



Designation: D4171 – 22

Standard Specification for Fuel System Icing Inhibitors¹

This standard is issued under the fixed designation D4171; 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 (for example, Specifications [D910](#), [D7547](#), and [D1655](#)) used to inhibit ice formation in aircraft fuel systems.

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

1.3 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use Caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

[D56](#) Test Method for Flash Point by Tag Closed Cup Tester
[D93](#) Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0.04 on Additives and Electrical 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.

[D268](#) Guide for Sampling and Testing Volatile Solvents and Chemical Intermediates for Use in Paint and Related Coatings and Material
[D891](#) Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals
[D910](#) Specification for Leaded Aviation Gasolines
[D1078](#) Test Method for Distillation Range of Volatile Organic Liquids
[D1209](#) Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)
[D1296](#) Test Method for Odor of Volatile Solvents and Diluents (Withdrawn 2021)³
[D1353](#) Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products
[D1364](#) Test Method for Water in Volatile Solvents (Karl Fischer Reagent Titration Method)
[D1476](#) Test Method for Heptane Miscibility of Lacquer Solvents (Withdrawn 2021)³
[D1613](#) Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products
[D1655](#) Specification for Aviation Turbine Fuels
[D1722](#) Test Method for Water Miscibility of Water-Soluble Solvents
[D3828](#) Test Methods for Flash Point by Small Scale Closed Cup Tester
[D4052](#) Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
[D5006](#) Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
[D5386](#) Test Method for Color of Liquids Using Tristimulus Colorimetry
[D7547](#) Specification for Hydrocarbon Unleaded Aviation Gasoline
[D8005](#) Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)
[E1](#) Specification for ASTM Liquid-in-Glass Thermometers
[E70](#) Test Method for pH of Aqueous Solutions With the Glass Electrode

³ The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

[E203](#) Test Method for Water Using Volumetric Karl Fischer Titration

[E300](#) Practice for Sampling Industrial Chemicals

[E1064](#) Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

[E2251](#) Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

[E2877](#) Guide for Digital Contact Thermometers

3. Classification

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

3.1.1 *Type II*—Anhydrous isopropanol, also described as 99 % grade 2-Propanol or isopropyl alcohol, is used as an anti-icing additive in aviation gasoline. (**Warning**—Isopropanol (2-Propanol) is both flammable and an irritant; use with caution.)

3.1.2 *Type III*—Diethylene glycol monomethyl ether (DiEGME) is used as an anti-icing additive in both aviation gasoline and aviation turbine fuel. (**Warning**—Diethylene glycol monomethyl ether, (DiEGME). Combustible, toxic material.)

3.1.2.1 Test Method [D5006](#) can be used to determine the concentration of DiEGME in aviation fuels.

NOTE 1—Ethylene glycol monomethyl ether (EGME) was previously included in this specification as Type I, last appearing in D4171 – 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.

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.

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

Property	Requirement	ASTM Test Method
Acidity, max, mg KOH/g	0.019	D1613
Relative density:		
20 °C/20 °C	0.785 to 0.787	D268
25 °C/25 °C	0.782 to 0.784	D268
Color, platinum-cobalt, max	10	D1209 , D8005 , or D5386
Distillation range, max, °C	1.5 (including 82.3 °C)	D1078
Nonvolatile matter, max, mg/100 mL	5	D1353
Odor	characteristic, nonresidual	D1296
Water, max, mass %	0.2	D1364
Heptane miscibility at 20 °C	miscible without turbidity with 19 vol heptane (99 % Grade)	D1476
Water miscibility at 25 °C	miscible without turbidity when diluted with 10 vol distilled water	D1722

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

Property	Requirement	
	DiEGME (Type III)	ASTM Test Method
Acid number, max, mg KOH/g	0.09	D1613
Color, platinum-cobalt, max	10	D1209 , D8005 , or D5386
Purity, min, mass %	99.0	Annex A1
pH of 25 % solution in water (25 °C ± 2 °C)	5.5–7.5	E70 ^A
Relative density, 20 °C/20 °C	1.020–1.025	D891 (Method A or B) or D4052
Water, max, mass %		D1364 , E1064 , or E203
Point of manufacture	0.10	
Point of use	0.8	
Flash point, min, °C	85 °C	D93 , D56 , or D3828
Antioxidant, mg/kg	50–150	^B

^A Pipette 25 mL of the inhibitor into a 100 mL volumetric flask and filled with freshly boiled and cooled distilled water having a pH of 6.5 to 7.5. Measure the pH value with a pH meter calibrated in accordance with Test Method [E70](#).

^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.

5. Sampling

5.1 The material shall be sampled in accordance with Practice [E300](#).

6. Test Methods

6.1 Determine the properties enumerated in this specification in accordance with the following ASTM methods:

6.1.1 *Relative Density*—Determine the relative density (that is, specific gravity) at 20 °C or 25 °C with respect to water by a method accurate to the third decimal place. See Section 5 of Test Method [D268](#), Test Method [D4052](#), or Method A or B of Test Methods [D891](#).

6.1.2 *Color*—Test Method [D1209](#), [D8005](#), or [D5386](#).

6.1.3 *Distillation Range*—Test Method [D1078](#) using ASTM Solvents Distillation Thermometers (40C with a range from 72 °C to 126 °C for isopropanol) conforming to the requirements of Specification [E1](#) or any other temperature measuring device that cover the temperature range of interest, such as thermocouples, thermistors, or resistance temperature detectors (RTDs). An instrument meeting Guide [E2877](#) or Specification [E2251](#) may be used in preference to 40C if the instrument provides equivalent or better accuracy and precision.

6.1.4 *Nonvolatile Matter*—Test Method [D1353](#).

6.1.5 *Odor*—Test Method [D1296](#).

6.1.6 *Water*—Test Method [D1364](#), [E1064](#), or [E203](#).

6.1.7 *Heptane Miscibility*—Test Method [D1476](#).

6.1.8 *Acidity*—Test Method [D1613](#).

6.1.9 *Water Miscibility*—Test Method [D1722](#).

6.1.10 *Flash Point*—Test Methods [D56](#), [D93](#), or [D3828](#).

7. Keywords

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