Designation: D 4171 – 98

An American National Standard

Standard Specification for Fuel System Icing Inhibitors[1]

This standard is issued under the fixed designation D 4171; 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 specification covers additives for aviation fuels (see Specifications D 910 and D 1655) used to inhibit ice formation in aircraft fuel systems.

1.2 The values stated in SI units are to be regarded as 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 56 Test Method for Flash Point by the Tag Closed Tester[2]

D 93 Test Methods for Flash Point by Pensky-Martens Closed Tester[2]

D 268 Test Methods of Sampling and Testing Volatile Solvents and Chemical Intermediates for Use in Paint and Related Coatings and Materials[3]

D 891 Test Methods for Specific Gravity of Liquid Industrial Chemicals[4]

D 910 Specification for Aviation Gasolines[2]

D 1078 Test Method for Distillation Range of Volatile Organic Liquids[3]

D 1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)[3]

D 1296 Test Method for Odor of Volatile Solvents and Diluents[3]

D 1353 Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer and Related Products[3]

D 1364 Test Method for Water in Volatile Solvents (Fischer Reagent Titration Method)[3]

D 1476 Test Method for Heptane Miscibility of Lacquer Solvents[3]

D 1613 Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products[3]

D 1655 Specification for Aviation Turbine Fuels[2]

D 1722 Test Method for Water Miscibility of Water-Soluble Solvents[3]

D 3828 Test Methods for Flash Point by Small Scale Closed Tester[5]

D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter[5]

E 1 Specification for ASTM Thermometers[6]

E 70 Test Method for PH of Aqueous Solutions with the Glass Electrode[4]

E 203 Test Method for Water Using Karl Fischer Reagent[4]

E 300 Practice for Sampling Industrial Chemicals[4]

E 450 Method for Measurement of Color of Low-Colored Clear Liquids Using the Hunterlab Color Difference Meter[4]

E 1064 Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration[4]

3. Classification

3.1 Two types of fuel system icing inhibitor are provided as follows:

3.1.1 *Type I*—Ethylene glycol monomethyl ether is used as an anti-icing additive in both aviation gasoline and aviation turbine fuels.

NOTE 1—Ethylene glycol monomethy ether (EGME) was previously included in this specification, last appearing in D 4171–94. EGME is considered technically satisfactory for this application, but has been generally replaced by DiEGME due to availability, reduced toxicological concerns, and lack of widely available methodology to determine FSII concentration in aviation fuels when a mixture is known to be present, or when the identity of the FSII present in the fuel is not clearly known.

3.2 *Type II*—Anhydrous isopropanol, also described as 99 % grade 2-Propanol or isopropyl alcohol, is used as an anti-icing additive in aviation gasoline.

NOTE 2—Isopropanol, (2-Propanol). Flammable material. Irritant.

3.3 *Type III*—Diethylene glycol monomethyl ether is used as an anti-icing additive in both aviation gasoline and aviation turbine fuel.

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0 on Aviation Fuels.

Current edition approved June 10, 1998. Published September 1998. Originally published as D 4171 – 82. Last previous edition D 4171 – 97a.

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

[3] *Annual Book of ASTM Standards*, Vol 06.04.

[4] *Annual Book of ASTM Standards*, Vol 15.05.

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

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

NOTE 3—**Warning:** Diethylene glycol monomethyl ether, (DiEGME). Combustible, toxic material.

4. Properties

4.1 *Type II*—Isopropanol anti-icing additive shall conform to the requirements of Table 1, as manufactured.

4.2 *Type III*—Diethylene glycol monomethyl ether shall conform to the requirements of Table 2, as manufactured.

5. Sampling

5.1 The material shall be sampled in accordance with Practice E 300.

6. Test Methods

6.1 The properties enumerated in this specification shall be determined in accordance with the following ASTM methods:

6.1.1 *Relative Density*—Determine the relative density (that is, specific gravity) at 20 or 25°C with respect to water by a method accurate to the third decimal place. See Section 5 of Test Method D 268, Test Method D 4052, or Method A or B of D891.

6.1.2 *Color*—Test Method D 1209 or E 450.

TABLE 1 Detailed Requirements for Isopropanol (99 % Grade) (Type II) FSII

Property	Requirement	ASTM Test Method
Acidity, max, mg KOH/g	0.019	D 1613
Relative density:		
20/20°C	0.785 to 0.787	D 268
25/25°C	0.782 to 0.784	D 268
Color, platinum-cobalt, max	10	D 1209 or E450
Distillation range, max, °C	1.5 (including 82.3°C)	D 1078
Nonvolatile matter, max, mg/100 mL	5	D 1353
Odor	characteristic, nonresidual	D 1296
Water, max, mass %	0.2	D 1364
Heptane miscibility at 20°C	miscible without turbidity with 19 vol 99 % heptane	D 1476
Water miscibility at 25°C	miscible without turbidity when diluted with 10 vol distilled water	D 1722

TABLE 2 Detailed Requirements for Fuel System Icing Inhibitors (Type III)

Property	Requirement	ASTM Test Method
	DiEGME (Type III)	
Acid number, max, mg KOH/g	0.09	D 1613
Color, platinum-cobalt, max	10	D 1209 or E450
Purity, min, mass %	99.0	Annex A1
pH of 25 % solution in water (25 ± 2°C)	5.5–7.5	E 70[A]
Relative density, 20°/20°C	1.020–1.025	D 891 (Method A or B) or D4052
Water, max, mass %		D 1364, E1064, or E 203
Point of manufacture	0.10	
Point of use	0.8	
Flash point, min, °C	85°C	D 93, D56, or D 3828
Antioxidant, mg/kg	50–150	[B]

[A] Twenty-five milliliters of the inhibitor shall be pipetted into a 100-ml volumetric flask and filled with freshly boiled and cooled distilled water having a pH of 6.5 to 7.5. The pH value shall be measured with a pH meter calibrated in accordance with Test Method E 70.

[B] Acceptable antioxidants are: 2,6-ditertiary-butyl-4-methylphenol, 2,4-dimethyl-6-tertiary-butyl phenol, 2,6-ditertiary-butyl phenol, and 75 % min 2,6-ditertiary-butyl phenol plus 25 % max tertiary and tritertiary butyl phenols.

6.1.3 *Distillation Range*—Test Method D 1078 using ASTM Solvents Distillation Thermometers (40C with a range from 72 to 126°C for isopropanol) conforming to the requirements of Specification E 1.

6.1.4 *Nonvolatile Matter*—Test Method D 1353.

6.1.5 *Odor*—Test Method 1296.

6.1.6 *Water*—Test Method D 1364, E 1064, or E 203.

6.1.7 *Heptane Miscibility*—Test Method D 1476.

6.1.8 *Acidity*—Test Method D 1613.

6.1.9 *Water Miscibility*—Test Method D 1722.

6.1.10 *Flash Point*—Test Methods 56, D 93, or D 3828.

7. Keywords

7.1 additives; aircraft fuel systems; aviation fuels; fuel system icing inhibitors; ice formation

ANNEX

(Mandatory Information)

A1. TEST METHOD FOR DETERMINING PURITY OF FUEL SYSTEM ICING INHIBITORS (TYPES I AND III)

A1.1 Scope

A1.1.1 This test method measures the purity of fuel system icing inhibitors (Type III). The test results are used to determine if the inhibitor meets the purity requirements listed in Table 2.

A1.2 Summary of Test Method

A1.2.1 A representative sample of fuel system icing inhibitor (Type III) is injected into a capillary gas chromatograph and the components of the inhibitor are separated and measured with a flame ionization detector. Quantitation is made by peak area measurement using external standardization and a computing integrator. As the linear dynamic range of many gas chromatographic detectors is often exceeded for the major component, the sum of all impurities (all components other than the inhibitor) are subtracted from 100 to calculate the purity of the icing inhibitor.

A1.3 Significance and Use

A1.3.1 Fuel system icing inhibitor performance (Type III) is based upon test results using the pure inhibitor in a specific concentration range. Impurities affect inhibitor solubility in the fuel and reduce the effective concentration. Methods are