



Standard Practice for Basic Calibration of Master Viscometers and Viscosity Oil Standards¹

This standard is issued under the fixed designation D2162; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers the calibration of master viscometers and viscosity oil standards, both of which may be used to calibrate routine viscometers as described in Test Method [D445](#) and Specifications [D446](#) over the temperature range from 15 °C to 100 °C.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 The SI-based units for calibration constants and kinematic viscosities are mm^2/s^2 and mm^2/s , respectively.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see Section 7.

2. Referenced Documents

2.1 ASTM Standards:²

[D445](#) Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

[D446](#) Specifications and Operating Instructions for Glass Capillary Kinematic Viscometers

[D1193](#) Specification for Reagent Water

[D1250](#) Guide for Use of the Petroleum Measurement Tables

[D1480](#) Test Method for Density and Relative Density (Specific Gravity) of Viscous Materials by Bingham Pycnometer

[D1590](#) Test Method for Surface Tension of Water

[E1](#) Specification for ASTM Liquid-in-Glass Thermometers

[E563](#) Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

[E644](#) Test Methods for Testing Industrial Resistance Thermometers

[E1137](#) Specification for Industrial Platinum Resistance Thermometers

[E1750](#) Guide for Use of Water Triple Point Cells

[E2593](#) Guide for Accuracy Verification of Industrial Platinum Resistance Thermometers

[E2877](#) Guide for Digital Contact Thermometers

2.2 ISO Standard:³

ISO 3666 Viscosity of Water

3. Terminology

3.1 Definitions:

3.1.1 *digital contact thermometer (DCT)*, *n*—an electronic device consisting of temperature measuring sensor in contact with the material that provides an output to a digital display of the measured value.

3.1.1.1 *Discussion*—This device consists of a temperature sensor connected to a measuring instrument; this instrument measures the temperature-dependent quantity of the sensor, computes the temperature from the measured quantity, and provides a digital output. This digital output goes to a digital display and/or recording device that may be internal or external to the device. These devices are sometimes referred to as a “digital thermometer”.

NOTE 1—Portable electronic thermometers (PET) is an acronym sometimes used to refer to a subset of the devices covered by this definition.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *basic calibration*, *n*—calibration based on the primary standard, water.

3.2.1.1 *Discussion*—Pure water has a kinematic viscosity of 1.0034 mm^2/s at 20 °C. See ISO 3666.

3.2.2 *master viscometer*, *n*—glass capillary viscometer with a liquid driving head of at least 400 mm.

3.2.2.1 *Discussion*—It is specially designed to minimize errors due to surface tension, kinetic energy, and capillary end effects.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

¹ This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.07 on Flow Properties.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

A = 7 - 8 O.D.

B = 3 mL - 3.3 mL + Volume F

C & E - Etched Lines

D = 3 mL - 3.3 mL

F = Working Capillary

G = 8 - 9 O.D.

J = 12 - 13 O.D.

N = 30 ± 1 I.D.

Dimensions are in mm

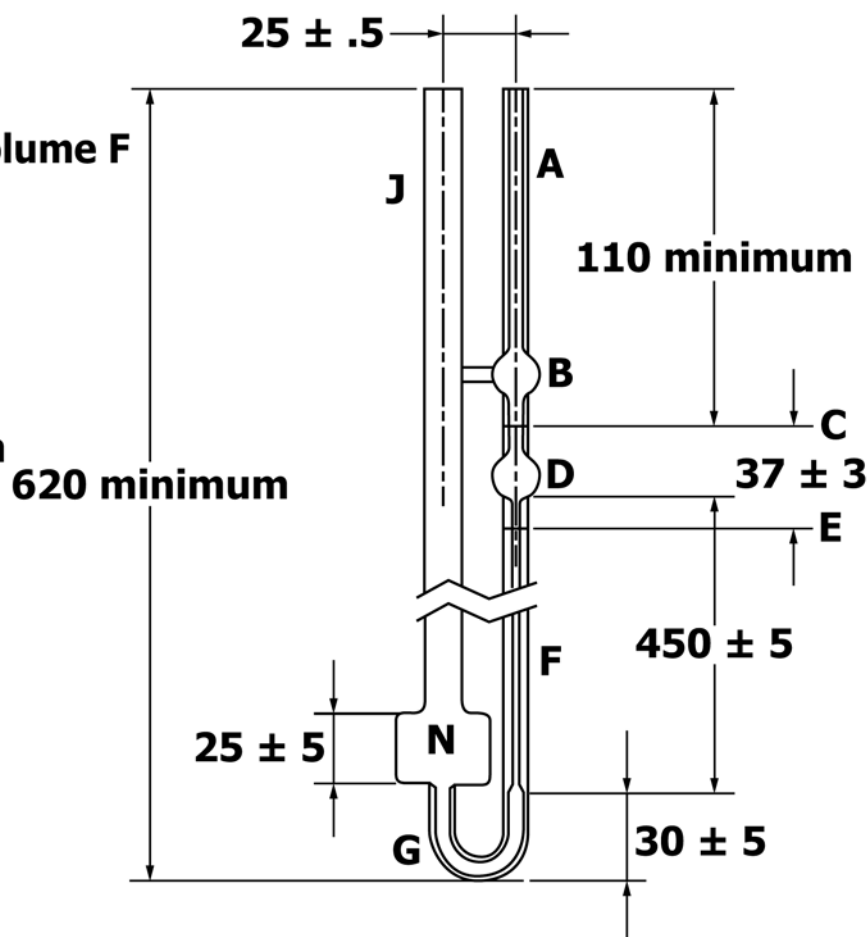


FIG. 1 Cannon Master Viscometer

3.2.3 *viscosity oil standard, n*—stable Newtonian liquid, the kinematic viscosity of which has been related to the kinematic viscosity of water through the step-up procedure described in this practice.

4. Summary of Practice

4.1 Two or more master viscometers, having calibration constants in the $0.001 \text{ mm}^2/\text{s}^2$ to $0.003 \text{ mm}^2/\text{s}^2$ range, are calibrated with water at 20°C . The kinematic viscosities of two or more oil standards are measured at 40°C in these two master viscometers. Corrections are made for buoyancy and, where necessary, for temperature and surface tension.

4.2 A third master viscometer, with a calibration constant of $0.003 \text{ mm}^2/\text{s}^2$ to $0.009 \text{ mm}^2/\text{s}^2$, is then calibrated at 40°C with the two standard oils and its calibration factor calculated at standard conditions for water at 20°C . In like manner additional viscosity oil standards and additional master viscometers are calibrated at 40°C using the average results from at least two master viscometers or two oil standards. Steps between successive calibration constants or viscosities increase by a factor of three or less until the desired viscosity range is covered.

4.3 Oils are calibrated at other temperatures using the average result from at least two master viscometers.

5. Significance and Use

5.1 Because there are surface tension or kinematic viscosity differences, or both, between the primary standard (7.4) and kinematic viscosity standards (7.5), special procedures using master viscometers are required to “step-up” from the kinematic viscosity of the primary standard to the kinematic viscosities of oil standards.

5.2 Using master viscometers calibrated according to this practice, an operator can calibrate kinematic viscometers in accordance with Specifications D446.

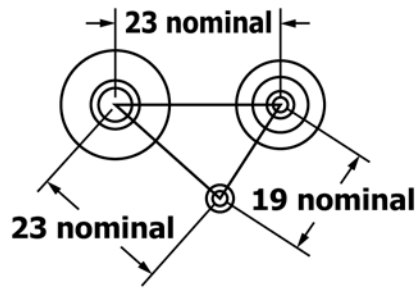
5.3 Using viscosity oil standards established in this practice, an operator can calibrate kinematic viscometers in accordance with Specifications D446.

6. Apparatus

6.1 *Master Viscometers:* Cannon⁴ or Ubbelohde⁵ Type—Acceptable viscometers are shown in Fig. 1 and Fig. 2. Two masters are required with calibration constants in the

⁴ Cannon, M. R., “Viscosity Measurement, Master Viscometers,” *Industrial and Engineering Chemistry*, Analytical Edition, Vol 16, 1944, p. 708.

⁵ Ubbelohde, L., “The Suspended Lever Viscometer,” *Journal Institute Petroleum Technologists* (London), Vol 22, 1936, p. 37.



A = 6 - 7 O.D. & 1 - 1.25 Wall
B = 12 O.D.
C & E - Etched Lines
D = 5.1 mL $\pm$ 0.1 mL & ~ 23 O.D.
F = Working Capillary
G = 17 - 19 O.D.
H = 9 - 10 O.D. & 1.25 - 2 Wall
J = 23 - 25 O.D.
M = 12 - 13 O.D. & 1 - 1.25 Wall
N = 6 - 7 O.D. & 1 - 1.25 Wall
Dimensions are in mm

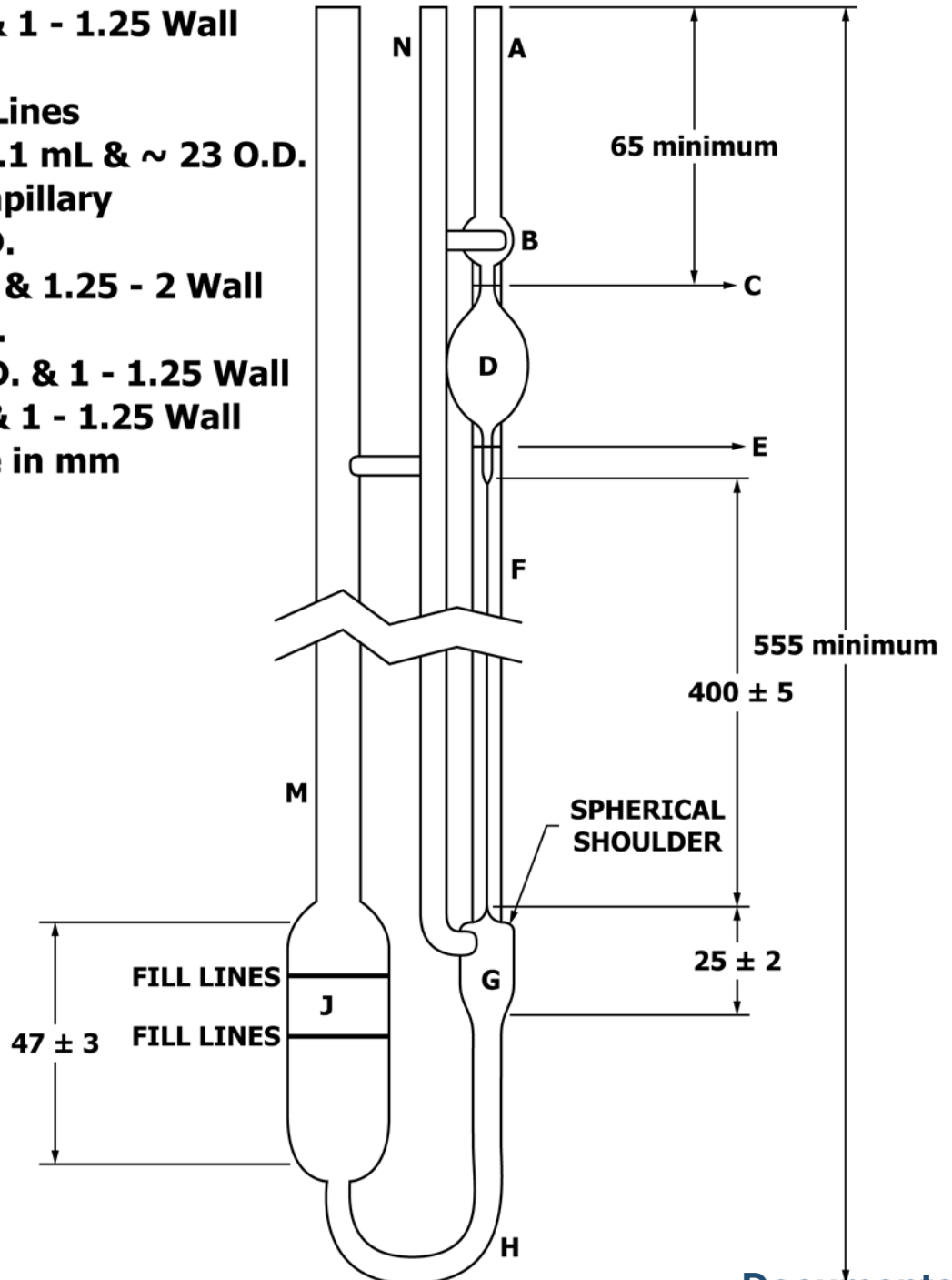


FIG. 2 Ubbelohde Master Viscometer