mm^2/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° in all directions. Those viscometers whose upper meniscus is offset from directly above the lower meniscus shall be suspended vertically within 0,3° 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 °C to 100 °C the temperature of the bath medium does not vary by more than ± 0,02 °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 ± 0,05 °C.

6.4 Temperature-measuring device, for the range 0 °C to 100 °C, either calibrated liquid-in-glass thermometer (annex B) of an accuracy after correction of ± 0,02 °C or better, or any other thermometric device of equal or better accuracy. When two thermometers are used in the same bath, they shall agree within 0,04 °C.

NOTE 8 If calibrated liquid-in-glass thermometers are used, the use of two thermometers is recommended.

Outside the range 0 °C to 100 °C, a calibrated liquid-in-glass thermometer of an accuracy after correction of ± 0,05 °C or better shall be used, and when two thermometers are used in the same bath they shall agree within ± 0,1 °C.

6.5 Timing device, capable of taking readings with a discrimination of 0,1 s or better, and having an accuracy within ± 0,07 % (see annex C) of the reading when tested over intervals of 200 s and 900 s.

NOTE 9 Electrical timing devices may be used if the current frequency is controlled to an accuracy of 0,05 % or better. Alternating currents, as provided by some public power systems, are intermittently rather than continuously controlled. When used to actuate electrical timing devices, such control can cause large errors in viscosity flow measurements.

7 Calibration and verification

7.1 Verify the viscometer calibration following the laboratory procedure using a certified viscosity reference standard (5.5). If the measured kinematic viscosity does not agree within ± 0,35 % of the certified value, recheck each step in the procedure, including thermometer and viscometer calibrations, to locate the source of error. Table 1 in ISO 3105 gives details of standards available.

NOTE 10 The most common sources of error are caused by particles of dust lodged in the capillary bore and temperature measurement errors. It should be appreciated that a correct result obtained on a standard oil does not preclude the possibility of a counterbalancing combination of the possible sources of error.

7.2 The calibration constant, C, is dependent upon the gravitational acceleration at the place of calibration and this shall therefore be supplied by the standardization laboratory, together with the instrument constant. Where the acceleration of gravity, g, differs by more than 0,1 %, correct the calibration constant as follows:

$$C_2 = (g_2/g_1)C_1$$

where the subscripts 1 and 2 indicate respectively the standardization laboratory and the testing laboratory.

8 General procedure for kinematic viscosity determination

8.1 Adjust and maintain the viscometer bath at the required test temperature within the limits given in 6.3, taking account of the conditions given in annex B and of the corrections supplied on the certificates of calibration for the thermometers.

Thermometers shall be held in an upright position under the same conditions of immersion as when calibrated.

NOTE 11 In order to obtain the most reliable temperature measurement, it is recommended that two thermometers with valid calibration certificates be used (see 6.4). They should be viewed with a lens assembly giving approximately × 5 magnification and be arranged to eliminate parallax errors.

8.2 Select a clean, dry, calibrated viscometer having a range covering the estimated kinematic viscosity (that is, a wide capillary for a very viscous liquid and a narrower capillary for a more fluid liquid). The flow time shall not be less than 200 s or the longer time noted in ISO 3105.

NOTE 12 The specific details of operation vary depending on the type of viscometer. The operating instructions for the different types of viscometers listed in table A.1 are given in ISO 3105.

8.2.1 When the test temperature is below the dew point, affix loosely-packed drying tubes to the open ends of the viscometer. The drying tubes shall fit the design of the viscometer and not restrict the flow of the sample by pressures created in the instrument. Carefully flush the moist room air from the viscometer by applying vacuum to one of the drying tubes. Finally, before placing the viscometer in the bath, draw up the sample into the working capillary and timing bulb and allow to drain back, as an additional safeguard against moisture condensing or freezing on the walls.

8.2.2 Viscometers used for silicone fluids, fluorocarbons and other liquids which are difficult to remove by the use of a cleaning agent shall be reserved for the exclusive use of those fluids, except during their calibration. Subject such viscometers to calibration checks at frequent intervals. The solvent washings from these viscometers shall not be used for the cleaning of other viscometers.