



Designation: D8235 – 21

# Standard Specification for Ethyl Tertiary-Butyl Ether (ETBE) for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel<sup>1</sup>

This standard is issued under the fixed designation D8235; 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 ( $\epsilon$ ) 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) utilized as a blend component at the 1 % to 22 % by volume for use as automotive spark-ignition engine fuel covered by Specifications **D4814** and **D8076** as well as other automotive fuel applications involving ETBE.

1.1.1 Other ETBE grades may be available for blending that are not covered by this specification. Specification **D7618** is also available from ASTM International.

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 The following applies to all specified limits in this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of Practice **E29**. All digits expressed in the specification limits are to be considered significant digits.

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.*

<sup>1</sup> 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.A0.02** on Oxygenated Fuels and Components.

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## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

- 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
- D2622** Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D3120** Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry
- D4057** Practice for Manual Sampling of Petroleum and Petroleum Products
- D4175** Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- D4177** Practice for Automatic Sampling of Petroleum and Petroleum Products
- D4306** Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
- D4806** Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
- D4814** Specification for Automotive Spark-Ignition Engine Fuel
- D5453** Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
- D5854** Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D5983** Specification for Methyl Tertiary-Butyl Ether (MTBE) for Blending With Gasolines for Use as Automotive Spark-Ignition Engine Fuel

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

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

- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
  - D7039 Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
  - D7618 Specification for Ethyl Tertiary-Butyl Ether (ETBE) for Blending with Aviation Spark-Ignition Engine Fuel
  - D7757 Test Method for Silicon in Gasoline and Related Products by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
  - D7796 Test Method for Analysis of Ethyl tert-Butyl Ether (ETBE) by Gas Chromatography
  - D7923 Test Method for Water in Ethanol and Hydrocarbon Blends by Karl Fischer Titration
  - D8076 Specification for 100 Research Octane Number Test Fuel for Automotive Spark-Ignition Engines
  - E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
  - 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
- 2.2 Government Regulations:<sup>3</sup>  
 CFR 40 Code of Federal Regulations

### 3. Terminology

3.1 For general terminology, refer to Terminology D4175.

NOTE 1—The user is advised that the definitions used by various industries, marketers, and regulatory bodies can differ from those used in this specification. It is the responsibility of the user to ensure that the terms used in a particular context are clearly understood.

#### 3.2 Definitions:

3.2.1 *ethanol, n*—ethyl alcohol, the chemical compound CH<sub>3</sub>CH<sub>2</sub>OH. **D4806**

3.2.2 *ethyl tertiary-butyl ether (ETBE), n*—the chemical compound CH<sub>3</sub>CH<sub>2</sub>OC(CH<sub>3</sub>)<sub>3</sub>

3.2.2.1 *Discussion*—ETBE is also known as 2-ethoxy-2-methylpropane.

3.2.3 *finished fuel, n*—a homogeneous mixture of blendstocks and fuel additives meeting all specification and regulatory requirements for its intended use at the location where sold. **D4814**

3.2.4 *methyl tertiary-butyl ether (MTBE), n*—the chemical compound CH<sub>3</sub>OC(CH<sub>3</sub>)<sub>3</sub>. **D5983**

3.2.4.1 *Discussion*—MTBE is also known as 2-methoxy-2-methylpropane.

3.2.5 *oxygenate, n*—a molecule composed solely of carbon, hydrogen, and oxygen. **D4814**

3.2.5.1 *Discussion*—In this standard, the oxygenate of interest is ETBE.

### 3.3 Abbreviations:

3.3.1 *C4*—a molecule containing 4 carbon atoms.

3.3.2 *C6*—a molecule containing 6 carbon atoms.

## 4. Performance Requirements

4.1 ETBE used in fuels for ground vehicles equipped with spark-ignition engines shall conform to the requirements of Table 1.

4.2 *Other Properties*—Limits more restrictive than those specified in Table 1, or the specification of additional properties may be agreed upon between the supplier and the purchaser.

## 5. Workmanship

5.1 At the point of custody transfer, the ETBE shall be visually free of undissolved water, sediment, suspended or undissolved matter. It shall be clear and bright at the fuel temperature at the point of custody transfer or at a lower temperature agreed upon by the purchaser and seller.

5.1.1 Ethers, such as ETBE, are visually clear and bright under normal conditions when free of contamination. If the product is not clear and bright, contamination of the product may have occurred.

5.2 The specification defines only a basic purity for this product. The product shall be free of any adulterant or contaminant that can render the material unacceptable for its commonly used applications.

5.2.1 If the product appears discolored prior to the addition of any colored additives, contamination of the product may have occurred and testing for contamination may be warranted. Test Method D156 may be helpful in assessing the degree of color of the product.

5.3 Manufacturers and importers of ETBE shall avoid contamination by silicon-containing materials. Silicon contamination of gasoline-oxygenate blends has led to fouled vehicle components (for example, spark plugs, exhaust oxygen sensors, catalytic converters) requiring parts replacement and repairs. Test Method D7757 is a procedure for determining silicon that might be applicable to ETBE. Additional studies will be needed to include ETBE into the scope of Test Method D7757. No specification limits have been established for silicon.

TABLE 1 Performance Requirements

Property	Limit	ASTM Test Method
ETBE, % by mass, min	95.0	D7796
Ethanol, % by mass, max	2.5	D7796
C4-C6 Hydrocarbons, % by mass, max	1.5	D7796
MTBE, % by mass, max	2.0	D7796
Water, % by mass, max	0.10	D6304, D7923, E203, E1064
Sulfur, mg/kg, max	30 <sup>A</sup>	D2622, D3120, D5453, D7039
Copper Strip Corrosion, max	1	D130
Solvent washed gum content, mg/100 mL, max	5 <sup>B</sup>	D381

<sup>A</sup> Individual jurisdictions may require a more restrictive sulfur limit. These requirements are to be negotiated between buyer and seller.

<sup>B</sup> The limit is included to ensure that finished fuels do not contain excess solvent-washed gum.

<sup>3</sup> Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

5.4 Manufacturers and importers of ETBE shall avoid contamination by chloride-containing materials such as salt water or halogenated hydrocarbons. Low concentrations of chloride ions are corrosive to many metals.

5.5 Manufacturers and importers of ETBE shall avoid contamination by sulfur-containing materials that can cause an increase in the fuel sulfur content.

5.6 In case of dispute or cargo contamination and to test for suitability for the intended use, corrosion test values shall not exceed those of automotive spark-ignition engine fuel specifications.

## 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 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 D4306 for aviation fuel container selection for tests sensitive to trace contamination. 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 have to 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 0.5 L is recommended.

6.5 *Lot Size*—A lot shall normally consist of the amount contained in a tanker compartment or other bulk container in which it is delivered. If this definition does not apply, the definition of a lot must be agreed upon between the supplier and purchaser.

NOTE 2—See Sections 5, 6, and 7 on Significance, Safety, and Statistical Considerations, respectively, of Practice E300 for a detailed discussion of the statistics of sampling.

## 7. Test Methods

7.1 The requirements of this specification shall be determined in accordance with the methods listed below. The precision of a test method can differ from the reported precision when testing ETBE. There may be government, state or local regulations that specify the test method to be used for compliance purposes.

7.2 *ETBE, percent by mass*—Test Method D7796.

7.3 *Ethanol, percent by mass*—Test Method D7796.

7.4 *C4-C6 Hydrocarbons, percent by mass*—Test Method D7796.

7.5 *MTBE, percent by mass*—Test Method D7796.

7.6 *Water Content, percent by mass*—Test Method D6304, D7923, E203, E1064.

7.7 *Sulfur, (mg/kg)*—Test Methods D2622, D3120, D5453, D7039.

7.8 *Copper Strip Corrosion*—Test Method D130. Preferable procedure is the Pressure Vessel procedure at 50 °C for 3 h.

7.9 *Solvent Washed Gum Content*—Test Method D381.

## 8. Keywords

8.1 automotive spark-ignition engine fuel; ETBE; ethyl tertiary-butyl ether; ethanol; MTBE; methyl tertiary-butyl ether; oxygenate; sulfur; water content

## APPENDIX

(Nonmandatory Information)

### X1. SIGNIFICANCE OF ASTM SPECIFICATION FOR ETBE FOR DOWNSTREAM BLENDING FOR USE IN AUTOMOTIVE SPARK-IGNITION ENGINE FUEL AND SPECIFIED PROPERTIES

#### X1.1 General

X1.1.1 Ethyl tertiary-butyl ether may be used as a blending component for automotive spark-ignition engine fuel to meet oxygenate content requirements or improve the antiknock quality, or both, of certain types of fuels.

X1.1.2 The composition of unleaded fuel is subject to the rules, regulations, and Clean Air Act waivers of the U.S. Environmental Protection Agency (EPA). The use of oxygenates in blends with unleaded gasoline is described under Section 211(f) (1) of the Clean Air Act. 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 finished fuel.

#### X1.2 Ethyl tertiary-Butyl Ether

X1.2.1 The ethyl tertiary-butyl ether minimum purity level limits the quantities of contaminants. Some organic compounds other than ETBE can adversely affect the properties of finished fuels.

#### X1.3 Ethanol

X1.3.1 Ethanol is one of the reactants in the production of ETBE. The limit is set to minimize the incremental effect on fuel vapor pressure.