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Date: 2024-xx

Petroleum products and related products — Determination of kinematic viscosity — Method by Stabinger type viscometer

Produits pétroliers et produits connexes — Détermination de la viscosité cinématique — Méthode ~~avec le~~par viscosimètre type Stabinger

FDIS stage

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ISO 20344, Personal protective equipment — Test methods for footwear

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 19, *Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 23581:2020), which has been technically revised.

The main changes are as follows:

— ——base oils, formulated oils, jet fuels and residual fuel oils have been included in the scope;

— ——the apparatus description, sample handling procedures and determinability criteria have been updated to accommodate the new scope.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Petroleum products and related products — — Determination of kinematic viscosity — Method by Stabinger type viscometer

WARNING — The use of this document can involve hazardous materials, operations and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of users of this document to take appropriate measures to ensure the safety and health of personnel prior to application of this document and fulfil other applicable requirements for this purpose.

1 Scope

This document specifies a procedure for the determination of kinematic viscosity ~~(, ν),~~ by calculation from dynamic viscosity ~~(, η),~~ and density ~~(, ρ),~~ of both transparent and opaque liquid petroleum products and crude oils using the Stabinger type viscometer.

The result obtained using the procedure described in this document depends on the rheological behaviour of the sample. This document is predominantly applicable to liquids whose shear stress and shear rate are proportional (Newtonian flow behaviour). If the viscosity changes significantly with the shear rate, comparison with other measuring methods is not possible except at similar shear rates.

The precision has been determined only for the materials, density ranges and temperatures described in ~~Clause 13.~~Clause 13. The test method can be applied to a wider range of viscosity, density, temperature and materials. It is possible that the precision and bias are applicable for materials which are not listed in ~~Clause 13.~~Clause 13.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

~~<std>~~ISO 3104, Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity~~</std>~~

~~<std>ISO 3170, *Petroleum liquids — Manual sampling*</std>~~

~~<std>ISO 3171, *Petroleum liquids — Automatic pipeline sampling*</std>~~

~~<std>ISO 12185, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*</std>~~

ISO 3170, *Petroleum liquids — Manual sampling*

ISO 3171, *Petroleum liquids — Automatic pipeline sampling*

ISO 12185, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*

3 Terms and definitions

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

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ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obphttps://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/https://www.electropedia.org/

3.1
dynamic viscosity
η
ratio of the applied shear stress to the resulting shear rate of a liquid

3.2
kinematic viscosity
ν
ratio of the *dynamic viscosity* (3.1)(3.1) to the *density* (3.3)(3.3) of a liquid at the same temperature and pressure

Note 1 to entry: The kinematic viscosity is a measure of a liquid's resistance to flow under gravity.

3.3
density
ρ
mass of a substance divided by its volume at a given temperature

3.4
determinability
d
quantitative measure of the variability associated with the same operator in a given laboratory obtaining successive determined values using the same apparatus for a series of operations leading to a single result

Note 1 to entry: Determinability is the difference between two such single determined values that would be exceeded about 5 % of the time (one case in 20 in the long run) in the normal and correct operation of the test method.

3.5
test specimen
portion or volume of the sample obtained from the laboratory sample, which is delivered to the measuring cells

4 Principle

A test specimen is introduced into the measuring cells, at a controlled and known temperature. The measuring cells consist of a pair of rotating concentric cylinders and an oscillating U-tube. The dynamic viscosity is determined from the equilibrium rotational speed of the inner cylinder under the influence of the shear stress of the test specimen and an eddy current brake in conjunction with adjustment data. The density is determined by the oscillation frequency of the U-tube in conjunction with adjustment data. The kinematic viscosity is calculated by dividing the dynamic viscosity by the density.

5 Reagents and materials

5.1 Cleaning solvent, able to remove the sample from the measuring cell after the measurement and completely miscible with all constituents of the sample. Commercially available volatile petroleum spirit or cleaner's naphtha of technical grade or better have been proven suitable as cleaning solvents.

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5.2 Drying solvent, highly volatile and miscible with the cleaning solvent, shall be filtered before use and shall be of an appropriate purity so that no residues remain in the instrument. *n*-Hexane, *n*-heptane (recommended due to lower toxicity) or, depending on the sample, concentrated ethanol (≥96 %) are suitable.

NOTE 1 A separate drying solvent is not needed if the cleaning solvent also meets the requirements of the drying solvent.

NOTE 2 When measuring residual fuel, asphaltic material can be removed by pre-washing with an aromatic solvent (e.g. toluene or xylene).

5.3 Compressed air, oil-free and filtered with a dew point lower than the lowest measuring cell temperature at which the instrument should be dried.

The pressure should be limited to 100 kPa.

It is also possible to use inert gases, for example technical nitrogen. The requirements given for compressed air are also valid here.

5.4 Certified reference liquids, for kinematic viscosity and density, which shall be identical to the reference standards for kinematic viscosity and density cited in ISO 3104 and ISO 12185, respectively.

5.5 Reference thermometer and probe, for verification of the temperature calibration.

The measuring uncertainty of the reference thermometer, including the probe, shall not exceed 0,01 °C. The resolution shall be at least 0,001 °C.

The probe used for the calibration (with an adapter if necessary) shall have a shape which fits the geometry of the viscosity cell. The probe replaces the measuring system (tube and measuring rotor).

6 Apparatus

Usual laboratory apparatus and glassware shall be used, in particular the following.

~~6.1~~ 6.1 Stabinger type viscometer.

~~6.1.1~~ 6.1.1 Viscosity measurement

The Stabinger type viscometer is a concentric rotating viscometer, containing an outer rotor and an inner rotor (see ~~Figure 1).~~Figure 1). The small concentric gap between these rotors is filled with the sample. The outer rotor is driven at constant speed, which makes the inner rotor rotate due to the sample's viscosity. The lightweight inner rotor is centred in the heavier sample due to the centrifugal forces. The equilibrated speed ratio depends on the driving viscous shear force and the opposing magnetic induction force (eddy current). The dynamic viscosity is a function of the equilibrated speed ratio and adjustment constants. The kinematic viscosity is obtained by dividing the measured dynamic viscosity by the measured density.

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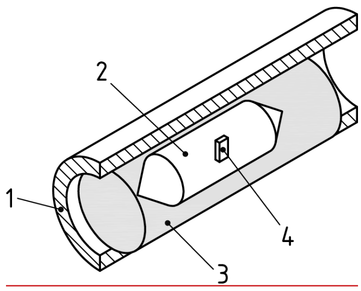

Key

1	outer rotor (constant speed)	3	sample fluid
2	inner rotor (measured speed)	4	magnet

Figure 1 — Viscosity cell

~~6.1.2~~ 6.1.2 Density measurement

The Stabinger type viscometer has an integrated density measurement based on the oscillating U-tube principle. The sample-filled U-tube is oscillated and the instrument calculates the density from the measured natural frequency of the filled tube using adjustment factors. The viscosity-dependent error of this procedure is corrected using the measured viscosity value.

~~6.1.3~~ 6.1.3 Temperature control

The Stabinger type viscometer has an integrated temperature control which keeps the viscosity and density measurement at the same temperature.

Using Peltier elements, a highly conductive measuring cell block which surrounds the measuring cells is set to the target temperature with a stability of ±0,005 °C over the whole temperature range at the position of the viscosity cell.

The measurement uncertainty of the temperature calibration (k = 2; 95 % confidence level) shall be within ±0,03 °C over the range from 15 °C to 100 °C and within ±0,05 °C outside this range.

~~6.2~~ 6.2 Syringes.

Commercially available syringes with a Luer tip of at least 5 ml in volume shall be used. The user shall ensure full chemical compatibility of the syringe construction materials with all sample and cleaning liquids by consulting the manufacturer's documentation.

~~6.3~~ 6.3 Flow-through or pressure adapter.

A flow-through or a pressure adapter may be used as an alternative to a syringe for introduction of the test specimen into the measuring cells. Such adapters apply either pressure or suction to the test specimen, therefore, care shall be taken to avoid the formation of bubbles. The user shall ensure full chemical compatibility of the flow-through or pressure adapter construction materials with all sample and cleaning liquids by consulting the manufacturer's documentation.

~~6.4~~ 6.4 Hot filling adapter.

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