Instructions for the use of
The Cannon-Fenske Opaque (Reverse-Flow) Viscometer

See also ASTM D 445, D 2170, D 446 and ISO 3105

1. Clean the viscometer using suitable solvents, and dry by passing clean, dry, filtered air through the instrument to remove the final traces of solvents. Periodically, traces of organic deposits should be removed with chromic acid or non-chromium cleaning solution.
2. If there is a possibility of lint, dust, or other solid material in the liquid sample, filter the sample through a fritted glass filter or fine mesh screen.
3. To charge the sample into the viscometer, invert the instrument and apply suction to tube L, immersing tube N in the liquid sample, and draw liquid to mark G. Wipe clean arm N, and turn the instrument to its normal vertical position.
4. Place the viscometer into the holder, and insert it into the constant temperature bath. A viscometer holder which fits the Cannon-Fenske Routine viscometer and the Cannon-Manning Semi-Micro viscometer will also fit the Cannon-Fenske Opaque viscometer. Align the viscometer vertically in the bath by means of a small plumb bob in tube L, if a self-aligning holder has not been used.
5. Allow sample to flow through capillary tube R and approximately half-fill bulb A, stopping the meniscus in bulb B by placing rubber stopper in tube N.
6. Allow approximately 10 minutes for the sample to come to bath temperature at 40°C and 15 minutes at 100°C. Make sure the meniscus in bulb B does not reach line E.
7. Remove the rubber stopper and allow the meniscus to travel upwards into bulbs C and D. Using two clocks, measure the efflux times for the meniscus to pass from mark E to mark F, and from mark F to mark I.
8. Calculate the kinematic viscosity of the sample by multiplying the efflux time in seconds for each bulb by the viscometer constant for each bulb.
9. Repeat measurement can be made by repeating steps 1 thru 8.

Cannon-Fenske (Reverse-Flow) Viscometer for Opaque and Transparent Liquids

RECOMMENDED VISCOSITY RANGES FOR THE CANNON-FENSKE OPAQUE VISCOMETERS

Size	Kinematic Viscosity Range mm^2/s^2, (cSt/s)			mm^2/s, (cSt)
25	0.002	0.5	to	2
50	0.004	0.8	to	4
75	0.008	1.6	to	8
100	0.015	3	to	15
150	0.035	7	to	35
200	0.1	20	to	100
300	0.25	50	to	250
350	0.5	100	to	500
400	1.2	240	to	1200
450	2.5	500	to	2500
500	8	1600	to	8000
600	20	4000	to	20000
650	45	9000	to	45000
700	100	20000	to	100000

The expanded uncertainty[1] with 95% confidence of the calibration measurements relative to the primary standard is as follows:

Range of Viscosity mm^2/s	Combined Expanded Uncertainty
< 10	0.16%
10 – 100	0.22%
100 – 1000	0.29%
1000 – 10000	0.38%
10000 - 100000	0.44%

The assigned uncertainty of the primary viscosity standard at 20°C is ± 0.17%. See ISO 3666.

[1] An expanded uncertainty U is determined by multiplying the combined standard uncertainty u_c by a coverage factor k: $U = ku_c$, where k = 2. See NIST Technical Note 1297, 1994 edition, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results.*

THIS PRODUCT WAS CALIBRATED WITHIN A QUALITY SYSTEM WHICH IS REGISTERED TO ISO 9001:2000.

CANNON INSTRUMENT COMPANY ®

Certificate of Calibration

Viscometer No. 300 935A

ACCREDITED

Certificate # 1262.01[1]

1262.01

The inclusion of the A2LA logo does not imply certification/approval of the products calibrated or tested.

CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2393	0.1735
Viscometer Constant at 100°C	0.2409	0.1748

The viscometer constant at other temperatures can be obtained by interpolation or extrapolation. To obtain kinematic viscosity in mm^2/s (cSt) multiply the efflux time in seconds by the viscometer constant. To obtain viscosity in mPa·s (cP), multiply the kinematic viscosity in mm^2/s (cSt) by the density in grams per milliliter.

The above constants assume a value for the coefficient of thermal expansion typical to that for mineral oil, and that the viscometer was filled with test sample at room temperature. If the filling temperature T_F is substantially different than room temperature, the viscometer constant at test temperature T_T is $C_o (1 + B [T_T - T_F])$. The values of C_o and B shown below are based on a coefficient of thermal expansion typical to that for a mineral oil.

Kinematic viscosities of the standards used in calibrating were established in Master Viscometers as described in Ind. Eng. Chem. Anal. Ed. 16,708(1944), ASTM D2162, and the Journal of Research of the National Bureau of Standards, Vol. 52, No. 3, March 1954, Research Paper 2479. Kinematic viscosities are based on the primary viscosity standard, water, at 20°C (ITS-90). The internationally accepted value for the viscosity of water at 20°C (ITS-90) is 1.0016 mPa·s or kinematic viscosity is 1.0034 mm^2/s as listed in ISO 3666. The gravitational constant, g, is 980.1 cm/sec^2 at the Cannon Instrument Company. The gravitational constant varies up to 0.1% in the United States. To make this small correction in the viscometer constant, multiply the above viscometer constant by the factor [g (at your laboratory) / 980.1]. The calibration data below are traceable to the National Institute for Standards and Technology. Temperature measurement traceable to NIST (SPRT Test No. available).

CALIBRATION DATA AT 40°C

Viscosity Standard	Kinematic Viscosity mm^2/s, (cSt)	Efflux time, Seconds C	D	Constant, mm^2/s^2, (cSt/s) C	D
160	67.66	282.87	390.39	0.2392	0.1733
1100	128.0	534.35	737.18	0.2395	0.1736

Room Temp. (approx.)	23	°C.			Average =	0.2393	0.1735
Charge (approx.)	11.8	ml.			C_o =	0.2389	0.1731
Driving fluid head (approx.)	15.3	cm for C,	11.2	cm for D.	B =	109	128 x 10^{-6}/°C,
Working diameter of upper reservoir	2.6	cm for C,	2.8	cm for D.			
Constant at 100° C. is	0.65	% for C,	0.77	% for D higher than at 40°C.			

Calibrated by RMB on 11/12/04 under supervision of

Please note: This calibration remains valid for 10 years unless (1) the viscometer has been damaged or (2) materials which chemically attack borosilicate glass (e.g., hydrofluoric acid or highly alkaline solutions) have been used. Nonetheless, it is recommended that the calibration be verified with kinematic viscosity standards periodically; if a change in calibration is indicated, carefully examine all sources of error, including especially temperature measurement since most apparent changes in calibration of the viscometer are due to errors in temperature measurement.

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Test No.: 111004 - 3

The S.I. unit of kinematic viscosity is 1 meter squared per second, and is equal to 10^4 stokes. The S.I. unit of viscosity is 1 pascal second, and is equal to 10 poises. One centistokes is equal to one millimeter squared per second.

CANNON INSTRUMENT COMPANY

Certificate of Calibration

Viscometer No. 300 937A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

A2LA ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2399	0.1727
Viscometer Constant at 100°C	0.2414	0.1740

Viscometer No. 300 934A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2333	0.1702
Viscometer Constant at 100°C	0.2349	0.1716

INSTRUMENT COMPANY

Viscometer No. 300 723A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2828	0.1911
Viscometer Constant at 100°C	0.2847	0.1926

Viscometer No. 300 935A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2393	0.1735
Viscometer Constant at 100°C	0.2409	0.1748

INSTRUMENT COMPANY

Viscometer No. 300 722A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2406	0.1683
Viscometer Constant at 100°C	0.2423	0.1697

INSTRUMENT COMPANY

Viscometer No. 300 714A

1262.01

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CANNON-FENSKE (REVERSE FLOW) TYPE FOR OPAQUE LIQUIDS
(Standard Test ASTM D 445 and 3104)

ACCREDITED

Certificate # 1262.01[1]

	Constant, mm^2/s^2, (cSt/s) C	D
Viscometer Constant at 40°C	0.2813	0.2449
Viscometer Constant at 100°C	0.2832	0.2468