

CANNON® GLASS CAPILLARY VISCOMETERS



 **CANNON**
INSTRUMENT COMPANY®

CANNON® GLASS CAPILLARY VISCOMETERS SIZE, RANGES, & EXPANDED UNCERTAINTY



Glass Capillary Viscometers

Why does CANNON offer so many different types of glass capillary viscometers? Primarily because no single capillary viscometer is ideally suited for all kinematic viscosity determinations. Individual analysts also have their own preferences. The brief descriptions on the following page may assist you in determining which viscometer is most appropriate for your particular application. Feel free to contact CANNON with your questions. Our experienced staff will be happy to assist you.

Expanded Uncertainty

Instead of listing the precision of our glass capillary viscometers, we now provide the expanded uncertainty. This is the universally accepted statistic when dealing with calibration data. In order to maintain A2LA accreditation, we are required to determine and specify the expanded uncertainty for all our calibration data.

ISO publications define expanded uncertainty as "quantity defining the interval about the result of a measurement within which the values that could reasonably be attributed to the measurement may be expected to lie with a high level of confidence."

Our use of expanded uncertainty instead of precision does not reflect any change in the accuracy or quality of our viscometers. It is a statistical term that is more comprehensive than precision. When comparing the accuracy of viscometers it is essential that the expanded uncertainty be specified.

A certificate specifying the expanded uncertainty is provided with every calibrated viscometer. We also provide such a certificate with every bottle of viscosity standard.

Specifications for CANNON® Viscometers

Table 1

Cannon-Fenske,
Cannon-Ubbelohde, and
Cannon-Ubbelohde Dilution
Viscometers

Size	Approx. constant, cSt/s	Range centistokes*
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 20 000
650	45	9000 to 45 000
700	100	20 000 to 100 000

* Ranges in centistokes represent flow times of 250 to 1000 seconds for Size 25, and 200 to 1000 for all other sizes.

Table 2

Ubbelohde Viscometers

Size	Approx. constant, cSt/s	Range centistokes*
0	0.001	0.3 to 1
0C	0.003	0.6 to 3
0B	0.005	1 to 5
1	0.01	2 to 10
1C	0.03	6 to 30
1B	0.05	10 to 50
2	0.1	20 to 100
2C	0.3	60 to 300
2B	0.5	100 to 500
3	1.0	200 to 1000
3C	3.0	600 to 3000
3B	5.0	1000 to 5000
4	10	2000 to 10 000
4C	30	6000 to 30 000
4B	50	10 000 to 50 000
5	100	20 000 to 100 000

* Ranges in centistokes represent flow times of 300 to 1000 seconds for Size 0, and 200 to 1000 seconds for all other sizes.

CANNON® GLASS CAPILLARY VISCOMETERS TYPES & APPLICATIONS

Cannon-Fenske Routine

The Cannon-Fenske Routine viscometer (page 4) is a rugged and inexpensive viscometer that works well if the liquid to be measured is transparent or translucent. In general, if the meniscus (the curvature at the top of the liquid column) can be readily observed through a column of liquid 3-mm in diameter, the Cannon-Fenske Routine viscometer and other transparent-type viscometers (such as the Zeitfuchs Transparent {page 9} and BS/U-Tube {page 11} viscometers) can be used.

Ubbelohde

The Ubbelohde viscometer (page 5) and other suspended level viscometers are also used to measure transparent liquids. Unlike the Cannon-Fenske Routine viscometer, suspended level viscometers possess the same viscometer constant at all temperatures. This property is advantageous when measurements are to be made at a number of different temperatures. CANNON has improved the design of the Ubbelohde viscometer to make a more rugged instrument called the Cannon-Ubbelohde viscometer (pages 5-6). Other suspended level viscometers in this catalog include the BS/IP/SL, BS/IP/SL(S), and BS/IP/MSL viscometers (pages 12-13).

CANNON offers many types of glass capillary viscometers that are not listed in our catalog. Examples include Atlantic, Cannon Master and Ubbelohde Master, Cannon-Ubbelohde Filter-Stick Dilution, Fitzsimons, Lantz-Zeitfuchs, Methylcellulose, SIL, and other viscometers. We can also manufacture glass capillary viscometers with customer-specified constants. Please contact CANNON for order information.

Reverse Flow Viscometers

Special reverse flow viscometers have been designed for testing opaque liquids. Reverse flow viscometers wet the timing section of the viscometer capillary only during the actual measurement. The Cannon-Fenske Opaque (page 4), Zeitfuchs Cross-Arm (page 10), and BS/IP/RF U-Tube viscometers (page 13) are all reverse flow types. Reverse flow viscometers must be cleaned, dried, and refilled before a repeat measurement can be made. By contrast, other viscometer types commonly used to measure transparent liquids allow the same sample to be repeatedly drawn up into the capillary, permitting multiple measurements for verification.

Small Volume Viscometers

In some situations, such as in a clinical laboratory, the amount of liquid available for measurement is quite small. Several viscometers have been designed which require one milliliter or less of liquid. These are referred to as semi-micro or micro viscometers. The Cannon-Manning Semi-Micro (page 8) is a U-tube viscometer that has been modified to measure the kinematic viscosity of samples as small as 1.0 mL. The Cannon-Ubbelohde Semi-Micro viscometer (page 6) is a modification of the standard size Cannon-Ubbelohde viscometer requiring a sample volume of only one milliliter. The Cannon-Manning Semi-Micro Extra Low Change viscometer (page 8) will permit kinematic viscosity determination with as little as 0.5 milliliters of sample.

Dilution Viscometers

Estimates of the molecular size and shape of large polymer molecules can be obtained from kinematic viscosity measurements of dilute solutions of the polymers. The Cannon-Ubbelohde Dilution viscometer (page 6) has an extra-large reservoir which allows polymer solutions to be diluted several times. Dilute polymer solutions frequently appear to exhibit changes in kinematic viscosity when the shear rate is changed. By using the Cannon-Ubbelohde Four-Bulb Shear Dilution viscometer (page 7), measurements can be made at four different shear rates.

Vacuum Viscometers

In most glass capillary viscometers, the samples flow under gravity. When liquids are too viscous to flow readily under gravity, vacuum viscometers may be used to measure viscosity (in mPa·s or cP). In these instruments a vacuum is applied to one end of the viscometer to pull the liquid through the capillary into the timing bulb(s). CANNON offers several types of vacuum viscometers, including the Cannon-Manning Vacuum (page 14), the Asphalt Institute Vacuum (page 14), and the Modified Koppers Vacuum (page 15). Like the Cannon-Fenske Opaque viscometer, these are all "reverse flow" viscometers. Vacuum viscometers require a vacuum that is very accurately controlled. The CANNON DVR-1000 or DVR-1500 Digital Vacuum Regulator is an ideal instrument for maintaining constant vacuum.

ROUTINE & OPAQUE CANNON-FENSKE VISCOMETERS



9721-A50 Series
9721-B50 Series

CANNON-FENSKE ROUTINE VISCOMETERS

Calibrated CFRC Series

For measuring kinematic viscosity of transparent Newtonian liquids, particularly petroleum products or lubricants, according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 7 mL. Require liquid bath depth of 203 mm (8 inches).
- Constants and ranges are as specified in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.
- Viscometers with special constants are available by special order at additional cost.

Uncalibrated CFRU Series

Similar to 9721-B50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.

Size	Uncalibrated CFRU Series	Calibrated CFRC Series
25	9721-A50	9721-B50
50	9721-A53	9721-B53
75	9721-A56	9721-B56
100	9721-A59	9721-B59
150	9721-A62	9721-B62
200	9721-A65	9721-B65
300	9721-A68	9721-B68
350	9721-A71	9721-B71
400	9721-A74	9721-B74
450	9721-A77	9721-B77
500	9721-A80	9721-B80
600	9721-A83	9721-B83
650	9721-A86	9721-B86
700	9721-A89	9721-B89



9721-E50 Series
9721-F50 Series

CANNON-FENSKE OPAQUE VISCOMETERS

Reverse-flow type for dark liquids

Calibrated CFOC Series

Reverse-flow type, for measurement of kinematic viscosity of dark Newtonian liquids according to ASTM D 445 and ISO 3104. Permit measurements of liquids whose meniscus cannot be seen at the timing marks when using Cannon-Fenske Routine-type viscometer. Used to measure kinematic viscosity of liquid (cutback) asphalts and road oils at 60°C (140°F) in range of 30 to 6000 centistokes according to ASTM D 2170. Also used to study lubricating oils at low temperatures when investigating the effect of various additives on lubricating and hydraulic oils. External pressure can be applied to vary shear stress and shear rate. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 12 mL. Require liquid bath depth of 229 mm (9 inches).
- Size 25 has approximate constant 0.002 cSt/s and range of 0.4 to 2 cSt. Constants and ranges for other sizes are as given in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.
- For replacement micro stoppers, see 9726-N98 on page 15.
- Viscometers with special constants are available by special order at additional cost.

Uncalibrated CFOU Series

Similar to 9721-F50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.

Size	Uncalibrated CFOU Series	Calibrated CFOC Series
25	9721-E50	9721-F50
50	9721-E53	9721-F53
75	9721-E56	9721-F56
100	9721-E59	9721-F59
150	9721-E62	9721-F62
200	9721-E65	9721-F65
300	9721-E68	9721-F68
350	9721-E71	9721-F71
400	9721-E74	9721-F74
450	9721-E77	9721-F77
500	9721-E80	9721-F80
600	9721-E83	9721-F83
650	9721-E86	9721-F86
700	9721-E89	9721-F89

SUSPENDED LEVEL UBBELOHDE VISCOMETERS



9721-N50 Series
9721-R50 Series
9721-U50 Series

UBBELOHDE VISCOMETERS Calibrated UBC Series

For measurement of kinematic viscosity of transparent Newtonian liquids by suspended level principle as described in ASTM D 445 and D 446, and ISO 3104 and 3105. Similar to Cannon-Ubbelohde but less rugged in design.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 11 mL. Require liquid bath depth of 241 mm (9.5 inches).
- Constants and ranges are as specified in Table 2 on page 2.
- Holder is not supplied. For holder, see 9726-M82 on page 15.

Uncalibrated UBU Series

Similar to 9721-R50 series, but uncalibrated.

- Holder is not supplied. For holder, see 9726-M82 on page 15.

Ubbelohde Unity Factor Calibrated UBXC Series

Similar to 9721-R50 series, but with constant within $\pm 0.2\%$ of values listed in Table 2 on page 2. Provided with certificate of calibration and instruction sheet.

- Holder is not supplied. For holder, see 9726-M82 on page 15.

Size	Uncalibrated UBU Series	Calibrated UBC Series	Calibrated UBXC Series
0	9721-N50	9721-R50	9721-U50
0C	9721-N53	9721-R53	9721-U53
0B	9721-N56	9721-R56	9721-U56
1	9721-N59	9721-R59	9721-U59
1C	9721-N62	9721-R62	9721-U62
1B	9721-N65	9721-R65	9721-U65
2	9721-N68	9721-R68	9721-U68
2C	9721-N71	9721-R71	9721-U71
2B	9721-N74	9721-R74	9721-U74
3	9721-N77	9721-R77	9721-U77
3C	9721-N80	9721-R80	9721-U80
3B	9721-N83	9721-R83	9721-U83
4	9721-N86	9721-R86	9721-U86
4C	9721-N89	9721-R89	9721-U89
4B	9721-N92	9721-R92	9721-U92
5	9721-N95	9721-R95	9721-U95

Size	Uncalibrated CUU Series	Calibrated CUC Series
25	9721-J50	9721-K50
50	9721-J53	9721-K53
75	9721-J56	9721-K56
100	9721-J59	9721-K59
150	9721-J62	9721-K62
200	9721-J65	9721-K65
300	9721-J68	9721-K68
350	9721-J71	9721-K71
400	9721-J74	9721-K74
450	9721-J77	9721-K77
500	9721-J80	9721-K80
600	9721-J83	9721-K83
650	9721-J86	9721-K86
700	9721-J89	9721-K89



9721-J50 Series
9721-K50 Series

CANNON-UBBELOHDE VISCOMETERS

Calibrated CUC Series

Suspended level viscometer for measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Also used for evaluating jet and hydraulic lubricants. Especially suited for use at temperatures above 93°C (200°F) or below -18°C (0°F). Require no kinetic energy corrections over 0.5 to 100 000 centistokes range. Viscometer constant is same at all temperatures. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 11 mL. Require liquid bath depth of 254 mm (10-inches); must be submerged to approximately 220 mm (8.5-inches).
- Constants and ranges are as specified in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Uncalibrated CUU Series

Similar to 9721-K50 series, but uncalibrated.

Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

SEMI-MICRO & DILUTION CANNON-UBBELOHDE VISCOMETERS



9722-G50 Series
9722-H50 Series

CANNON-UBBELOHDE SEMI-MICRO VISCOMETERS

Semi-Micro Calibrated CUSMC Series

For measuring kinematic viscosity of small samples of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105. Viscometer constant is same at all temperatures.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume approximately 1.0 mL. Sizes 400 through 600 may require larger sample volume. Initial sample can be diluted to as much as 20 mL for intrinsic viscosity determinations. Require liquid bath depth of 240 mm (9.5 inches).
- Size 25 has approximate constant 0.002 cSt/s and a range of 0.4 to 2 cSt. Constants and ranges for all other sizes are as given in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Semi-Micro Uncalibrated CUSMU Series

Similar to 9722-H50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

	Uncalibrated CUSMU Series	Calibrated CUSMC Series
Size		
25	9722-G50	9722-H50
50	9722-G53	9722-H53
75	9722-G56	9722-H56
100	9722-G59	9722-H59
150	9722-G62	9722-H62
200	9722-G65	9722-H65
300	9722-G68	9722-H68
350	9722-G71	9722-H71
400	9722-G74	9722-H74
450	9722-G77	9722-H77
500	9722-G80	9722-H80
600	9722-G83	9722-H83

	Uncalibrated CUDU Series	Calibrated CUDC Series
Size		
25	9722-L50	9722-M50
50	9722-L53	9722-M53
75	9722-L56	9722-M56
100	9722-L59	9722-M59
150	9722-L62	9722-M62
200	9722-L65	9722-M65
300	9722-L68	9722-M68
350	9722-L71	9722-M71
400	9722-L74	9722-M74
450	9722-L77	9722-M77
500	9722-L80	9722-M80
600	9722-L83	9722-M83



9722-L50 Series
9722-M50 Series

CANNON-UBBELOHDE DILUTION VISCOMETERS

Dilution Type Calibrated CUDC Series

For measurement of intrinsic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105. Viscometer constant is same at all temperatures.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume of 8 mL can be diluted to 40 mL. Require liquid bath depth of 305 mm (12 inches). The CANNON CT-500 bath is recommended.
- Constants and ranges are as specified in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Dilution Type Uncalibrated CUDU Series

Similar to 9722-M50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

CANNON-UBBELOHDE FOUR-BULB SHEAR DILUTION VISCOMETERS



9723-L50 Series
9723-M50 Series
9723-N50 Series

CANNON-UBBELOHDE FOUR-BULB SHEAR DILUTION VISCOMETERS

Five-fold dilution type

Calibrated CUSDC-11 Series

For measurement of intrinsic viscosities extrapolated to zero shear rate. Provide five-fold range of shear rates. Design gives extra mechanical strength. Negligible kinetic energy correction.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 20 mL. Require liquid bath depth of 280 mm (11 inches).
- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Uncalibrated CUSDU-11 Series

Similar to 9723-M50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Ten-fold dilution type

Calibrated CUSDC-17 Series

Similar to 9723-M50 series, but provide ten-fold range of shear rates.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 20 mL. Require liquid bath depth of 430 mm (17 inches). The CT-518 bath is recommended.
- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Uncalibrated CUSDU-17 Series

Similar to 9723-R50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M70, -M73, and -M76 on page 15.

Specifications for Ten-fold Dilution Type

Size	Approx. constant, cSt/s	*Range cSt	Shear rate at wall, reciprocal seconds
25	0.002	0.4 to 2	82 to 3300
50	0.004	0.8 to 4	45 to 1800
75	0.008	1.6 to 8	24 to 960
100	0.015	3 to 15	15 to 600
150	0.035	7 to 35	8 to 320

* Ranges in centistokes represent flow times of 200 to 1000 seconds.

Size	Uncalibrated CUSDU-11 Series	Calibrated CUSDC-11 Series
25	9723-L50	9723-M50
50	9723-L53	9723-M53
75	9723-L56	9723-M56
100	9723-L59	9723-M59
150	9723-L62	9723-M62

Specifications for Five-fold Dilution Type

Size	Approx. Constant, cSt/s	*Range cSt	Shear rate at wall, reciprocal seconds
25	0.002	0.4 to 2	82 to 1650
50	0.004	0.8 to 4	45 to 900
75	0.008	1.6 to 8	24 to 480
100	0.015	3 to 15	15 to 300
150	0.035	7 to 35	8 to 160

* Ranges in centistokes represent flow times of 200 to 1000 seconds.

Size	Uncalibrated CUSDU-17 Series	Calibrated CUSDC-17 Series
25	9723-N50	9723-R50
50	9723-N53	9723-R53
75	9723-N56	9723-R56
100	9723-N59	9723-R59
150	9723-N62	9723-R62

CANNON-MANNING SEMI-MICRO LOW CHARGE VISCOMETERS



9721-X50 Series
9721-Y50 Series

CANNON-MANNING SEMI-MICRO VISCOMETERS

Calibrated CMSMC Series

For measurement of kinematic viscosity of small samples of transparent Newtonian liquids, including petroleum products or lubricants, according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Sample volume approximately 1.0 mL. Sizes 400 through 600 may require more sample. Require liquid bath depth of 200 mm (8 inches).
- Size 25 has approximate constant 0.002 cSt/s and a range of 0.4 to 2 cSt. Constants and ranges for all other sizes are as given in Table 1 on page 2.
- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.

Uncalibrated CMSMU Series

Similar to 9721-Y50 series, but uncalibrated.

- Holder is not supplied. For holders, see 9726-M50 and -M53 on page 15.

Size	Uncalibrated CMSMU Series	Calibrated CMSMC Series
25	9721-X50	9721-Y50
50	9721-X53	9721-Y53
75	9721-X56	9721-Y56
100	9721-X59	9721-Y59
150	9721-X62	9721-Y62
200	9721-X65	9721-Y65
300	9721-X68	9721-Y68
350	9721-X71	9721-Y71
400	9721-X74	9721-Y74
450	9721-X77	9721-Y77
500	9721-X80	9721-Y80
600	9721-X83	9721-Y83

Size	Uncalibrated CMSMEU Series	Calibrated CMSMEC Series
25	9722-C50	9722-D50
50	9722-C53	9722-D53
75	9722-C56	9722-D56
100	9722-C59	9722-D59
150	9722-C62	9722-D62
200	9722-C65	9722-D65
300	9722-C68	9722-D68
350	9722-C71	9722-D71
400	9722-C74	9722-D74
450	9722-C77	9722-D77
500	9722-C80	9722-D80
600	9722-C83	9722-D83



9722-C50 Series
9722-D50 Series

CANNON-MANNING SEMI-MICRO EXTRA LOW CHARGE VISCOMETERS

Extra Low Charge Calibrated CMSMEC Series

Similar to 9721-Y50 series, but require smaller sample volume of approximately 0.5 mL. Sizes 200 through 600 may require larger volume of sample.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Without holder.

Extra Low Charge Uncalibrated CMSMEU Series

Similar to 9722-D50 series, but uncalibrated.

- Without holder.

CANNON® ZEITFUCHS VISCOMETERS



9723-A50 Series
9723-B50 Series

ZEITFUCHS® TRANSPARENT VISCOMETERS

With permanently attached round metal holder

Calibrated ZTC-RO Series

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105. Filling, measurement, and cleaning can be done without removal from constant temperature bath.

Certificate of calibration and instruction sheet provided. See page 2 for expanded uncertainty.

- Minimum sample volume 15 mL. Require liquid bath depth of 292 mm (11.5 inches).
- For constants and ranges, see table at right.
- Manufactured with permanently attached round metal holder, for hole 51 mm (2 inches) in diameter.

Uncalibrated ZTU-RO Series

Similar to 9723-B50 series, but uncalibrated.



9723-C50 Series
9723-D50 Series

With permanently attached rectangular metal holder

Calibrated ZTC-RE Series

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105. Filling, measurement, and cleaning can be done without removal from constant temperature bath.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 15 mL. Require liquid bath depth of 292 mm (11.5 inches).
- For constants and ranges, see table (above right).
- Manufactured with permanently attached rectangular metal holder which requires a bath opening of 25 x 48 mm (1 x 1.9 inches).

Calibrated ZTU-RE Series

Similar to 9723-D50 series, but uncalibrated.

Specifications for Zeifuchs® Transparent* & Zeifuchs® Cross-Arm Viscometers

Size	Approximate constant, cSt/s	Viscosity, cSt†
1	0.003	0.6 to 3
2	0.01	2 to 10
3	0.03	6 to 30
4	0.1	20 to 100
5	0.3	60 to 300
6	1.0	200 to 1000
7	3.0	600 to 3000
8	10	2000 to 10 000
9	30	6000 to 30 000
10	100	20 000 to 100 000

* Zeifuchs Transparent viscometers are available only in sizes 1 through 7.

† Ranges in centistokes represent flow times of 200 to 1000 seconds.

Size	Uncalibrated ZTU-RO Series	Calibrated ZTC-RO Series
1	9723-A50	9723-B50
2	9723-A55	9723-B55
3	9723-A60	9723-B60
4	9723-A65	9723-B65
5	9723-A70	9723-B70
6	9723-A75	9723-B75
7	9723-A80	9723-B80

Size	Uncalibrated ZTU-RE Series	Calibrated ZTC-RE Series
1	9723-C50	9723-D50
2	9723-C55	9723-D55
3	9723-C60	9723-D60
4	9723-C65	9723-D65
5	9723-C70	9723-D70
6	9723-C75	9723-D75
7	9723-C80	9723-D80

CANNON® ZEITFUCHS CROSS-ARM VISCOMETERS



9723-S50 Series
9723-U50 Series

CALIBRATED ZEITFUCHS® CROSS-ARM VISCOMETERS

For measurement of kinematic viscosity of transparent and opaque Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105. Also used to measure kinematic viscosity of liquid (cutback) asphalts and road oils at 60°C (140°F) and asphalt cements at 135°C (275°F) in the range of 30 to 6000 centistokes according to ASTM D 2170. Can be filled and cleaned while in constant temperature bath.

- Minimum sample volume 1 to 3 mL. Require liquid bath depth of 230 mm (9 inches).
- Constants and ranges are as described in table on page 9.
- All instruments calibrated. Certificate of calibration and instruction sheet provided. See page 2 for expanded uncertainty. Offered with and without holder as described below.

ZCAC Series

As described above. Without holder.

- For holder, see 9726-M95 and -M98 on page 15.

Unity Factor ZCAXC Series

Similar to 9723-S50 series, but have constant within $\pm 0.2\%$ of values listed in table on page 9.

- For holder, see 9726-M95 and -M98 on page 15.

With permanently attached round metal holder

ZCAC-RO Series

As described above. Supplied with permanently attached round metal holder, for hole 51 mm (2 inches) in diameter.

Unity Factor ZCAXC-RO Series

Similar to 9723-W50 series, but have constant which is within $\pm 0.2\%$ of values listed in table on page 9.

With permanently attached rectangular metal holder

ZCAC-RE Series

As described above. Supplied with permanently attached rectangular metal holder which requires bath opening 25 x 48 mm (1 x 1.9 inches).

Unity Factor ZCAXC-RE Series

Similar to 9724-B50 series, but have constant within $\pm 0.2\%$ of value listed in table on page 9.

Size	ZCAC Series	ZCAXC Series Unity Factor
1	9723-S50	9723-U50
2	9723-S53	9723-U53
3	9723-S56	9723-U56
4	9723-S59	9723-U59
5	9723-S62	9723-U62
6	9723-S65	9723-U65
7	9723-S68	9723-U68
8	9723-S71	9723-U71
9	9723-S74	9723-U74
10	9723-S77	9723-U77

Size	ZCAC-RO Series	Unity Factor ZCAXC-RO Series
1	9723-W50	9723-Y50
2	9723-W53	9723-Y53
3	9723-W56	9723-Y56
4	9723-W59	9723-Y59
5	9723-W62	9723-Y62
6	9723-W65	9723-Y65
7	9723-W68	9723-Y68
8	9723-W71	9723-Y71
9	9723-W74	9723-Y74
10	9723-W77	9723-Y77

Size	ZCAC-RE Series	Unity Factor ZCAXC-RE Series
1	9724-B50	9724-D50
2	9724-B53	9724-D53
3	9724-B56	9724-D56
4	9724-B59	9724-D59
5	9724-B62	9724-D62
6	9724-B65	9724-D65
7	9724-B68	9724-D68
8	9724-B71	9724-D71
9	9724-B74	9724-D74
10	9724-B77	9724-D77



9723-W50 Series
9723-Y50 Series
9724-B50 Series
9724-D50 Series

CANNON® BS/U-TUBE VISCOMETERS



9724-E50 Series

BS/U-TUBE VISCOMETERS FOR TRANSPARENT LIQUIDS

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 7 mL in sizes A to C, 12 mL in sizes D to F, and 23 mL in sizes G and H. Require liquid bath depth of 280 mm (11 inches).
- Without holder.

Specifications for BS/U-Tube Viscometers

Size	Approx. Constant, mm^2/s^2 (cSt/s)	Viscosity Range mm^2/sec (cSt)*
A	0.003	0.9 to 3
B	0.01	2.0 to 10
C	0.03	6 to 30
D	0.1	20 to 100
E	0.3	60 to 300
F	1.0	200 to 1000
G	3.0	600 to 3000
H	10.0	2000 to 10 000

* Ranges in centistokes represent flow times of 300 to 1000 seconds for Size A and 200 to 1000 seconds for all other sizes.

Calibrated BS/U-Tube Series

Size	Calibrated BS/U-Tube Series
A	9724-E50
B	9724-E53
C	9724-E56
D	9724-E59
E	9724-E62
F	9724-E65
G	9724-E68
H	9724-E71



9724-E80 Series

BS/U/M MINIATURE U-TUBE VISCOMETERS

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 2 mL. Require liquid bath depth of 230 mm (9 inches).
- Without holder.

Specifications for BS/U/M Miniature U-Tube Viscometers

Size	Approx. Constant, mm^2/s^2 (cSt/s)	Viscosity Range, mm^2/sec (cSt)*
M1	0.001	0.2 to 1
M2	0.005	1 to 5
M3	0.015	3 to 15
M4	0.04	8 to 40
M5	0.1	20 to 100

* Ranges in centistokes represent flow times of 200 to 1000 seconds.

Calibrated BS/U/M Series

Size	Calibrated BS/U/M Series
M1	9724-E80
M2	9724-E83
M3	9724-E86
M4	9724-E89
M5	9724-E92

CANNON® SUSPENDED LEVEL VISCOMETERS



9724-F10 Series

BS/IP/SL SUSPENDED LEVEL VISCOMETERS

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 11 mL. Require liquid bath depth of 250 mm (10 inches).
- Holder is not supplied. For holder, see 9726-M99 on page 15.

Specifications for BS/IP/SL Suspended Level Viscometers

Size	Approx. Constant mm^2/s^2 (cSt/s)	Viscosity Range, mm^2/sec (cSt)*	Calibrated BS/IP/SL Series
1	0.01	3.5 to 10	9724-F10
1A	0.03	6 to 30	9724-F13
2	0.1	20 to 100	9724-F16
2A	0.3	60 to 300	9724-F19
3	1.0	200 to 1000	9724-F22
3A	3.0	600 to 3000	9724-F25
4	10	2000 to 10 000	9724-F28
4A	30	6000 to 30 000	9724-F31
5	100	20 000 to 100 000	9724-F34

* Ranges in centistokes represent flow times of 350 to 1000 seconds for Size 1 and 200 to 1000 seconds for all other sizes.

Specifications for Shortened Form BS/IP/SL(S) Suspended Level Viscometers

Size	Approx. Constant, mm^2/s^2 (cSt/s)	Viscosity Range, mm^2/sec (cSt)	Calibrated BS/IP/SL(S) Series
1	0.0008	1.05 minimum*	9724-F50
2	0.003	2.1† to 3	9724-F53
3	0.01	3.8‡ to 10	9724-F56
4	0.03	6 to 30	9724-F59
5	0.1	20 to 100	9724-F62
6	0.3	60 to 300	9724-F65
7	1.0	200 to 1000	9724-F68
8	3.0	600 to 3000	9724-F71
9	10	2000 to 10 000	9724-F74

* 1 320 seconds minimum flow time.

† 600 seconds minimum flow time to 1000 seconds.

‡ 380 seconds minimum flow time to 1000 seconds.

□ Ranges in centistokes represent flow times of 200 to 1000 seconds for all other sizes.

BS/IP/SL(S) VISCOMETERS

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

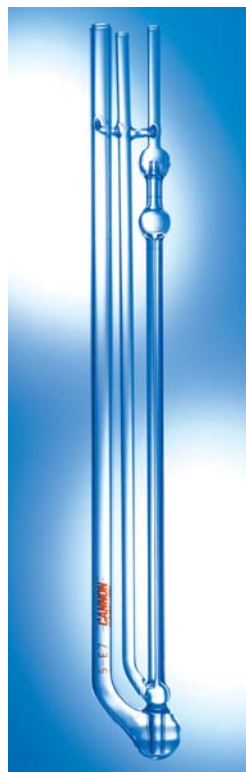
Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 10 mL. Require liquid bath depth of 230 mm (9 inches).
- Holder is not supplied. For holder, see 9726-M99 on page 15.



9724-F50 Series

SUSPENDED LEVEL & REVERSE FLOW BS/IP VISCOMETERS



9724-G10 Series

BS/IP/MSL MINIATURE SUSPENDED LEVEL VISCOMETERS

For measurement of kinematic viscosity of transparent Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 4 mL. Require liquid bath depth of 305 mm (12 inches).
- Holder is not supplied. For holder, see 9726-M99 on page 15.

Specifications for BS/IP/MSL Miniature Suspended Level Viscometers

Size	Approx. Constant, mm^2/s^2 (cSt/s)	Viscosity Range, mm^2/sec (cSt)*	Calibrated Series BS/IP/MSL
1	0.003	0.6 to 3	9724-G10
2	0.01	2 to 10	9724-G13
3	0.03	6 to 30	9724-G16
4	0.1	20 to 100	9724-G19
5	0.3	60 to 300	9724-G22
6	1.0	200 to 1000	9724-G25
7	3.0	600 to 3000	9724-G28

* Ranges in centistokes represent flow times of 200 to 1000 seconds.

Specifications for BS/IP/RF U-Tube Reverse Flow Viscometers

Size	Approx. Constant, mm^2/s^2 (cSt/s)	Viscosity Range, mm^2/sec (cSt)*	Calibrated BS/IP/RF U-Tube Series
1	0.003	0.6 to 3	9724-G50
2	0.01	2 to 10	9724-G53
3	0.03	6 to 30	9724-G56
4	0.1	20 to 100	9724-G59
5	0.3	60 to 300	9724-G62
6	1.0	200 to 1000	9724-G65
7	3.0	600 to 3000	9724-G68
8	10	2000 to 10 000	9724-G71
9	30	6000 to 30 000	9724-G74
10	100	20 000 to 100 000	9724-G77
11	300	60 000 to 300 000	9724-G80

* Ranges in centistokes represent flow times of 200 to 1000 seconds.



9724-G50 Series

BS/IP/RF U-TUBE REVERSE FLOW VISCOMETERS

For measurement of kinematic viscosity of opaque Newtonian liquids according to ASTM D 445 and ISO 3104. Specifications conform to ASTM D 446 and ISO 3105.

Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.

- Minimum sample volume 7 mL. Require liquid bath depth of 280 mm (11 inches).
- Holder is not supplied. For holder, see 9726-N45 on page 15.

CANNON® VACUUM VISCOMETERS



9724-H50 Series

CANNON-MANNING VACUUM VISCOMETERS

Cannon-Manning Vacuum Calibrated CMVC Series

For measurement of viscosity of highly viscous materials such as asphalt cement at 60°C (140°F) according to ASTM D 2171. Applicable to materials with viscosity range of 0.036 to 80 000 poise. Vacuum of 300 mm Hg is applied to small arm with timing bulbs; two bulbs are incorporated to extend viscosity range of viscometer.

- Minimum sample volume 6 mL. Require liquid bath depth of 180 mm (7.1 inches).
- Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.
- Holder is not supplied. For holder, see 9726-N15.

Cannon-Manning Vacuum Calibrated CMVC-RO Series

Same as 9724-H50 series, but with permanently attached round metal holder, for hole 51 mm (2 inches) in diameter.

ASPHALT INSTITUTE VACUUM VISCOMETERS

Asphalt Institute Vacuum Calibrated AIVC Series

Similar to 9724-H50 series, but with graduated capillary instead of two timing bulbs.

- Minimum sample size 3 mL. Require bath depth of 180 mm (7.1 inches).
- Note: For sizes 400R and 800R, the "roofing" design is normally used for segment B, below, which extends the viscosity range to 1 400 000 and 5 800 000 poise, respectively. See ASTM D 2171, Table X2.
- Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.
- Holder is not supplied. For holder, see 9726-N15.

Asphalt Institute Vacuum Calibrated AIVC-RO Series

Same as 9724-R50 series, but with permanently attached round metal holder, for hole 51 mm (2 inches) in diameter.



9724-R50 Series

Specifications for Cannon-Manning Vacuum Viscometers

Size	Viscosity range, poise	Approx. constant poise/second at 300 mm Hg vacuum	
		Bulb B	Bulb C
4	0.036 to 0.8	0.002	0.0006
5	0.12 to 2.4	0.006	0.002
6	0.36 to 8	0.02	0.006
7	1.2 to 24	0.06	0.02
8	3.6 to 80	0.2	0.06
9	12 to 240	0.6	0.2
10	36 to 800	2	0.6
11	120 to 2400	6	2
12	360 to 8000	20	6
13	1200 to 24 000	60	20
14	3600 to 80 000	200	60

Size	Calibrated CMVC Series	Calibrated CMVC-RO Series
4	9724-H50	9724-L50
5	9724-H53	9724-L53
6	9724-H56	9724-L56
7	9724-H59	9724-L59
8	9724-H62	9724-L62
9	9724-H65	9724-L65
10	9724-H68	9724-L68
11	9724-H71	9724-L71
12	9724-H74	9724-L74
13	9724-H77	9724-L77
14	9724-H80	9724-L80

Specifications for Asphalt Institute Vacuum Viscometers

Size	Viscosity range, poise	Approx. constant poise/second at 300 mm Hg vacuum		
		at B	at C	at D
25	42 to 800	2	1	0.7
50	180 to 3200	8	4	3
100	600 to 12 800	32	16	10
200	2400 to 52 000	128	64	40
400R	9600 to 1 400 000	500	250	160
800R	38 000 to 5 800 000	2000	1000	640

Size	Calibrated AIVC Series	Calibrated AIVC-RO Series
25	9724-R50	9724-T50
50	9724-R55	9724-T55
100	9724-R60	9724-T60
200	9724-R65	9724-T65
400R	9724-R70	9724-T70
800R	9724-R75	9724-T75

CANNON® VACUUM VISCOMETERS & VISCOMETER HOLDERS



9724-W/50 Series

CANNON MODIFIED KOPPERS VACUUM VISCOMETERS

Calibrated MKVC Series

For measurement of viscosity of asphalts at 60°C (140°F) in accordance with ASTM Standard D 2171. Applicable to materials with viscosity range of 42 to 200 000 poise. Two-piece design, with sample reservoir and calibrated capillary. Vacuum of 300 mm Hg must be applied to top of capillary tube.

- Minimum sample volume 2 mL. Require liquid bath depth of 178 mm (7 inches).
- Provided with certificate of calibration and instruction sheet. See page 2 for expanded uncertainty.
- Holder is not supplied. For holder, see 9726-N30.

Specifications for Cannon Modified Koppers Vacuum Viscometers

Size	Viscosity range, poise	Approx. constant poise/second at 300 mm Hg vacuum		
		at B	at C	at D
25	42 to 800	2	1	0.7
50	180 to 3200	8	4	3
100	600 to 12 800	32	16	10
200	2400 to 52 000	128	64	40
400	9600 to 200 000	500	250	160

Size	Calibrated MKVC Series
25	9724-W50
50	9724-W55
100	9724-W60
200	9724-W65
400	9724-W70

REMOVABLE HOLDERS FOR CANNON VISCOMETERS

All CANNON viscometer holders fit holes 51 mm (2-inches) in diameter. Rubber holders are made of neoprene rubber. Plastic holders hold the viscometer firmly by means of a spring clip. Metal holders are constructed of chrome-plated machined brass and are provided with a handle.



Viscometer Holders

Viscometer	Type of Holder		
	Plastic	Rubber	Metal
Cannon-Fenske Routine	H100	H110	H113
Cannon-Fenske Opaque	H100	H110	H113
Cannon-Ubbelohde	H101	H120	H131
Ubbelohde	—	—	H130
Cannon-Manning Semi-Micro	H100	H110	—
Cannon-Ubbelohde Semi-Micro	H101	H120	H131
Cannon-Ubbelohde Dilution	H101	H120	H131
Cannon-Ubbelohde Four-Bulb Shear Dilution	H101	H120	H131
Zeitfuchs® Cross-Arm	—	H115	H132
BS/IP/SL Suspended Level	—	—	H133
BS/IP/SL(S) Suspended Level	—	—	H133
BS/IP/MSL Miniature Suspended Level	—	—	H133
BS/IP/RF U-Tube Reverse Flow	—	H142	—
Cannon-Manning Vacuum	—	H140	—
Asphalt Institute Vacuum	—	H140	—
Modified Koppers Vacuum	—	H141	—
Cannon-Ubbelohde Filter Stick	—	H142	—

Catalog Numbers For Viscometer Holders

Holder	Catalog #	Holder	Catalog #	Holder	Catalog #	Holder	Catalog #
H100	9726-M50	H115	9726-M95	H132	9726-M98	H142	9726-N45
H101	9726-M70	H120	9726-M73	H133	9726-M99		
H110	9726-M53	H130	9726-M82	H140	9726-N15		
H113	9726-M79	H131	9726-M76	H141	9726-N30		

CAPILLARY VISCOMETERS — HOW DO YOU CLEAN THEM?

Clean viscometers are essential if precise and accurate measurements are to be made. Because CANNON receives a significant number of requests for advice about cleaning methods, we offer the following instructions as a guide to cleaning most glass capillary viscometers.

Removing the test sample from the viscometer

The first step in cleaning is to remove the bulk of the test sample. For low viscosity liquids, the viscometer may be turned upside down and allowed to hang while the test sample drains into a trough. For high viscosity liquids, the sample may have to be drawn out under vacuum. The material remaining in the viscometer must then be removed by flushing with a suitable solvent. Distilled water is an obvious choice for aqueous solutions. Petroleum-based lubricants and asphalts can usually be dissolved with light naphtha, heptane, octane, highly aromatic solvents, and many other petroleum-derived solvents. Varsol® is a commercial solvent that works very well for this purpose. For some types of samples it may be difficult to find a suitable solvent.

Highly viscous samples will not easily pour from the instrument nor do they respond well even under vacuum. The best approach is to lower the viscosity by heating the instrument in an open oven or with a stream of hot air. Simply inverting the instrument and suspending it in an open oven over a receptacle to catch the sample usually works well. Another method is to draw the bulk of the sample out while the instrument is at an elevated temperature in a constant temperature bath. This method works particularly well for certain viscometers (such as the Zeitfuchs® Cross-Arm viscometer), as the entire cleaning can

be performed while the viscometer remains fixed in the constant temperature bath. CANNON often places viscometers in an open aluminum oven (2" wide x 7" long x 5" deep), maintained at an elevated temperature, during the cleaning procedure. Even after the bulk of a viscous sample has been removed from the instrument, dissolving the rest of it may pose a considerable problem. We have found that a mixture of octane isomers is especially effective in removing the last traces of high viscosity standards from viscometers.

Drying the viscometer after cleaning

The viscometer must be completely dry before another sample is loaded. Highly volatile solvents are recommended for cleaning since any remaining solvent will evaporate quickly after the sample has been flushed from the viscometer. Often, however, the best choice of solvent for the material in the viscometer is not especially volatile. In this case, a second highly volatile solvent, which will dissolve the first solvent, can be used for the final step in cleaning. Acetone is commonly used as the second solvent because of its high volatility and its ability to dissolve traces of petroleum solvents and water.

A low velocity stream of clean air will be sufficient to evaporate remaining traces of a volatile solvent, but be aware that rapid evaporation of these solvents can cool the surface of the glass to such an extent that humid air may be brought below the dew point, causing a film of water to form on the inner surfaces of the viscometer. Heating the air being drawn into the instrument or heating the glass itself will usually overcome this problem.

Cleaning insoluble deposits from viscometers

Capillary viscometers are often used to measure materials which leave stains or significant deposits of material insoluble in normal cleaning solvents. The most common approach for removing this material involves filling the instrument with a chromic acid cleaning solution and allowing the instrument to soak in the acid for up to 24 hours. Chromic acid solutions are strongly oxidizing and will convert many materials to a soluble form. Chromic acid will not attack the borosilicate glass of the viscometer and thus will not alter the calibration constant. Proper procedures must be followed when using and discarding chromic acid since it is a hazardous material. A commercially manufactured oxidizing reagent (Nochromix®) is chromium-free and may be substituted for chromic acid solutions. Nochromix is available from CANNON.

Beware of glass cleaners with a high pH. Changes in viscometer calibration as great as 20% have been observed due to the prolonged use of alkaline cleaning solutions. If alkaline cleaning solutions with a pH greater than 10 have been used, the viscometer calibration should be verified to ensure that there has not been a significant change.

Insoluble particles stuck in the capillary of a viscometer can sometimes be dislodged by using an ultrasonic cleaner.

If you are encountering a special cleaning problem, we urge you to contact us for assistance.

Varsol is a registered trademark of the Exxon Company.

Nochromix is a registered trademark of Godax.



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