

DISCUSSION OF DATA¹

Derivation of Certified Values: CANNON Instrument Company certifies that the kinematic viscosities were determined by the Cannon-Ubbelohde technique reported in the Journal of Research of the National Bureau of Standards, (Vol. 52, No. 3, March 1954, Research Paper 2479) using CANNON® Laboratory Standard viscometers. All temperature measurements were conducted according to The International Temperature Scale of 1990 (ITS-90) using SPRTs with fixed point calibrations. The provided viscosity data are based upon the primary standard, water at 20 °C, with a kinematic viscosity of 1.0034 mm²/s and an assigned accuracy of ± 0.17% as per ISO 3666. See also ASTM methods D2162, D445, D446, D2161, and ISO methods 3104 and 3105.

Kinematic viscosity (ν) measurements in mm²/s at temperatures of 20, 25, 37.78, and 40 °C were generally made using CANNON® and/or Cannon-Ubbelohde (long capillary) Master viscometers, as described in ASTM methods D2162, D445, and D446. Measurements at other temperatures have been made using Cannon-Ubbelohde Laboratory Standard viscometers.

The kinematic viscosity at temperatures between 20 and 25 °C was determined through regression of all measured data using industry standard equations. These equations include the linear or quadratic viscosity/density-temperature equation derived from the ASTM viscosity-temperature charts for petroleum products as well as the NBS viscosity-temperature equation for petroleum products. See ASTM method D341 and NBS equation.

Viscosity cup flow times were calculated using the equations referenced in Table 1.

TABLE 1

Cup No.	Equation	Flow Time Limitation (s)		Cup No.	Equation	Flow Time Limitation (s)	
		Min.	Max.			Min.	Max.
	Source: ISO 2431				Source: DIN 53211		
ISO 3 mm	mm ² /s (cSt) = 0.443 t - 200/t	30	100	DIN 4	mm ² /s (cSt) = 4.57 t - 452/t	30	110
ISO 4 mm	mm ² /s (cSt) = 1.37 t - 200/t	30	100				
ISO 6 mm	mm ² /s (cSt) = 6.90 t - 570/t	30	100				
	Source: ASTM D1200[#]				Source: ASTM D4212[#]		
Ford No. 1	mm ² /s (cSt) = 0.49 (t - 35.0)	55	100	Zahn No. 1	mm ² /s (cSt) = 1.1 (t - 29)	35	80
Ford No. 2	mm ² /s (cSt) = 1.44 (t - 18.0)	20	100	Zahn No. 2	mm ² /s (cSt) = 3.5 (t - 14)	20	80
Ford No. 3	mm ² /s (cSt) = 2.31 (t - 6.58)	20	100	Zahn No. 3	mm ² /s (cSt) = 11.7 (t - 7.5)	20	80
Ford No. 4	mm ² /s (cSt) = 3.85 (t - 4.49)	20	100	Zahn No. 4	mm ² /s (cSt) = 14.8 (t - 5)	20	80
Ford No. 5	mm ² /s (cSt) = 12.1 (t - 2.00)	20	100	Zahn No. 5	mm ² /s (cSt) = 23 t	20	80
	Source: ASTM D4212[#]				Source: ASTM D4212[#]		
Shell No. 1	mm ² /s (cSt) = 0.226 (t - 13)	20	80	Shell No. 3 ½	mm ² /s (cSt) = 2.17 (t - 1.5)	20	80
Shell No. 2	mm ² /s (cSt) = 0.576 (t - 5)	20	80	Shell No. 4	mm ² /s (cSt) = 3.45 (t - 1)	20	80
Shell No. 2 ½	mm ² /s (cSt) = 0.925 (t - 3)	20	80	Shell No. 5	mm ² /s (cSt) = 6.5 (t - 1)	20	80
Shell No. 3	mm ² /s (cSt) = 1.51 (t - 2)	20	80	Shell No. 6	mm ² /s (cSt) = 16.2 (t - 0.5)	20	80

[#]The form of the equations used in ASTM D1200 and ASTM D4212 is not of the preferred form (kin vis = Ct - B/t), and may lead to significant errors especially at the minimum flow times.

Traceability: All data are traceable to intrinsic standards and National Institute of Standards and Technology (NIST) calibration or calculated by ASTM or NIST methods. Kinematic viscosity values are traceable to the viscosity of water. Temperature measurements were conducted with SPRTs that have NIST traceable fixed-point calibrations. A complete traceability statement is available for purchase from CANNON Instrument Company.

Measurement Uncertainty: CANNON Instrument Company has determined and reported the measurement uncertainty of its laboratory capabilities. The expanded uncertainties of the laboratory measurements summarized at the 95% confidence interval are as follows:

Kinematic Viscosity (15 °C to 45 °C)

Range of Kinematic Viscosity (mm ² /s)	Expanded Uncertainty* (%)
<10	0.16
10-100	0.22
100-1000	0.29
1000-10,000	0.38

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

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¹Consult www.cannoninstrument.com for additional information.