Designation: D5983 – 15

Standard Specification for Methyl Tertiary-Butyl Ether (MTBE) for Downstream Blending for Use in Automotive Spark-Ignition Engine Fuel[1]

This standard is issued under the fixed designation D5983; 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 methyl *tertiary*-butyl ether utilized in commerce, terminal blending, or downstream blending with fuels for spark-ignition engines. Other MTBE grades may be available for blending that are not covered by this specification.

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

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
D4045 Test Method for Sulfur in Petroleum Products by Hydrogenolysis and Rateometric Colorimetry
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
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
D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
D4814 Specification for Automotive Spark-Ignition Engine Fuel
D4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
D5441 Test Method for Analysis of Methyl Tert-Butyl Ether (MTBE) by Gas Chromatography
D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
D7757 Test Method for Silicon in Gasoline and Related Products by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
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 *methanol, n*—the chemical compound CH_3OH.

3.1.2 *methyl tertiary-butyl ether (MTBE), n*—the chemical compound $(CH_3)_3COCH_3$ [$C_5H_{12}O$].

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

4. Performance Requirements

4.1 Methyl *tertiary*-butyl ether utilized in commerce, terminal blending, or downstream blending with fuels for ground vehicles equipped with spark-ignition engines shall conform to the requirements of Table 1.

NOTE 1—Individual applications may require a more restrictive sulfur limit. These requirements are to be negotiated between buyer and seller.

5. Workmanship

5.1 At the point of custody transfer, the MTBE 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.

NOTE 2—Fuel components should be resistant to phase separation or

[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.A0.02 on Oxygenated Fuels and Components.

Current edition approved Oct. 1, 2015. Published October 2015. Originally approved in 1996. Last previous edition approved in 2013 as D5983 – 13. DOI: 10.1520/D5983-15.

[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.

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

TABLE 1 Performance Requirements

Property	Limits
Appearance	Clear and bright
Color, Saybolt, min	+ 5
Sulfur, mg/kg, max	300
Solvent-washed gum content, mg/100 mL, max	5.0
Copper strip corrosion, max	1
MTBE, % by mass, min	95.0
Methanol, % by mass, max	0.5
Vapor pressure, kPa, max	62
Water, % by mass, max	0.10
API gravity at 15.6 °C or density at 15 °C, kg/L	Report

undissolved matter at the lowest temperatures to which it is likely to be subjected, dependent on the time and place of its intended use. See Specification D4814, Table X7.1 for guidance.

NOTE 3—Solubility is temperature dependent. As this fuel component cools, water and some high molecular weight additives can become insoluble.

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.

5.3 Manufacturers and importers of MTBE 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 MTBE. Additional studies will be needed to include MTBE into the scope of Test Method D7757. No specification limits have been established for silicon.

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, MTBE 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.

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.

7. Test Methods

7.1 The scope of some of the test methods specified below do not include MTBE. The precision of those test methods may differ from the reported precisions when testing MTBE.

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

7.3 *Sulfur*—Test Method D4045 (see Note 4).

7.4 *Solvent-Washed Gum Content*—Test Method D381, air-jet apparatus.

7.5 *MTBE, %* by mass —Test Method D5441.

7.6 *Methanol, %* by mass —Test Method D5441.

7.7 *API Gravity at 15.6 °C*—Practice D1298.

7.8 *Density at 15 °C*—Practice D1298 or Test Method D4052.

7.9 *Copper Strip Corrosion*—Test Method D130, 3 h at 50 °C.

7.10 *Water Content*—Test Methods E203 or E1064.

7.11 *Vapor Pressure*—Test Method D4953.

7.12 *Color, Saybolt*—Test Method D156.

NOTE 4—Test Method D4045 may require dilution of the sample with a sulfur-free diluent.

8. Keywords

8.1 automotive spark-ignition engine fuel; blending; corrosion; impurities; methanol; methyl *tertiary*-butyl ether; oxygenate; water content

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF ASTM SPECIFICATION FOR MTBE FOR DOWNSTREAM BLENDING FOR USE IN AUTOMOTIVE SPARK-IGNITION ENGINE FUEL

X1.1 General

X1.1.1 Methyl *tertiary*-butyl ether may be used as a blending component for automotive spark-ignition engine fuel to meet the oxygenate content requirements or improve the antiknock quality, or both, of certain types of fuels. MTBE purchased under this specification will assist terminal or downstream blenders in the use of MTBE as a blending component.

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 MTBE as described in this specification would not be detrimental to the properties of the fuel blend.

X1.2 Appearance

X1.2.1 Methyl *tertiary*-butyl ether as covered by this specification is a relatively pure material. Suspended materials, sediments, or contaminants in the MTBE which cause a cloudy or colored appearance may adversely affect the performance of the finished fuel blend in automotive spark-ignition engines. Also, a cloudy or colored appearance may indicate excessive water or contamination by materials not directly measured under this specification.

X1.2.1.1 Fuel components can encounter conditions in the bulk distribution system that could cause the material to fail a workmanship visual evaluation. Some fuel components can contain water, dirt, or rust particles during distribution. Terminals or bulk plants can address these issues with proper operating procedures, for example, by allowing sufficient time for the free water, dirt, or particles to settle in a tank, by filtration or by other means.

X1.2.1.2 Turbidity, phase separation, or evidence of precipitation normally indicate contamination.

X1.3 Sulfur

X1.3.1 Sulfur and sulfur-containing compounds contribute to engine wear, deterioration of engine oil, exhaust catalyst deactivation, and corrosion of exhaust system parts in spark-ignition engine systems. The limit on sulfur is included to ensure that the finished blend of fuel is not detrimental to these systems.

X1.4 Solvent-Washed Gum Content

X1.4.1 The test for solvent-washed gum content measures the amount of residue after evaporation of the fuel component and following a heptane wash. The heptane wash removes the heptane-soluble, nonvolatile material such as additives, carrier oils used with additives, and diesel fuels. Solvent-washed gum consists of fuel-insoluble gum and fuel-soluble gum. The fuel-insoluble portion can clog fuel filters. Both can be deposited on surfaces when the fuel evaporates. The solvent-washed gum content test may also indicate contamination of the methyl *tertiary*-butyl ether during shipping and storage. The limit is included to ensure that finished blends of gasoline do not contain excess solvent-washed gum and handling contamination is minimized.

X1.4.2 Solvent-washed gum can contribute to deposits on the surfaces of carburetors, fuel injectors, and intake manifolds, ports, valves, and valve guides. The impact of solvent-washed gum on malfunctions of modern engines is not well established, and the current limit has been assumed from the historic gasoline limit rather than from any recent correlative work. It depends on where the deposits form, the presence of other deposit precursors such as airborne debris, blowby and exhaust gas, recirculation gases, and oxidized engine oil, and the amount of deposits.

X1.4.3 Because the precision statements for Test Method D381 were developed using only data on hydrocarbons, they may not be applicable to MTBE.

X1.5 Copper Strip Corrosion

X1.5.1 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 methyl *tertiary*-butyl ether does not contribute to copper corrosion.

X1.6 Methyl Tertiary-Butyl Ether Purity

X1.6.1 The methyl *tertiary*-butyl ether minimum purity level limits the quantities of contaminants. Some organic compounds other than MTBE may adversely affect the properties of finished fuel blends.

X1.7 Methanol Content

X1.7.1 Methanol is one of the reactants in the production of MTBE and is a potential contaminant. Methanol contributes to vapor pressure increase and poorer water tolerance of finished fuel blends. The U.S. EPA *substantially similar rule* limits the methanol content of unleaded fuels. Therefore, it is necessary to limit the methanol content of MTBE.

X1.8 Water Content

X1.8.1 Blends of MTBE and hydrocarbon gasoline have a limited solvency for water. This solvency will vary with the chemical composition, temperature, and MTBE content of the fuel. Excess water (which may be soluble in the MTBE) may not be soluble in the gasoline-MTBE blend and could result in a hazy fuel that does not meet the *clear and bright* requirement of Specification D4814. The water content of MTBE used for

blending with hydrocarbon gasoline is limited to reduce the risk of haze formation.

X1.9 Vapor Pressure

X1.9.1 The vapor pressure of a finished fuel blend must be high enough to ensure ease of engine starting. Excessive vapor pressure, however, may contribute to vapor lock or high evaporative emissions and running losses.

X1.9.2 The vapor pressure of MTBE is controlled to prevent adversely affecting the vapor pressure of the finished blend. A vapor pressure in excess of the value specified in Section 4 may indicate contamination by a light hydrocarbon. Therefore, the vapor pressure must be controlled.

SUMMARY OF CHANGES

Subcommittee D02.A0 has identified the location of selected changes to this standard since the last issue (D5983 – 13) that may impact the use of this standard. (Approved Oct. 1, 2015.)

(1) Revised subsection 5.1 and 5.2; added new Note 2 and Note 3.

(2) Added new subsections X1.2.1.1 and X1.2.1.2.