

Viscosity Measurement Series

Constant-Temperature Baths for Viscometers

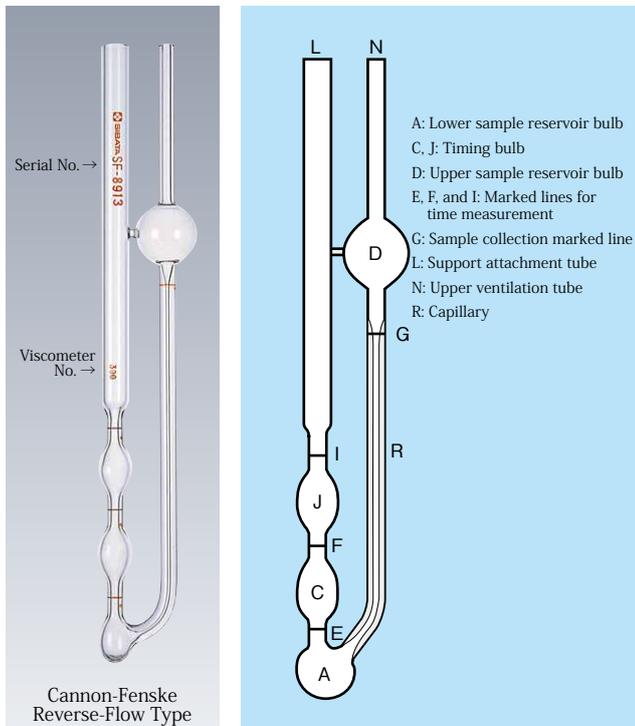
Glass Viscometers (As per JIS K 2283 3000)

Made in Japan



Along with the growth of the petrochemistry, polymer chemistry, and other industries involving viscous materials, viscosity measurements are increasingly being performed for a variety of fluids. The advanced glass manufacturing technology of SIBATA SCIENTIFIC TECHNOLOGY, Ltd. allows us to provide support for highly precise viscosity measurements.





Cannon-Fenske Reverse-Flow Type

Typical Product

Representation

* A serial No. is indicated for each viscometer.

The viscometer constant is noted on a card included with the product.

* Please note that it is not possible to manufacture a viscometer with a specified constant. We appreciate your understanding.

Viscometer-Related JIS

K2283: Crude petroleum and petroleum products—Determination of kinematic viscosity and calculation of viscosity index from kinematic viscosity

Z8803: Methods for viscosity measurement of liquid

Z8809: Standard liquids for calibrating viscometer

How to Obtain the Kinematic Viscosity

Kinematic viscosity refers to the viscosity of a fluid divided by its density under identical conditions (temperature and pressure). In terms of units, it is expressed as cm^2/s (St (stokes)) or mm^2/s (cSt (centistokes)).

When a shearing velocity (shear rate) exists within a fluid, viscosity refers to the fluid's internal resistance, indicated by the size of the shear stress produced at a surface perpendicular to this shearing velocity. In terms of units, it is expressed as $\text{Pa}\cdot\text{s}$ (10P poise) or $\text{mPa}\cdot\text{s}$ (cP (centipoise)).

Viscosity and kinematic viscosity are related as follows. (Formula (1), Formula (2))

$$\text{Kinematic viscosity } \text{mm}^2/\text{s} \text{ (cSt)} = \frac{\text{Viscosity } \text{mPa}\cdot\text{s} \text{ (cP)}}{\text{Density } (\text{g}/\text{cm}^3)} \dots \text{Formula (1)}$$

The kinematic viscosity of the target fluid is obtained by measuring the capillary tube outflow time for a fixed quantity of the fluid under identical conditions, and then using this time and the viscometer constant in the following formula.

$$\text{Kinematic viscosity } \text{mm}^2/\text{s} \text{ (cSt)} = \frac{\text{Viscometer constant}}{\text{Outflow time (sec)}} \dots \text{Formula (2)}$$

Viscometers Glass, SO, SF, SU series

Viscosity measurements are now performed for a variety of fluids, in accordance with the development of petrochemistry, polymer chemistry and other industries involving viscous materials.

With many years of experience in the manufacture of capillary tube viscometers, SIBATA has expanded the production and inspection facilities to manufacture capillary tube viscometers and constant-temperature baths for measuring viscosity. SIBATA viscometers are glass capillary tube viscometers manufactured in accordance with JIS standards, and are used to measure the kinematic viscosity of petroleum and other oils. The time for a fixed amount of fluid to flow through the capillary tube is measured under given measurement conditions, and the kinematic viscosity is obtained by multiplying that time by the viscometer constant. A wide range of kinematic viscosities can be measured using capillary tubes with different diameters, and measurements can be performed with small quantity samples.

Types

Generally, four types are widely used: Cannon-Fenske, Cannon-Fenske reverse-flow type, and Ubbelohde viscometers, Ostwald.

Cannon-Fenske (SO)	Suitable for measuring small quantity samples.	Measurement Range 0.5 to 20000 mm^2/s [cSt]	12 types
Cannon-Fenske Reverse-Flow Type (for opaque fluids) (SF)	Suitable for measuring opaque samples.	Measurement Range 0.4 to 20000 mm^2/s [cSt]	12 types
Ubbelohde (SU)	It keeps the liquid column difference always constant and offers higher accuracy than the SO and SF types.	Measurement Range 0.3 to 100000 mm^2/s [cSt]	16 types
Ostwald	Used for comparative measurements.	Capillary tube inner diameter 0.5 mm to 1.75 mm	6 types
	For PVAC	Manufactured in accordance with JIS K6725-1977.	1 types
	For PVA	Manufactured in accordance with JIS K6726-1994.	1 types

Selecting a Viscometer

Reference Example-1

When to measuring the viscosity of a fluid having a viscosity of approximately 1.24 cP at 20°C in about 500 seconds

Given a fluid density of approximately 0.79 at 20°C the following can be found from formulas ① and ②:

$$\textcircled{1} \text{ Kinematic viscosity} = \frac{1.24}{0.79} = \text{Approximately } 1.57 \text{ mm}^2/\text{s} \text{ [cSt]}$$

$$\textcircled{2} \text{ Viscometer constant} = \frac{\text{Kinematic viscosity}}{\text{Outflow time}} = \frac{1.57}{5.00} = 0.003$$

Therefore, it can be determined that the following would be appropriate:

	(item code)	(kinematic viscosity range)
Cannon-Fenske	026110-0002	0.5 to 2
Cannon-Fenske (for opaque fluids)	026120-0002	0.4 to 2
Ubbelohde	026130-0003	0.6 to 3

Reference Example-2

When measuring the viscosity of an unknown substance at 20°C

Select a similar substance from the viscosities $\text{mPa}\cdot\text{s}$ (cP) of liquid organic compounds in the viscosities of the Handbook of Chemistry-Fundamentals II.

For example, if the similar substance is ethanol:
20°C 1.19 $\text{mPa}\cdot\text{s}$ (cP) Density:0.7892

$$\text{Kinematic viscosity} = \frac{1.19}{0.7892} \approx 1.5078$$

Therefore, it can be determined that the following would be appropriate:

	(item code)	(kinematic viscosity range)
Cannon-Fenske	026110-0004	0.8 to 4
Cannon-Fenske (for opaque fluids)	026120-0004	0.8 to 4
Ubbelohde	026130-0003	0.6 to 3

■ Viscosity and Kinematic Viscosity of Distilled Water (excerpt from JIS Z8803: 2011)

Temperature °C	Viscosity mPa·s	Kinematic Viscosity mm ² /s
0	1.7906	1.7909
5	1.5185	1.5186
10	1.3064	1.3068
15	1.1378	1.1388
20	1.0016	1.0034
25	0.8899	0.8925
30	0.7970	0.8005
35	0.7189	0.7232
40	0.6524	0.6576
45	0.5960	0.6019
50	0.5469	0.5535
55	0.5043	0.5116
60	0.4668	0.4748
65	0.4338	0.4424
70	0.4045	0.4137
75	0.3784	0.3882
80	0.3550	0.3653
85	0.3340	0.3448
90	0.3150	0.3263
95	0.2977	0.3095
100	0.2821	0.2943

※ The values in this table are established with a viscosity of 1.0016 mPa·s at 20.00 °C as the standard.

■ Standard Fluids Used for Viscosity Measurement (excerpt from JIS Z8803: 2011)

(1) If the viscosity is to be measured using the comparative measurement method, the viscometer must be calibrated using a standard fluid with a known viscosity or kinematic viscosity.

(2) As standard fluids for viscosity, use the standard fluids for viscometer calibration specified in JIS Z8809, and distilled water at the temperatures shown in the table at left. The table at left shows the viscosity and kinematic viscosity of distilled water at various temperatures.

(3) For other standard fluids for viscosity, you can use fluids of which the viscosity or kinematic viscosity value is obtained by the absolute measurement method, or fluids of which the viscosity value is obtained by the comparative measurement method using distilled water.

■ Standard Fluids for Viscometer Calibration (excerpt from JIS Z8809: 2011)

Standard fluids for viscometer calibration are stipulated in JIS Z 8809. Their types and approximate values for kinematic viscosity are shown in the table. Note that the determined value for kinematic viscosity for each standard fluid is listed in the performance guarantee that is provided with the standard fluid.

Types	Kinematic Viscosity Approximate Value mm ² /s {cSt}			
	20°C	25°C	30°C	40°C
JS 2.5	2.5	—	2.1	1.8
JS 5	5.0	—	3.9	3.2
JS 10	10	—	7.4	5.7
JS 20	20	—	14	10
JS 50	50	—	32	21
JS 100	100	—	59	38
JS 200	200	—	110	66
JS 500	500	—	260	150
JS 1000	1000	—	500	270
JS 2000	2000	—	940	480
JS 14000	14000	—	5500	2400
JS 52000	52000	—	20000	8500
JS160000	160000	100000	—	—

※ 1 cm²/s {St} = 100 mm²/s {cSt}

■ Document

The image shows three overlapping document templates for SIBATA Scientific Technology Ltd. The top-left document is a 'TEST CERTIFICATE' with fields for Customer, Product Name, Serial No., and Calibration Date, and a table for Measuring Range and Result. The middle document is a 'CERTIFICATE OF TRACEABILITY' with similar fields and a section for Calibration Standards and Used Instruments. The bottom-right document is a 'TRACEABILITY CHART' showing a hierarchical flow from National Standard (National Institute of Advanced Industrial Science and Technology) through Standard Institution (JAMP, Nippon Grease Co., Ltd., Sasee-Japan Co., Ltd.), Calibration Standards (Standard Liquids for Calibrating Viscometers, Stopwatch), Calibration Instruments (Thermometer, Stopwatch), and finally to Products. All documents include the SIBATA Scientific Technology Ltd. logo and name.

Viscometer Cannon-Fenske (SO)

Manufactured in accordance with JIS K2283-2000.

With these viscometers, the viscosity is obtained by measuring the time for a fixed quantity sample (the volume between marked lines E and F) to flow out a capillary tube. They are suitable for measuring the kinematic viscosity of particularly small quantity samples. The 12 types shown in the table below enable the measurement of kinematic viscosities ranging from 0.5 mm²/s {cSt (centistokes)} to 20000 mm²/s {cSt (centistokes)}. (Constant table provided) With these viscometers, the center of the timing bulb and the sample reservoir bulb are positioned on the same central axis in order to minimize measurement errors from tilt. These viscometers are generally widely used.

Item Code	Viscometer No.	Viscometer Constant (approximate value) mm ² /s ² {cSt/s}	Kinematic viscosity measurement range mm ² /s{cSt}
026110-0002	25	0.002	0.5 to 2
-0004	50	0.004	0.8 to 4
-0008	75	0.008	1.6 to 8
-0015	100	0.015	3 to 15
-0035	150	0.035	7 to 35
-01	200	0.1	20 to 100
-025	300	0.25	50 to 250
-05	350	0.5	100 to 500
-12	400	1.2	240 to 1200
-25	450	2.5	500 to 2500
-8	500	8	1600 to 8000
-20	600	20	4000 to 20000

Viscometer Cannon-Fenske (SO)

■ Selection Procedure

- (1) From the table, select a viscometer that has an outflow time between 200 seconds (250 seconds for Cannon-Fenske viscometer No. 25) and 1,000 seconds.
- (2) See Reference Example-1 and Reference Example-2 on page 2.

■ Selecting a Viscometer

[Method of Measurement] (As per JIS K2283: 2000)

- (1) As shown in Fig. 2, insert tube N into the sample with the viscometer upside down. Apply suction through tube L so that the sample is drawn up to marked line F.
- (2) Quickly restore the viscometer to the orientation in Fig. 1. Wipe the sample off the outside of tube N. The sample will flow out and collect in sample reservoir bulb A.
- (3) Place the viscometer in the constant-temperature bath. At this point, position the viscometer so that the centers of sample reservoir bulb A, timing bulb C, and upper sample bulb D are aligned on the same straight line, and leave it to settle until the sample reaches the prescribed temperature.
- (4) Apply pressure through tube L or apply suction through tube N until the upper level of the fluid sample is approximately 5 mm above E.
- (5) Allow the sample to flow down naturally. Read out the outflow time from E to F in increments of 0.1 seconds. If the outflow time is less than 200 seconds (less than 250 seconds for viscometer No. 25) or more than 1000 seconds, choose another viscometer and repeat the procedure from step (1).

For the calculation procedure, refer to JIS K2283:2000.

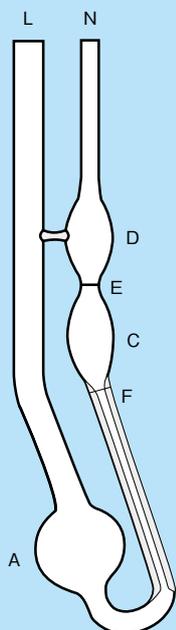


Fig. 1

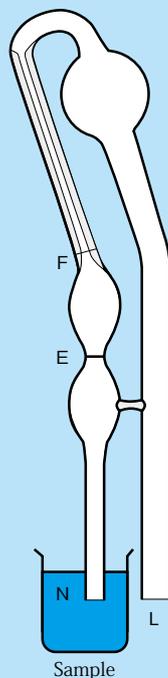


Fig. 2

Viscometer Cannon-Fenske (for opaque fluids) Reverse-Flow Type (SF)

These viscometers are generally used for kinematic viscosity measurements of opaque samples.

The 12 types shown in the table below enable the measurement of kinematic viscosities ranging from 0.4 mm²/s {cSt (centistokes)} to 20000mm²/s {cSt (centistokes)}. (Constant table provided)

With reverse-flow viscometers, the viscosity is obtained by measuring the time for the sample to flow into a timing bulb, which is provided at the lower section of the viscometer.

These viscometers are particularly suited to measurements of opaque fluids since the sample flows into a dried timing bulb. Moreover, there is no effect produced by the sample remaining on the walls inside the timing bulb, so they are also suited to viscosity measurements of high viscosity fluids.

Note that the time measurement can be made twice.

Item Code	Viscometer No.	Viscometer Constant (approximate value) mm ² /s ² {cSt/s}	Kinematic viscosity measurement range mm ² /s{cSt}
026120-0002	25	0.002	0.4 to 2
-0004	50	0.004	0.8 to 4
-0008	75	0.008	1.6 to 8
-0015	100	0.015	3 to 15
-0035	150	0.035	7 to 35
-01	200	0.1	20 to 100
-025	300	0.25	50 to 250
-05	350	0.5	100 to 500
-12	400	1.2	240 to 1200
-25	450	2.5	500 to 2500
-8	500	8	1600 to 8000
-20	600	20	4000 to 20000

■ Selection Procedure

(1) From the 12 types spanning a kinematic viscosity measurement range of 0.4 mm²/s {cSt} to 20000 mm²/s {cSt}, select an appropriate viscometer. At the same time, select a viscometer that has an outflow time between 200 seconds and 1,000 seconds.

(2) See Reference Example-1 and Reference Example-2 on page 2.

■ Selecting a Viscometer

[Method of Measurement] (As per JIS K2283: 2000)

(1) As shown in Fig. 2, insert tube N into the sample with the viscometer upside down. Apply suction through tube L so that the sample is drawn up to marked line G.

(2) Return the viscometer to the orientation shown in Fig. 1. Wipe the sample off the outside of tube N, and insert the rubber tube (about 50 mm in length).

The sample flows out of the capillary tube. When the content in sample reservoir bulb A reaches about 1/2, use a pinchcock to seal the rubber tube to prevent any further sample outflow.

(3) Position the viscometer vertically in the constant-temperature bath, so it reaches the prescribed temperature.

(4) When the settling time has elapsed, open sealed tube N. Measure the time for the sample to flow from E to F. Then read out the outflow time from F to I in increments of 0.1 seconds.

If the outflow time is less than 200 seconds or more than 1000 seconds, choose another viscometer and repeat the procedure from step (1).

For the calculation procedure, refer to JIS K2283:2000.



Viscometer Cannon-Fenske Reverse-Flow Type (SF)

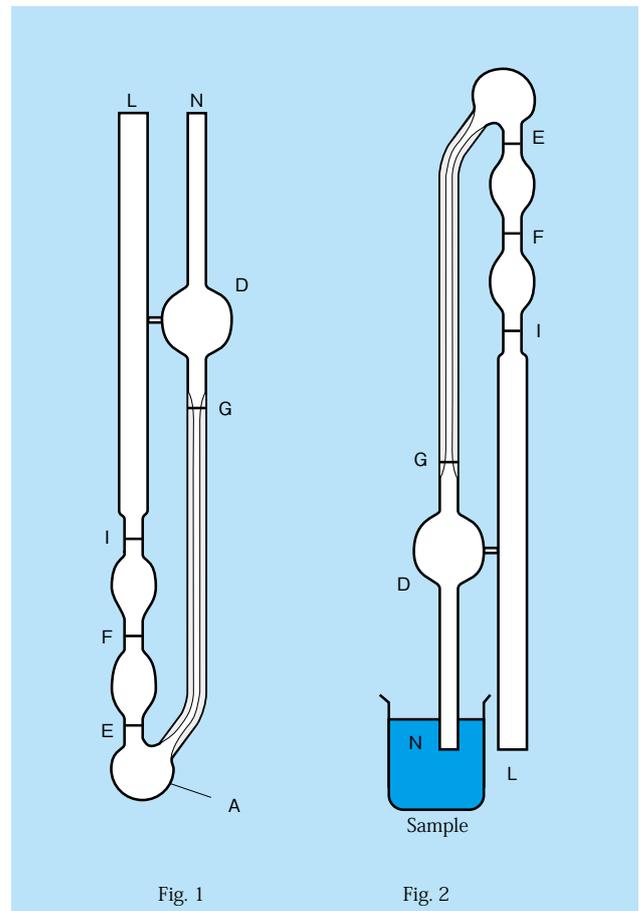


Fig. 1

Fig. 2



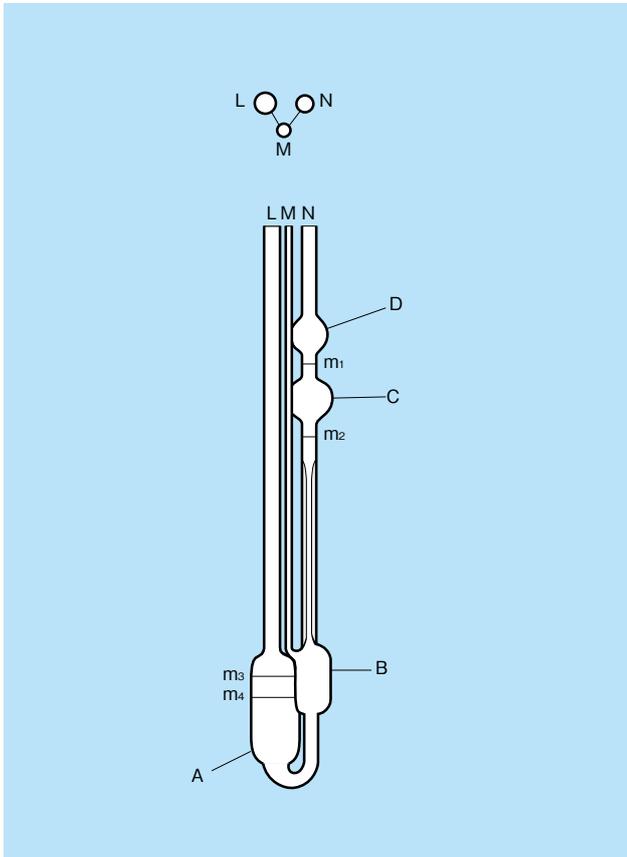
Viscometer Ubbelohde (SU)

With Ubbelohde viscometers, the viscosity is obtained by placing an appropriate quantity of the sample in the viscometer, and then measuring the time required for the sample in timing bulb C (the quantity between marked lines m_1 and m_2) to flow through the capillary tube. These are standard kinematic viscometers that do not require correction for differences in surface tension.

The 16 types shown in the table below enable the measurement of kinematic viscosities ranging from 0.3 mm²/s {cSt (centistokes)} to 100000 mm²/s {cSt (centistokes)}. (Constant table provided)

They keep the liquid column difference always constant and offer higher accuracy than the SO and SF types.

Item Code	Viscometer No.	Viscometer Constant (approximate value) mm ² /s ² {cSt/s}	Kinematic viscosity measurement range mm ² /s{cSt}
026130-0001	0	0.001	0.3 to 1
-0003	0C	0.003	0.6 to 3
-0005	0B	0.005	1 to 5
-001	1	0.01	2 to 10
-003	1C	0.03	6 to 30
-005	1B	0.05	10 to 50
-01	2	0.1	20 to 100
-03	2C	0.3	60 to 300
-05	2B	0.5	100 to 500
-1	3	1	200 to 1000
-3	3C	3	600 to 3000
-5	3B	5	1000 to 5000
-10	4	10	2000 to 10000
-30	4C	30	6000 to 30000
-50	4B	50	10000 to 50000
-100	5	100	20000 to 100000



■ Selecting a Viscometer

[Method of Measurement] (As per JIS K2283: 2000)

(1) From the 16 types spanning a kinematic viscosity measurement range of 0.3 mm²/s {cSt} to 100000 mm²/s {cSt}, select a viscometer indicating an outflow time between 200 seconds (300 seconds for Ubbelohde viscometer No. 0) and 1000 seconds.

(2) Tilt the viscometer slightly, allowing the sample to flow in through tube L until the fluid level of the sample is between marked lines m_3 and m_4 in sample reservoir bulb A. When the viscometer is positioned vertically, the fluid level must not exceed marked line m_3 due to the outflow of sample adhering to tube L. Ensure that no bubbles enter the tube connecting A and B.

(3) Position the viscometer in the constant-temperature bath, and allow it to reach the prescribed temperature.

(4) When the settling time has elapsed, close tube M with your fingers. Apply suction through tube N (or apply pressure through tube L for volatile samples), raising the sample until the upper fluid level exceeds m_1 (approximately 8 mm).

(5) Stop applying suction or pressure. Open tube M and then immediately seal tube N with your fingers. When the sample flows out of the bottom end of the capillary tube, release your fingers, and allow the sample to flow out naturally.

(6) Read out the sample outflow time from m_1 to m_2 in increments of 0.1 seconds. If the outflow time is less than 200 seconds (less than 300 seconds for viscometer No. 0) or more than 1000 seconds, choose another viscometer and repeat the procedure from step (1).

For the calculation procedure, refer to JIS K2283:2000.

Viscometer Ostwald (Relative Viscometer)

Ostwald viscometers are used for comparative measurements.

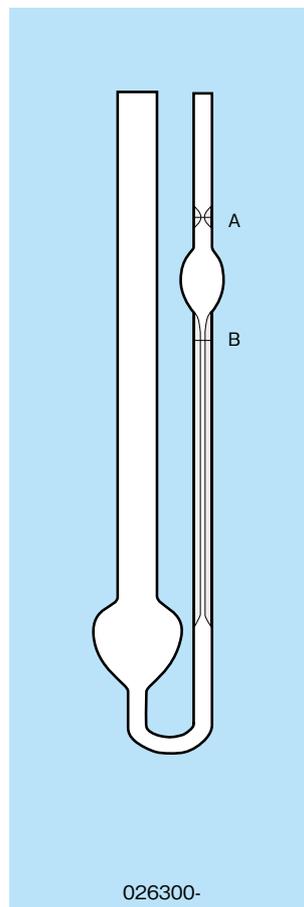
Use a pipette to place 5 mL to 8 mL (always a fixed volume) of the fluid sample in the lower bulb shown in the figure at right.

Immerse the viscometer in the viscometer temperature-constant bath so that the liquid level of the bath reaches above the marked line A. Apply suction until the fluid sample is above marked line A. Then allow it to flow down naturally. Measure the time taken by the fluid sample to flow down from marked line A to B through the capillary tube. Using the same procedure, measure a standard fluid of known viscosity, being careful that the volume of fluid placed in the lower bulb is identical.

- Types no. 1 to 6 are available with different capillary tube diameters.
- These are relative viscometers for comparative measurements. The bulb capacity is approximately 3mL.

Item Code	Viscometer No.	Capillary Tube Inner Diameter (approximate) mm
026300-1	1	0.5
-2	2	0.75
-3	3	1
-4	4	1.25
-5	5	1.5
-6	6	1.75

Note: No measured viscometer constant is provided, so kinematic viscosity measurements are impossible with these viscometers.



Viscometer Ostwald for Polyvinyl Acetate(PVAC)

10 mL of the sample is placed in the Ostwald viscometer. The viscometer is then immersed in a constant-temperature bath at 30 ± 0.1 °C and is used to measure the relative viscosity with respect to benzene at the same temperature. The outflow time for water at 30 °C is 120 ± 20 seconds.

- Capillary tube inner diameter: 0.48 to 0.52 mm
- Manufactured in accordance with JIS K6725-1977.

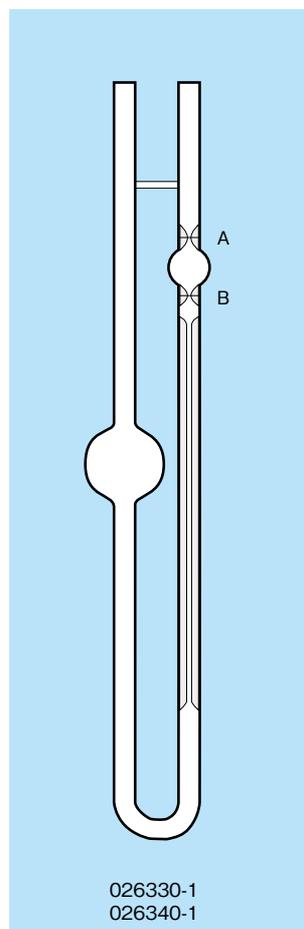
Item Code	Product Name	Applications
026330-1	Viscometer Ostwald	For PVAC

Viscometer Ostwald for Polyvinyl Alcohol(PVA)

10 mL of the sample is placed in the Ostwald viscometer. The viscometer is then immersed in a constant-temperature bath at 30 ± 0.1 °C and is used to measure the relative viscosity with respect to water at the same temperature. The outflow time for water at 30 °C is 100 ± 20 seconds.

- Capillary tube inner diameter: 0.57 to 0.60 mm
- Manufactured in accordance with JIS K6726-1994.

Item Code	Product Name	Applications
026340-1	Viscometer Ostwald	For PVA





VB-3T Water Bath for Viscometers with 6 Suspension Clamps (With Timer)

This water bath can be used for measuring kinematic viscosity using Cannon-Fenske, Cannon-Fenske reverse-flow type, Ubbelohde, and Ostwald viscometers.

Features

- This constant-temperature bath provides highly accurate temperature control, thanks to a high resolution digital temperature controller and propeller pump.
- Three stopwatches are built in.
- A total of six viscometers, four Cannon-Fenske and two Ubbelohde, can be suspended inside.
- It can offer stable temperature control even at close to room temperature, with the cooling pipe provided inside the bath. (A separate cool water circulator is required.)
- For information on glass viscometers, see page 2-7.

Spare Parts

Item Code	Product Name	Applications
051260-0301	Viscometer mounting bracket (3 holes)	For Ubbelohde
-0302	Viscometer mounting bracket (2 holes)	For Cannon-Fenske, Ostwald



Specifications

Item code	051260-031	
Model	VB-3T	
Number of viscometers suspendable	6	
Temperature settings range	From room temperature to 85 °C*1	
Operating ambient temperature	+5°C to +35°C	
Accuracy of temperature control	±0.1°C (when used in constant temperature room)	
Accuracy of temperature distribution	±0.1°C (when used in constant temperature room)	
Temperature adjustment method	Main heater	Digital temperature indicating controller (PID control method) Display resolution: 0.01°C
	Sub-heater	Liquid expansion type temperature controller (ON/OFF)
Heater	Main heater	300 W × 2, SUS316L
	Sub-heater	300 W × 2, SUS316L
Agitation motor	Induction motor, 4-pole, 15W	
Temperature sensor	Pt100Ω	
Thermometer	100°C in 1/10°C graduations**2	
Stopwatches	Number of measured CH	3 channels (2-mode type)
	Display method	LED, 5 digits
	Measurement range	0~9999.9 sec
Drain bulb	Nozzle outer diameter, 10.5 mm	
Cold water supply port	Nozzle outer diameter, 10.5 mm	
Unit protection functions	Earth leakage breaker, overheat protection	
Accessories	1 glass rod thermometer**2、 1 thermometer holder,	
	Viscometer mounting brackets (3 holes × 2, 2 holes × 4)	
Dimensions	Bath	335 (W) × 180 (D) × 315 (H) mm, Approx. 19 L
	Main Unit	530 (W) × 225 (D) × 420 (H) mm (excluding protrusions and motor)
Weight	Approx. 23 kg	
Power Supply	100 V AC 50/60 Hz, 14 A	

*1: If the temperature to which to adjust is near room temperature, a separate cool water circulator needs to be connected.

*2: The purpose of this thermometer is for checking the temperature of the water bath for viscometers alone. If necessary, a separate JIS standard thermometer should be acquired.

Note 1: This product is not explosion-proof.

Note 2: The specifications and external appearance of this product are subject to change without notice in the interest of product improvement.

Viscometer Storage Case



This wooden storage case is designed to organize and store Cannon-Fenske, Cannon-Fenske reverse-flow type, and Ubbelohde viscometers. Four viscometers can be packed into a single case.

Item Code	Number Storable	Specifications
026880-01	4	One level, with cover

Specifications, and appearance described in this document are based on information as of January 18, 2017. They are subject to change without notice for improvement of the product.

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