Pure & Appl. Chem., Vol.52, pp.2393-2404.
Pergamon Press Ltd. 1980. Printed in Great Britain.

0033-4545/80/1001-2393$02.00/0

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

PHYSICAL CHEMISTRY DIVISION

COMMISSION ON PHYSICOCHEMICAL MEASUREMENTS AND STANDARDS*

RECOMMENDED REFERENCE MATERIALS FOR REALIZATION OF PHYSICOCHEMICAL PROPERTIES

(Recommendations 1977)

EDITOR: K. N. MARSH

SECTION : VISCOSITY

COLLATOR: T. PLEBANSKI

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INTRODUCTION

The symbol for viscosity (still sometimes referred to as dynamic viscosity, though this term is now commonly reserved for a frequency dependent property) recommended by the IUPAC is η (or sometimes μ) (Ref. 1). The SI unit for viscosity is the pascal second (Pa s). Alternative forms of this unit are the newton second per square metre (N s m^{-2}) and the kilogram per metre per second (kg m^{-1} s^{-1}).* The viscosity is 1 pascal second for a fluid for which there is a tangential force of 1 newton on 1 square metre of either of two infinite parallel planes 1 metre apart when (a) the space between those planes is filled with the fluid, (b) one of the planes moves with a velocity of 1 metre per second in its own plane relative to the other, and (c) the flow of the fluid is steady and laminar.

The symbol of kinematic viscosity recommended by the IUPAC is ν (Ref. 1). The SI unit for kinematic viscosity is the square metre per second (m^2 s^{-1}) where 1 square metre per second is the kinematic viscosity of a fluid having a viscosity of 1 pascal second and a density of 1 kilogram per cubic metre.†

Additional ways of representing the viscosity of dilute solutions have been defined (Ref. 2). The relative viscosity η_r is defined as the ratio between the viscosity of the solution and the viscosity of the pure solvent at the same temperature and pressure, while the relative viscosity increment η_i, formerly called the specific viscosity, is defined by $\eta_i = \eta_r - 1$. Both these quantities are dimensionless.

This recommendation concerns only reference liquids which are Newtonian, that is their viscosity is independent of the rate of shear. A detailed discussion of Newtonian and non-Newtonian behaviour of fluids is given in reference 2.

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* A commonly used unit for the viscosity the poise (P) has been defined (Ref. 1) in terms of SI units as P = 10^{-1}Pa s. A commonly used subunit is the centipoise (cP) where cP = 10^{-3}Pa s. This unit does not belong to the International System of Units and its use should be progressively discouraged.

† A commonly used unit for kinematic viscosity the stokes (St) has been defined (Ref. 1) in terms of SI units as St = 10^{-4} m^2 s^{-1}. A commonly used subunit is the centistokes (cSt) where cSt = 10^{-6} m^2 s^{-1}. This unit does not belong to the International System of Units and its use should be progressively discouraged. An author who uses either the poise or stokes must define it in terms of the SI unit in each publication in which he uses it.

The viscosity is given by

$$\tau_{xz} = F_x/A = \eta(dv_x/dz).$$

The kinematic viscosity is given by

$$\nu = \eta/\rho.$$

Equation (1) can be used to determine the viscosity of a fluid directly by measuring the shear stress τ_{xz} required to give laminar flow with a rate of shear dv_x/dz. In practice, such a measurement is difficult to make. There is a variety of other methods which can be used to make measurements of the viscosity (Refs. 3-5, 7). One such method is to measure the time taken for a known volume of liquid to flow through a capillary of known dimensions under a known pressure difference (Ref. 3). This method is not routinely used because it is difficult to measure the area of the capillary with sufficient precision and it is also necessary to apply corrections for various kinetic effects which occur at the ends of the capillary. Thus a reference material is convenient for the calibration of viscometers. The internationally recognized reference material is water in equilibrium with air at 293.15 K and atmospheric pressure (Ref. 6).

The viscosity of fluids can range from less than 10^{-6} Pa s to more than 10^{6} Pa s. For organic liquids the viscosity ranges generally from 10^{-3} Pa s to 10^{3} Pa s. Hence viscometers which are designed to give a suitable measured quantity when calibrated with water will have unsuitable measured quantities when used to determine the viscosities of highly viscous liquids. For this reason reference materials with certified values are used to calibrate viscometers. The certified values of these reference materials are always determined by comparison with a viscosity of water, either directly or indirectly, through a chain of intermediate reference liquids and master class instruments. In each step of the comparison a part of the accuracy is lost, so that with increasing viscosity the uncertainty increases. The viscosities of a number of reference materials relative to that of water are often given with an uncertainty considerably less than the known uncertainty of the absolute value for water (Refs. 6, 7). The consistency of the various national viscosity scales is checked by a continuing programme of direct international comparisons made by the exchange of both master viscometers and reference materials between the various suppliers. This comparison suggests that the viscosity of reference materials can, at best, be certified to 0.2% with reference to water, even though in many cases agreement between laboratories is better than 0.1%.

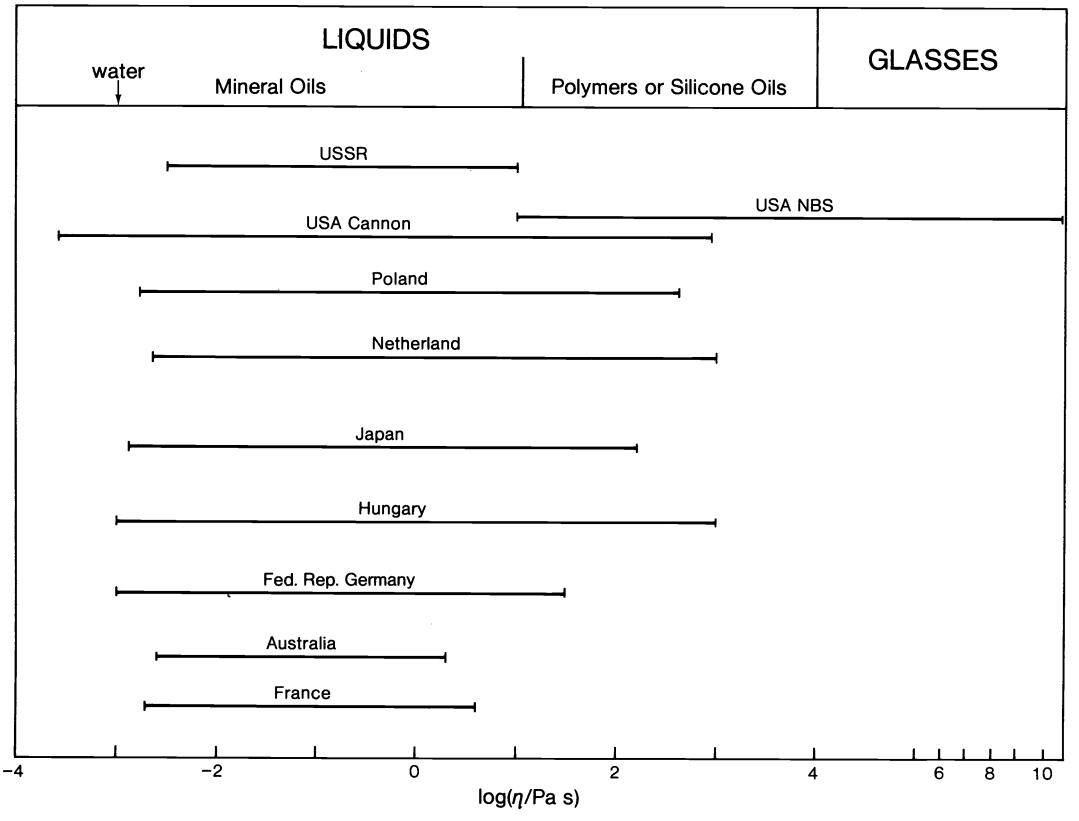

FIGURE 1. Coverage of the viscosity scale by available certified reference materials

Selected pure materials have not always been used as reference materials because the viscosity usually depends significantly and indeterminately on the purity of the material. Suppliers use a wide range of reference materials which are usually of indeterminate composition, the materials being petroleum oils, polyisobutenes, silicone oils, undefined polymers and asphalts, and molten glasses. It is necessary that the materials show Newtonian behaviour, that they are non-corrosive, and except for the molten glasses, have a high solubility in at least two readily available organic solvents so as to enable appropriate cleaning. In the viscosity range greater than 10^2 Pa s, special care must be taken to ensure that the liquids are Newtonian in behaviour under the conditions of calibration.

The viscosity range covered by the reference materials available from various laboratories is given in figure 1. There is a considerable number of reference materials for use within the viscosity range 10^{-3} to 30 Pa s, while in the range 30 Pa s to 10^4 Pa s there is an inadequate number of reference materials and there are no reference materials for viscosity greater than 10^4 Pa s at 298 K. The coverage of the temperature scale is not adequate in that only a few reference materials are certified below 273 K and there are no materials for use within the temperature range 373 K and 850 K. A variety of glasses are certified for use between 737 and 1818 K. One supplier provides reference materials with certified numerical values for an equation that enables viscometers to be calibrated at temperatures other than those at which the viscosity value is certified. In the viscosity range 10^{-3} to 10^{-1} Pa s it is generally necessary for the temperature to be controlled within 0.01 K of the temperature of certification in order to use the reference material within its specified uncertainty, which is usually 0.2 per cent with reference to water. In the higher viscosity range, temperature control is not so important since in the viscosity ranges 10^{-1} to 10 Pa s and greater than 10 Pa s the uncertainty of the reference materials are of te order of 0.3 per cent and 1 per cent respectively. However, as shown in table 1, the temperature dependence of the viscosity of high viscosity fluids is much greater than that for low viscosity fluids, so that temperature control must still be of the order of 0.02 K.

TABLE 1. Temperature dependence of viscosity of selected certified reference materials (CRM).

Polish CRM		Cannon CRM S8000		Cannon CRM S3		NBS SRM-710	
T/K	η/Pa s	T/K	η/Pa s	T/K	10^3η/Pa s	T/K	η/Pa s
293.15	589	293.15	33	219.26	260	850.1	10^{11}
323.15	59	298.15	20	233.15	70	930.6	10^9
353.15	10	313.15	5.9	293.15	3.9	979.3	10^7
373.15	4.05			313.15	2.4	1094.7	10^5
				373.15	0.9	1292.2	10^3
						1707.5	10

Most reference materials must be used within a specified time period otherwise there is loss of certification. In general, materials with viscosities in the range 10^{-3} to 10^3 Pa s must be used within times varying from 12 to 2 months. This is because the viscosity of reference materials in the medium to high viscosity range made from petroleum oils increase at a rate of from 0.01 to 0.03 per cent per month. For petroleum oils the viscosity changes with pressure seldom exceeds 0.003 per cent per kilopascal so that changes in atmospheric pressure can be neglected in most cases.

No reference materials are available for calibrating and checking viscometers to be used for measuring the viscosity of gases. Hanley (Refs. 8-10) has published several reviews on the viscosity of a variety of gases over a temperature and pressure range.

The following provisos apply to the information on reference materials:

(a) the recomended materials have not been checked independently by the IUPAC, (b) The quality of the material may change with time, (c) the quoted sources of supply may not be the exclusive sources because no attempt has been made to seek out all possible alternative sources, and (d) the IUPAC does not guarantee any material that has been recommended.

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1.

Physical property: Viscosity η and kinematic viscosity ν.
Units: Pa s, $m^2\ s^{-1}$
Recommended reference material: Water (H_2O)
Range of variables: 293.15 K, atmospheric pressure
Physical state within the range: liquid
Class: Calibration Material
Contributors: T. Plebanski, K. N. Marsh

Intended Usage: Water is used for calibration of viscometers intended for the measurement of the viscosity of liquids.

Sources of supply and/or methods of preparation: Purification by double distillation and passing through a fine sintered glass frit (to saturate the sample with air) just prior to use is recommended (Ref. 1).

Pertinent physicochemical data: In 1958 the International Organization for Standardization Technical Commission 66 circulated a draft proposal to accept water at 293.15 K as a reference material for the calibration of viscometers (Ref. 9). A value of 0.001002 Pa s was recommended based on a number of determinations (Refs. 1-3) but primarily based on the value of 0.0010019 Pa s reported by Swindells, Coe, and Godfrey (Ref. 1). The values in references 1 and 3 were obtained in capillary viscometers, with possible systemic errors which could not be estimated.

In many cases the true value of the viscosity is not as important as consistency with other measurements throughout the world. Since the value of 0.001002 Pa s was already used rather widely by 1958, a change could only have been justified by convincing evidence that this value differed from the true value by more than its uncertainty. An estimate of this uncertainty was published in 1971 (Refs. 4-7). The viscosity of a liquid was measured by two independent absolute methods involving different types of flow. The results differed by more than 0.5 per cent, five times the uncertainty (including both the variability and estimate of systematic errors) assigned to either measurement. Based on all the above results it is recommended (Refs. 8, 9) that viscometer calibrations be based on the following value for the viscosity of water

$$\eta(H_2O,\ 293.15\ K,\ 101.325\ kPa) = 0.001002\ Pa\ s$$

with the proviso that when only agreement between measurements made in different laboratories is important, the uncertainty associated with this value be ignored but that when a true value of the viscosity is required, an uncertainty of ±0.25 per cent be assigned to this value.

The kinematic viscosity of water is derived from the recommended value for the dynamic viscosity and the recommended value (Ref. 10) for the density of air free water at 293.15 K and atmospheric pressure. At 293.15 K air saturated water is about 1×10^{-3} kg m^{-3} less dense than air free water (Ref. 10). This difference is insignificant.

The recommended value is

$$\nu(H_2O,\ 293.15\ K,\ 101.325\ kPa) = 1.0038 \times 10^{-6}\ m^2\ s^{-1}$$

with the proviso that when only agreement between measurements made in different laboratories is important, the uncertainty associated with this value be ignored but that when a true value of the kinematic viscosity is required, an uncertainty of ±0.25 per cent be assigned to this value. The last figure given here is not significant, and is retained only because of its established usage.

The viscosity of water at other temperatures relative to the value of 293.15 K given in the table below have been derived from the measurements of Coe and Godfrey (Ref. 11) and Weber (Ref. 12).

Viscosity of water at various temperatures

T/K	$10^3\eta$/Pa s	T/K	$10^3\eta$/Pa s	T/K	$10^3\eta$/Pa s
273.15	1.787	303.15	0.7975	343.15	0.404_9
283.15	1.306	313.15	0.6531	353.15	0.355_9
293.15	1.002	323.15	0.5467	363.15	0.315_6
298.15	0.8903	333.15	0.4666	373.15	0.282_9

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2.

Physical Property: Viscosity η and kinematic viscosity ν.
Units: Pa s, $m^2\ s^{-1}$
Recommended reference materials: Variety of oils, polyisobutenes, and glasses.
Range of variables: 220 to 1696 K, 101.325 kPa
Physical state within the range: liquid
Class: Certified Reference Materials
Contributors: T. Plebanski, K. N. Marsh.

Intended Usage: These certified reference materials are used to calibrate and to check viscometers intended for measurements on liquids. Methods for measuring the viscosity of liquids have been summarized by Johnson, Martin, and Porter (Ref. 1). For silicone oils with viscosity greater than 10^3 Pa s care should be taken to ensure that the liquids are Newtonian under the conditions of calibration.

Sources of supply and/or method of purification: Samples are available from suppliers (A,B,C,D,E,F,G,H,I,J,K) with certified value of one or more of the three properties; viscosity, density, and kinematic viscosity. In general the uncertainties stated are at a 95% confidence limit.

Pertinent physicochemical data: Supplier A (CSIRO National Measurement Laboratory, Australia) produces six reference materials with viscosities ranging from 1.9×10^{-3} to

2.0 Pa s. The materials are certified at 298.15 K and 313.14 K for viscosity and density. The uncertainty in the density of the samples is 0.02%. The certification periods for the four lower viscosity samples and the two higher viscosity samples are 12 months and 9 months respectively.

CSIRO National Measurement Laboratory (Australia) Certified Reference Viscosity Materials. Values are at 298.15 and 313.15 K and the uncertainty is given in brackets

Designation	$10^3\eta$/Pa s 298.15 K	313.15 K
AS 2.5	2.6 (0.07%)	1.9 (0.07%)
AS 7.5	9.1 (0.08%)	5.7 (0.08%)
AS 25	43 (0.10%)	22 (0.10%)
AS 75	140 (0.12%)	60 (0.12%)
AS 200	580 (0.25%)	190 (0.25%)
AS 600	2 000 (0.5%)	560 (0.5%)

The values given in this table are nominal values only and should not be taken to be the actual values of the reference materials supplied. Sample size is 275 cm^3. The uncertainty values given assume no uncertainty in the value for the viscosity of water.

Supplier B (Laboratoire National d'Essais, France) produces sixteen reference materials with viscosities ranging from 3 to 4200 x $10^{-6}m^2\ s^{-1}$ at 293.15 K, or 2 to 790 x $10^{-6}m^2\ s^{-1}$ respectively at 313.15 K, and 220 to 350 x $10^{-6}m^2\ s^{-1}$ at 253.15 K. The materials are all mineral oils.

The thirteen viscosity samples from S-2 to H are certified at 313.15 K. On demand, viscosity and density materials will be certified at 298.15, 323.15, and 373.15 K. Samples size is 125 cm^3. The incertainty in the viscosity is 0.2%. This value assumes no uncertainty in the value for the viscosity of water.

Laboratoire National d'Essais (France) Certified Reference Viscosity Materials.

Designation	$10^6\nu/m^2\ s^{-1}$ 293.15 K	313.15 K	Designation	$10^6\nu/m^2\ s^{-1}$ 293.15 K	313.15 K	253.15 K
S-2	3	2	F	400	120	
S-5	7	4	200	635	175	
S-10	18	9	350	1230	330	
A	50	20	G	2100	475	
B	75	30	H	4200	790	
C	110	38	BT 200			220
D	210	70	BT 200A			245
E	270	85	BT 300A			350

The values given in this table are nominal values only.

Supplier C (Physikalisch-Technische Bundesanstalt, Federal Republic of Germany) produces 25 reference materials with viscosities ranging from 1 x 10^{-3} to 31.4 Pa s. The materials are certified at 293.15 K for viscosity, kinematic viscosity, and density. On demand the materials can be certified at any other additional temperature.

Physikalisch-Technische Bundesanstalt (Federal Republic of Germany) Certified Reference Viscosity Materials. Values at 293.15 K

Designation	$10^3\eta$/Pa s	$10^6\nu$/m^2 s^{-1}	Designation	$10^3\eta$/Pa s	$10^6\nu$/m^2 s^{-1}
1B	0.98	1.26	200G*	339	382
2A	2.12	2.65	500B	430	485
5B	4.59	5.72	500F	650	725
10A	8.5	10.2	500E*	875	970
10B	12.9	15.2	2000C	1790	1990
10D*	14.7	16.7	2000E	3040	3500
20C	21.2	24.9	2000F	1940	2260
20E*	45.7	49.8	5000A	4200	4800
50C	88	100	10000A	8900	10200
100D*	131	149	10000D	13600	15400
100C	157	177	10000B	17500	20000
200A	223	254	20000D	31400	35600

Sample sizes are 100 cm^3, 200 cm^3, and 500 cm^3. Samples marked by * indicate that amounts of 1000 cm^3 are also available. For viscosities up to 2 Pa s the uncertainty is 0.2% and for higher viscosities the uncertainty is 0.3%. The viscosity of the samples increase with time but remain within 0.2% within three months. On demand the materials can be certified at additional temperatures. The values given in this table are nominal values only.

Supplier D (National Office of Measures, Hungary) produces a variety of reference materials with viscosities ranging from 2 x 10^{-3} to 1000 Pa s. The materials are certified at 293.15 K for viscosity, kinematic viscosity, and density. Their materials are divided into three groups. Group 1 are mineral oils with viscosities from 2 x 10^{-3} to 5 Pa s having an uncertainty of 0.1%, Group 2 are polymers with viscosities in the range 5 to 100 Pa s having an uncertainty of 0.5% and Group 3 are polymers with viscosities in the range of 100 to 1000 Pa s having an uncertainty of 1.0%. The certification period for all materials is six months. The materials are said to be proved as Newtonian liquids. The uncertainty values given for the viscosity assume no uncertainty in the viscosity of water.

Supplier E (National Research Laboratory of Metrology, Japan) produces 13 reference materials with viscosities ranging from 2 x 10^{-3} to 150 Pa s at 293.15 K. Twelve of the materials are certified at 293.15, 303.15, and 313.15 K, while the highest viscosity material is certified at 293.15 and 298.15 K. The 298.15 K value is not included in the following table.

National Research Laboratory of Metrology (Japan) Certified Reference Viscosity Materials

Designation	η/Pa s			$10^3\nu$/m^2 s^{-1}		
	293.15 K	303.15 K	313.15 K	293.15 K	303.15 K	313.15 K
JS 2.5	0.002	0.0016	0.0013	0.0025	0.0021	0.0017
JS 5	0.004	0.003	0.0025	0.005	0.004	0.003
JS 10	0.008	0.006	0.005	0.010	0.007	0.006
JS 20	0.017	0.011	0.008	0.020	0.014	0.01
JS 50	0.042	0.025	0.018	0.050	0.03	0.021
JS 100	0.085	0.050	0.030	0.1	0.06	0.035
JS 200	0.17	0.090	0.052	0.2	0.11	0.06
JS 500	0.45	0.22	0.12	0.5	0.25	0.14
JS 1000	0.90	0.44	0.22	1	0.5	0.25
JS 2000	1.8	0.80	0.39	2	0.9	0.44
JS 20H	16	6	3	18	7	3
JS 60H	50	19	8	56	21	9
JS 200H	150			170		

The values given in this table are nominal values only and should not be taken to be the actual values of the reference materials supplied. Sample size is 500 cm^3.

Supplier F (Fysisch Chemisch Instituut, Netherlands) produces a variety of reference materials with viscosities ranging from 2.5 x 10^{-3} to 1000 Pa s. The materials are certified at 293.15 K for viscosity and are listed in five groups. Group 1 are mineral oils with

viscosities in the range 2.5 x 10^{-3} to 1 Pa s having an uncertainty of 0.2%, Group 2 are polymers with viscosities in the range 1 to 20 Pa s having an uncertainty of 0.3%, Group 3 are polymers with viscosities in the range 20 to 50 Pa s having an uncertainty of 0.5%, Group 4 are polymers with viscosities in the range 50 to 500 Pa s having an uncertainty of 1%, while Group 5 are polymers with viscosities in the range 500 Pa s to 1000 Pa s having an uncertainty of 2%. The certification period for samples with viscosity less than 1 Pa s is 1 year while the certification period for the high viscosity materials is six months. Samples can be supplied certified at higher and lower temperatures on request. The materials are stated to be Newtonian.

Supplier G (Research and Development Centre for Standard Reference Materials, Poland) produces 18 reference materials with viscosities ranging from 1.5 x 10^{-3} to 600 Pa s. The 11 materials (mineral oils) in the viscosity range 1.5 x 10^{-3} to 4 Pa s are certified at 293.15, 323.25, and 353.15 K for viscosity, kinematic viscosity, and density. The 7 materials (polyisobutenes) in the viscosity range 4.1 to 589 Pa s are certified at 293.15, 323.15 and 313.15 K for viscosity only. The uncertainty limits on the viscosity range from 0.1 per cent in the low viscosity material to 2 per cent for the high viscosity material. An equation is supplied to allow the material to be used at any desired temperature within the range.

Supplier H (National Physical Laboratory, U.K.) does not, at present, produce reference materials but it plans to provide certified liquids for viscosity and kinematic viscosity at 298.15 K in the near future. Seven mineral oils will cover the range 2 x 10^{-3} to 2 Pa s and three polybutenes will cover the range 6 to 60 Pa s. At present this supplier will calibrate glass capillary viscometers.

Supplier J (Cannon Instrument Company, U.S.A.) produces 19 reference materials with viscosities ranging from 0.3 x 10^{-3} to 900 Pa s. The majority of these materials are certified at 293.15 K for viscosity, kinematic viscosity, and density. Some of the materials are certified at a variety of temperatures ranging between 219.2 K and 408 K. Five of the materials specifically reproduce asphalt viscosities up to 900 Pa s between 293.15 K and 408 K and two reproduce viscosities of standard engine lubricants at 219.25 and 233.15 K. These reference materials are sponsored by ASTM D-2, RDDVII-A.

Cannon Instrument Company (U.S.A.) Certified Reference Viscosity Materials

Designation	$10^3\eta$/Pa s 293.15 K	298.15 K	313.15 K	373.15 K
N.4	0.41	0.29	0.26	
N.8	0.73	0.68	0.56	
N1.0	0.92	0.85	0.69	
S3	3.9	3.3	2.4	0.9
S6	9.4	7.6	4.8	1.4
S20	38	29	15	3.1
S60	150	110	46	5.9
S200	560	390	150	14
S600	2100	1400	460	28
S2000	7600	4900	1500	62
S8000	33000	20000	5900	
S30000		72000	20000	

Designation	$10^6\nu$/m^2 s^{-1} 293.15 K	298.15 K	313.15 K	373.15 K
N.4	0.47	0.45	0.40	
N.8	0.95	0.89	0.75	
N1.0	1.3	1.2	0.97	
S3	4.6	4.0	2.9	1.2
S6	11	8.9	5.7	1.8
S20	44	34	18	3.9
S60	170	120	54	7.2
S200	640	450	180	17
S600	2400	1600	520	32
S2000	8700	5600	1700	75
S8000	37000	23000	6700	
S30000		81000	23000	

Designation	Viscosity			
N600	160×10^{-6} m^2 s^{-1}	(333.15 K);	12×10^{-6} m^2 s^{-1}	(408.15 K)
N2000	470×10^{-6} m^2 s^{-1}	(333.15 K);	26×10^{-6} m^2 s^{-1}	(408.15 K)
N8000	1700×10^{-6} m^2 s^{-1}	(333.15 K);		
N30000	120 Pa s	(293.15 K);	24 Pa s	(310.93 K)
N190000	900 Pa s	(293.15 K);	190 Pa s	(310.93 K)
N27B	low temperature viscosity reference material			
N115B	low temperature viscosity reference material			

Certified samples can be supplied at specified temperatures between 273 and 373 K on request. Custom viscosity samples are also supplied. The values given in this table are nominal values only. Sample size is 470 to 500 cm^3.

Supplier J (National Bureau of Standards, U.S.A.) produces 3 reference materials with viscosities ranging from 10 to 10^{11} Pa s. The materials are certified for viscosity in the temperature range 737 K to 1818 K. These materials are designed for testing and calibrating rotating cylinder instruments and fibre elongation equipment.

National Bureau of Standards Certified Reference Materials.

Designation	T/K at η/Pa s 10	10^2	10^3	10^4	10^5	10^6
SRM 710	1707.5	1459.9	1292.2	1178.5	1094.9	1030.3
SRM 711	1600.3	1346.0	1182.2	1067.9	983.6	918.8
SRM 717	1818.3	1522.0	1332.6	1201.1	1104.4	1030.3

Designation	10^7	10^8	10^9	10^{10}	10^{11}
SRM 710	979.3	937.9	903.6	874.7	850.1
SRM 711	867.5	825.9	791.4	762.4	737.7
SRM 717	971.8	924.3	885.1	852.2	824.1

Supplier K (All Union Scientific Research Institute of Metrology, U.S.S.R.) produces 18 reference materials with kinematic viscosities ranging from 2.5×10^{-6} m^2 s^{-1} to 10^2 m^2 s^{-1}.

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I. Cannon Instrument Company, P.O. Box 16, State College, PA 16801 (U.S.A.)

J. National Bureau of Standards, Washington, D.C. 20234 (U.S.A.)

K. All Union Scientific Research Institute of Metrology, Sverdlousk Branch, All Union Scientific Research Centre of the State Service for Standard Samples. (U.S.S.R.)