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AASHTO No: T72
Method 304—Federal Test
Method Standard No. 791b
Replaces Method 4285 of Federal Test
Method Standard No. 141A

Standard Test Method for Saybolt Viscosity¹

This standard is issued under the fixed designation D 88; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the empirical procedures for determining the Saybolt Universal or Saybolt Furol viscosities of petroleum products at specified temperatures between 21 and 99°C (70 and 210°F). A special procedure for waxy products is indicated.

NOTE 1—Test Methods D 445 and D 2170 are preferred for the determination of kinematic viscosity. They require smaller samples and less time, and provide greater accuracy. Kinematic viscosities may be converted to Saybolt viscosities by use of the tables in Practice D 2161. It is recommended that viscosity indexes be calculated from kinematic rather than Saybolt viscosities.

1.2 The values stated in SI units are to be regarded as the standard.

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.*

2. Referenced Documents

2.1 ASTM Standards:

- D 93 Test Methods for Flash Point by Pensky-Martens Closed Tester²
- D 117 Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin³
- D 140 Practice for Sampling Bituminous Materials⁴
- D 244 Test Methods for Emulsified Asphalts⁴

¹ This test method is under the jurisdiction of ASTM Committee D-8 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.05 on Solvent-Bearing Bituminous Compounds for Roofing and Waterproofing.

Current edition approved Sept. 15, 1994. Published November 1994. Originally published as D 88 – 21 T. In 1923, combined with former Methods D 47. Last previous edition D 88 – 81 (1987) ϵ ¹.

² *Annual Book of ASTM Standards*, Vol 05.01.

³ *Annual Book of ASTM Standards*, Vol 10.03.

⁴ *Annual Book of ASTM Standards*, Vol 04.03.

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)²

D 2161 Practice for Conversion of Kinematic Viscosity to Saybolt Universal Viscosity or to Saybolt Furol Viscosity²

D 2170 Test Method for Kinematic Viscosity of Asphalts (Bitumens)⁴

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products⁵

D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products⁵

E 1 Specification for ASTM Thermometers⁶

E 11 Specification for Wire-Cloth Sieves for Testing Purposes⁷

E 102 Test Method for Saybolt Furol Viscosity of Bituminous Materials at High Temperatures⁸

3. Terminology

3.1 Definitions:

3.1.1 *Furol*—an acronym of “Fuel and road oils.”

3.1.2 *Saybolt Furol viscosity*—the corrected efflux time in seconds of 60 mL of sample flowing through a calibrated Furol orifice under specified conditions. The viscosity value is reported in Saybolt Furol seconds, abbreviated SFS, at a specified temperature.

3.1.3 *Saybolt Universal viscosity*—the corrected efflux time in seconds of 60 mL of sample flowing through a calibrated Universal orifice under specified conditions. The viscosity value is reported in Saybolt Universal seconds, abbreviated SUS, at a specified temperature.

4. Summary of Test Method

4.1 The efflux time in seconds of 60 mL of sample, flowing through a calibrated orifice, is measured under carefully

⁵ *Annual Book of ASTM Standards*, Vol 05.02.

⁶ *Annual Book of ASTM Standards*, Vol 14.03.

⁷ *Annual Book of ASTM Standards*, Vol 14.02.

⁸ *Annual Book of ASTM Standards*, Vol 04.04.

controlled conditions. This time is corrected by an orifice factor and reported as the viscosity of the sample at that temperature.

5. Significance and Use

5.1 This test method is useful in characterizing certain petroleum products, as one element in establishing uniformity of shipments and sources of supply.

5.2 See Guide D 117 for applicability to mineral oils used as electrical insulating oils.

5.3 The Saybolt Furol viscosity is approximately one tenth the Saybolt Universal viscosity, and is recommended for characterization of petroleum products such as fuel oils and other residual materials having Saybolt Universal viscosities greater than 1000 s.

5.4 Determination of the Saybolt Furol viscosity of bituminous materials at higher temperatures is covered by Test Method E 102.

6. Apparatus

6.1 *Saybolt Viscometer and Bath*, as shown in Fig. 1 and described in Annex A1.

6.2 *Withdrawal Tube*, as shown in Fig. 2.

6.3 *Thermometer Support*, as shown in Fig. 3.

6.4 *Saybolt Viscosity Thermometers*, as listed in Table 1, for reading the temperature of the sample. Each thermometer shall conform to the requirements listed in Specification E 1 for that ASTM Thermometer Number.

6.5 *Bath Thermometers*—Saybolt Viscosity thermometers, or any other temperature-indicating means of equivalent accuracy.

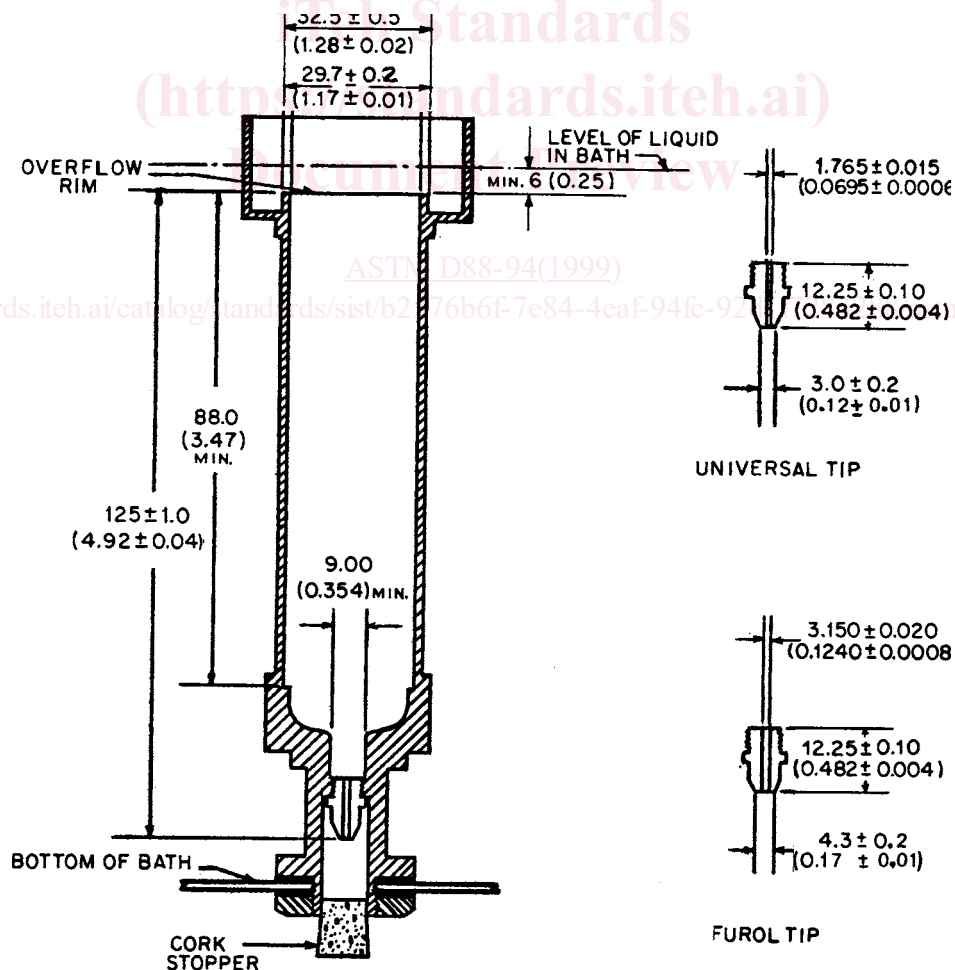
6.6 *Filter Funnel*, as shown in Fig. 4, equipped with interchangeable 150- μm (No. 100) and 75- μm (No. 200) wire-cloth inserts meeting the requirements of Specification E 11 with respect to the wire cloth.

6.7 *Receiving Flask*, as shown in Fig. 5.

6.8 *Timer*, graduated in tenths of a second, and accurate to within 0.1 % when tested over a 60-min interval. Electric timers are acceptable if operated on a controlled frequency circuit.

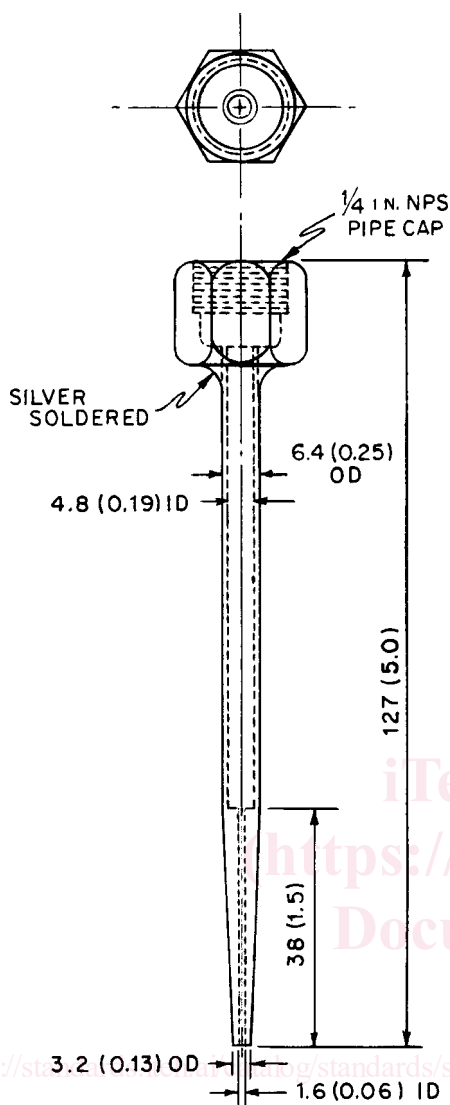
7. Sampling

7.1 Sample the material in accordance with Practices D 140, D 4057, or D 4177, as appropriate.



NOTE 1—All dimensions are in millimetres (inches).

FIG. 1 Saybolt Viscometer with Universal and Furol Orifice



NOTE 1—All dimensions are in millimetres (inches).

FIG. 2 Withdrawal Tube for Use with Saybolt Viscometer

8. Preparation of Apparatus

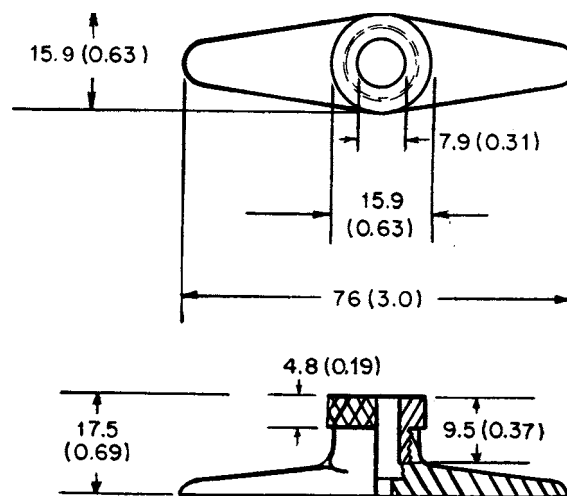
8.1 Use a Universal orifice or tip for lubricants and distillates with efflux times greater than 32 s to give the desired accuracy. Liquids with efflux times greater than 1000 s are not conveniently tested with this orifice.

8.2 Use a Furol orifice or tip for residual materials with efflux times greater than 25 s to give the desired accuracy. See also 5.3.

8.3 Clean the viscometer thoroughly with an appropriate solvent of low toxicity; then remove all solvent from the viscometer and its gallery. Clean the receiving flask in the same manner.

NOTE 2—The plunger commonly supplied with the viscometer should never be used for cleaning; its use might damage the overflow rim and walls of the viscometer.

8.4 Set up the viscometer and bath in an area where they will not be exposed to drafts or rapid changes in air temperature, and dust or vapors that might contaminate a sample.



NOTE 1—All dimensions are in millimetres (inches).

FIG. 3 Thermometer Support

TABLE 1 ASTM Saybolt Viscosity Thermometers

Standard Test Temperature °C (°F)	ASTM Thermometer No.	Thermometer	
		Range° C (°F)	Subdivisions,° C (°F)
21.1 (70)	17C (17F)	19 to 27 (66 to 80)	0.1 (0.2)
25.0 (77)	17C (17F)	19 to 27 (66 to 80)	0.1 (0.2)
37.8 (100)	18C (18F)	34 to 42 (94 to 108)	0.1 (0.2)
50.0 (122)	19C (19F)	49 to 57 (120 to 134)	0.1 (0.2)
54.4 (130)	19C (19F)	49 to 57 (120 to 134)	0.1 (0.2)
60.0 (140)	20C (20F)	57 to 65 (134 to 148)	0.1 (0.2)
82.2 (180)	21C (21F)	79 to 87 (174 to 188)	0.1 (0.2)
98.9 (210)	22C (22F)	95 to 103 (204 to 218)	0.1 (0.2)

8.5 Place the receiving flask (Fig. 5) beneath the viscometer so that the graduation mark on the flask is from 100 to 130 mm (4 to 5 in.) below the bottom of the viscometer tube, and so that the stream of oil will just strike the neck of the flask.

8.6 Fill the bath to at least 6 mm (1/4 in.) above the overflow rim of the viscometer with an appropriate bath medium selected from Table 2.

8.7 Provide adequate stirring and thermal control for the bath so that the temperature of a test sample in the viscometer will not vary more than $\pm 0.03^\circ\text{C}$ ($\pm 0.05^\circ\text{F}$) after reaching the selected test temperature.

8.8 Do not make viscosity measurements at temperatures below the dew point of the room's atmosphere.

8.9 For calibration and referee tests, keep the room temperature between 20 and 30°C (68 and 86°F), and record the actual temperature. However room temperatures up to 38°C (100°F) will not introduce errors in excess of 1 %.

9. Calibration and Standardization

9.1 Calibrate the Saybolt Universal viscometer at periodic intervals by measuring the efflux time at 37.8°C (100°F) of an