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An American National Standard

Standard Specification for Ethyl Tertiary-Butyl Ether (ETBE) for Blending with Aviation Spark-Ignition Engine Fuel[1]

This standard is issued under the fixed designation D7618; 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 requirements for fuel grade ethyl *tertiary*-butyl ether (ETBE) that may be used for blending with fuels for aviation spark-ignition engines where permissible. Other ETBE grades available in the marketplace that do not comply with the requirements of this specification, are not suitable for blending with aviation fuels.

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 *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.*

1.4 *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]

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D156 Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

D381 Test Method for Gum Content in Fuels by Jet Evaporation

D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4171 Specification for Fuel System Icing Inhibitors

D4176 Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

D7796 Test Method for Analysis of Ethyl tert-Butyl Ether (ETBE) by Gas Chromatography

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

3. Terminology

3.1 *Definitions:*

3.1.1 *ethanol, n*—chemical compound C_2H_5OH.

3.1.2 *methanol, n*—chemical compound CH_3OH.

3.1.3 *ethyl tertiary-butyl ether (ETBE), n*—chemical compound $CH_3CH_2OC(CH_3)_3$.

3.1.4 *tertiary-butyl alcohol (TBA), n*—chemical compound $(CH_3)_3COH$.

3.1.5 *methyl tertiary-butyl ether (MTBE), n*—chemical compound $CH_3OC(CH_3)_3$.

3.1.6 *oxygenate, n*—oxygen-containing ashless, organic compound, such as an alcohol or ether, which may be used as a fuel or fuel supplement.

4. Detailed Requirements

4.1 ETBE that may be used for blending with fuels for aviation spark-ignition engines shall conform to the requirements of Table 1.

[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.

TABLE 1 Detailed Requirements

Property	Limits	ASTM Test Method[A]
Ethyl tertiary-butyl ether, % by mass, min.	95.0	D7796
Ethanol, % by mass, max.	1.5	D7796
Methanol, % by mass, max.	0.3	D7796
Tertiary-butyl alcohol, % by mass, max	1.5	D7796
Methyl tertiary-butyl ether, % by mass, max.	2.0	D7796
C_2-C_4 Oxygenates,[B] % by mass, max.	1.5	D7796
C_4-C_6 Hydrocarbons,[C] % by mass, max.	1.5	D7796
C_8-C_{10} Hydrocarbons,[D] % by mass, max.	2.0	D7796
Unidentified hydrocarbons, % by mass, max.	1.0	D7796
Water, % by mass, max.	0.1	E1064 or E203
Copper strip corrosion, max.	1	D130
Appearance	Clear and bright	D4176
Color, Saybolt, min.	+ 16	D156
Existent gum content, mg/100 mL, max.	5.0	D381
Density at 15 °C, kg/L	0.735 to 0.755	D1298 or D4052

[A] The test methods indicated in this table are referred to in Section 7.
[B] Oxygenates, excluding alcohols, of combined concentrations of diethyl and dimethyl ethers, acetone and methyl ethyl ketone.
[C] Combined concentrations of isopentane, pentane, and hexane paraffins, and isobutylene olefin.
[D] Combined concentrations of C_8 isobutylene dimers mainly derived from the dimerization of C_4-C_5 compounds, and *iso*octane.

5. Workmanship

5.1 The ETBE shall be visually free of undissolved water, sediment, and suspended matter. It shall be clear and bright at the ambient temperature or 21 °C, whichever is lower.

5.2 The specification defines only a basic purity for this product. The product shall be free of any adulterant or contaminant that could render the material unacceptable for the intended application.

6. Sampling, Containers, and Sample Handling

6.1 The user is strongly advised to review all intended test methods prior to sampling in order to understand the importance and effects of sampling technique, proper containers, and special handling required for each test method.

6.2 Correct sampling procedures are critical to obtain a sample representative of the lot intended to be tested. Use of appropriate procedures in Practice D4057 or Practice E300 for manual method sampling and in Practice D4177 for automatic method sampling as applicable.

6.3 The correct sample volume and appropriate container selection are important decisions that can impact test results. Refer to Practice D5854 for procedures on container selection and sample mixing and handling. Where practical, ETBE should be sampled in glass containers. If samples must be collected in metal containers, do not use soldered metal containers. This is because the soldering flux in the containers and the lead in the solder can contaminate the samples. Plastic containers should be avoided.

6.4 *Sample Size*—A minimum of about 2 L is recommended.

7. Test Methods

7.1 The scopes of some of the test methods specified below do not include ETBE, thus the precision of those test methods when testing ETBE can differ from the reported precisions.

7.2 *ETBE, mass %*—Test Method D7796.

7.3 *Ethanol, mass %*—Test Method D7796.

7.4 *Methanol, mass %*—Test Method D7796.

7.5 *Water, mass %*—Test Method E1064 or E203.

7.6 *Copper Strip Corrosion*—Test Method D130, 2 h at 100 °C.

7.7 *Appearance*—Test Method D4176, Procedure 1.

7.8 *Color, Saybolt*—Test Method D156.

7.9 *Existent Gum Content*—Test Method D381, air-jet apparatus.

7.10 *Density at 15 °C, kg/L*—Test Method D1298 or D4052.

8. Keywords

8.1 aviation spark-ignition engine fuel; blending; corrosion; ETBE; ethanol; ethyl *tertiary*-butyl ether; impurities; methanol; water content

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF ASTM SPECIFICATION FOR ETBE FOR BLENDING WITH AVIATION SPARK-IGNITION ENGINE FUEL

X1.1 General

X1.1.1 ETBE may be used as a blending component for certain aviation spark ignition engine fuel, if listed as an approved blending component in the specification for that aviation fuel. The performance requirements of this specification were established to help ensure that the addition (in appropriate amounts) of ETBE as described in this specification would not be detrimental to the properties of the fuel blend.

X1.2 Ethyl Tertiary Butyl Ether Purity

X1.2.1 The ETBE minimum purity level limits the quantities of contaminants. Laboratory analyses and engine tests performed with distinct neat ETBE products, revealed that higher purities (higher ETBE content) yielded corresponding higher knock performance characteristics, and some organic compounds other than ETBE can adversely affect other properties of finished fuel blends.

X1.3 Ethanol Content

X1.3.1 Ethanol is one of the reactants in the production of ETBE and is a potential contaminant. Ethanol contributes to vapor pressure increase, reduced knock performance, adverse impact on water reaction tests of the finished fuel, and when used in conjunction with Specification D4171 Type II isopropanol icing inhibitor additive, it could cause corrosion of metallic fuel system components and/or degradation of elastomeric components.

X1.4 Methanol Content

X1.4.1 Methanol is reportedly used by some technologies in the last stage of the etherification process to increase the conversion. As a potential contaminant, methanol contributes to vapor pressure increase and could cause corrosion of metallic fuel system components, and/or degradation of elastomeric components.

X1.5 Tertiary-butyl Alcohol Content

X1.5.1 As a potential contaminant, TBA exhibits solvent characteristics and an adverse impact on water reaction tests of the finished fuel, and when used in conjunction with Specification D4171 Type II isopropanol icing inhibitor additive, it could cause corrosion of metallic fuel system components and/or degradation of elastomeric components.

X1.6 Methyl Tertiary-Butyl Ether Content

X1.6.1 Concentrations under 1.0 % MTBE have been routinely reported on finished product, however, extensive testing on aviation engines and fuel systems materials compatibility tests revealed no problems with gasoline blends exhibiting MTBE mass concentrations exceeding 15 %.

X1.7 C_2-C_4 Oxygenates Content

X1.7.1 The combined C_2-C_4 oxygenate concentrations of diethyl and dimethyl ethers, acetone and methyl ethyl ketone, are limited to control the volatility impact of the ethers and the solvency characteristics of the ketones.

X1.8 C_4-C_6 Hydrocarbons Content

X1.8.1 Combined C_4-C_6 hydrocarbon concentrations of isopentane, pentane, isobutylene and hexane, are mostly stable components found in gasoline.

X1.9 C_8-C_{10} Hydrocarbon Content

X1.9.1 Combined concentrations of both C8 isobutylene dimers mainly derived from the dimerization of C_4-C_5 compounds, and *iso*octane, while common hydrocarbon components in gasoline, must be limited due to their low storage stability characteristics.

X1.10 Unidentified Hydrocarbons Content

X1.10.1 Combined unidentified hydrocarbons are mainly hydrocarbon - type compounds, such as 2,3 dimethyl-pentane or 2,4 dimethyl-pentane, or possibly oxygenates but as the name suggests, they are unrecognized in the gas chromatographic analyses.

X1.11 Water Content

X1.11.1 Blends of ETBE and hydrocarbon gasoline have a limited solvency for water. This solvency varies with the chemical composition, temperature, and ETBE content of the fuel. Excess water (which may be soluble in the ETBE) may not be soluble in the gasoline-ETBE blend resulting in a hazy fuel, and may compromise the fuel system icing prevention features.

X1.12 Copper Strip Corrosion

X1.12.1 Fuels must pass the copper strip corrosion test to minimize corrosion in fuel systems due to sulfur compounds in the fuel. This limit is included to ensure that the ETBE does not contribute to copper corrosion.

X1.13 Appearance

X1.13.1 ETBE, as covered by this specification, is a relatively pure material. Suspended materials, sediments, or contaminants in the ETBE which cause a cloudy or colored appearance may adversely affect the performance of the finished fuel blend in aviation spark-ignition engines. Also a cloudy or colored appearance may indicate excessive water or contamination by materials not measured by this specification.

X1.14 Color

X1.14.1 The color of a product may serve as an indication of possible contamination with another product.

X1.15 Existent Gum Content

X1.15.1 The test for existent gum content measures the amount of residue after evaporation of the fuel component without any further treatment. The limit is included to indicate contamination before ETBE is blended to gasoline.

X1.15.2 Because the precision statements for Test Method D381 were developed using only data on hydrocarbons, they may not be applicable to ETBE.

X1.16 Density

X1.16.1 Determination of the density of this product is necessary for the conversion of measured volumes to volumes at the standard temperature of 15 °C.