

B. GENERAL TESTS

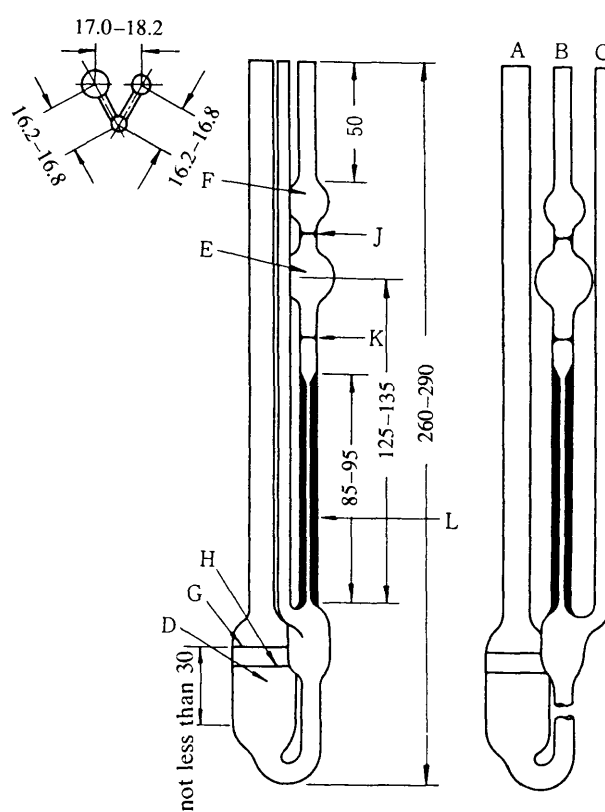
Viscosity

The Viscosity Determination Test is designed to determine the kinematic viscosity and (absolute) viscosity of a sample, using a viscometer. The units are millimeters squared per second (mm^2s^{-1}) and milli-Pascal second ($\text{mPa} \cdot \text{s}$), respectively.

Method 1 Viscosity measurement by capillary tube viscometer

The method is applied to the kinematic viscosity determination of Newtonian liquids.

Apparatus Use a Ubbelohde-type viscometer, illustrated below.



(Unit: mm)

A, B, C: Tube

D, E, F: Bulb

G, H, J, K: Graduation mark

L: Capillary tube

The table, below, gives the approximate relations between the internal diameters of the capillary tubes and the kinematic viscosity range suitable for measurements.

Although the internal diameters of the capillary tubes need not be exactly the same as shown in the table, a viscometer should be selected so that the time of drift-

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ing down a capillary tube can range between 200 seconds and 1,000 seconds.

Internal diameter of capillary tubes (mm)	Range of kinematic viscosity (mm ² s ⁻¹)
0.56 - 0.60	2 - 10
0.75 - 0.79	6 - 30
0.85 - 0.89	10 - 50
1.07 - 1.13	20 - 100
1.40 - 1.46	60 - 300
1.61 - 1.67	100 - 500
1.92 - 1.98	200 - 1,000
2.63 - 2.71	600 - 3,000
3.01 - 3.11	1,000 - 5,000
3.58 - 3.66	2,000 - 10,000
4.68 - 4.88	6,000 - 30,000
5.33 - 5.55	10,000 - 50,000
6.41 - 6.67	20,000 - 100,000

Procedure Transfer a sample into tube A, preventing the formation of bubbles in the sample solution, and adjust the meniscus of the sample to be on a level between the two graduation marks G and H of bulb D, when the viscometer is maintained vertically.

Place the viscometer in a thermostatic water bath maintained at the specified temperature (± 0.1) so that bulb F of tube B may be immersed completely in water.

Fix the viscometer vertically, and allow to stand for about 20 minutes until the sample reaches the specified temperature. Close tube C with a finger, transfer the sample to tube B by gentle suction until the meniscus of the sample rises to the middle of bulb F, remove the finger from the inlet of tube C, and immediately close the inlet of tube B with the finger. When the sample has flowed down from the lower end of the capillary tube, remove the finger from the inlet of tube B, and measure the time t (seconds) required for the meniscus of the sample to pass from mark J to mark K in tube B. Calculate the kinematic viscosity () by the formula

$$v = kt,$$

where k is the viscometer constant, which is determined previously, using distilled water or a reference standard solution with known viscosity in the same manner as for the sample. The temperature of this measurement may differ from that of the measurement of the sample.

Method 2 Viscosity measurement by rotational viscometer

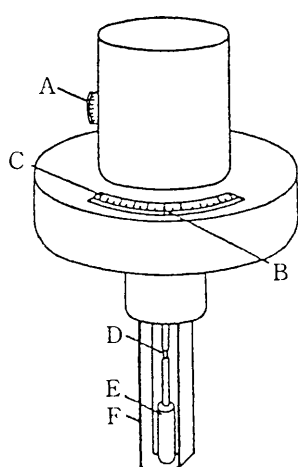
This method is applied to the viscosity measurement of Newtonian or non-

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Newtonian liquids. The principle of the method is the detection and determination of the torque, generated by viscosity resistance to the surface of a rotor rotating in a sample liquid at a constant angular velocity. The torque acting on the rotor surface is detected in terms of the degree of the torsion of spring in the viscometer, and the viscosity of the sample is calculated from the dial reading which corresponds to the degree of torsion.

Apparatus

Use the Brookfield-type viscometer, illustrated in the left column. The type of rotor and the rotational frequency is variable, and select the adequate ones suitable to the sample used.



- A: Rotational-frequency changing dial
- B: Indicator
- C: Scale
- D: Immersion mark
- E: Rotor
- F: Guard

Procedure

Attach rotor E and guard F (except that an adapter for low viscosity is used) specified in the individual monograph. Adjust rotational-frequency changing dial A to the specified frequency. Immerse rotor E slowly into the sample liquid, and adjust immersion mark D to the surface of the sample. Switch on the viscometer to rotate E. Indicator B starts to move from zero. Either when the readings of B stabilize or after the passage of the specified time, as directed in the individual monograph, stop the rotor and take reading B on scale C. To obtain the viscosity of the sample, multiply the reading by the appropriate conversion factor, given in the table, which is determined from rotor E used and the rotational frequency selected.

Hereinafter in the Monographs, such a specification as “1,500 - 2,500 mPa · s (No.2, 12 rotations, 30 seconds)” indicates that when a No.-2 rotor is used and the rotational frequency is 12 rotations/min, the viscosity observed after 30 seconds is 1,500 - 2,500 mPa · s. Also, such a specification as “30,000 - 40,000 mPa · s (No.4, 12 rotations, stable)” indicates that when a No. 4 rotor is used and the rotational frequency is 12 rotation/min, and when the reading on the scale stabilizes, the viscosity is 30,000 - 40,000 mPa · s.

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Conversion factor

Rotational frequency Rotor	60	30	12	6
Adapter	0.1	0.2	0.5	1.0
No. 1	1	2	5	10
No. 2	5	10	25	50
No. 3	20	40	100	200
No. 4	100	200	500	1000