



Designation: **D7901–14 D7901 – 14a**

## Standard Specification for Dimethyl Ether for Fuel Purposes<sup>1</sup>

This standard is issued under the fixed designation D7901; 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-Scope\*

1.1 This specification covers dimethyl ether (DME) for use as a fuel in engines specifically designed or modified for DME and for blending with liquefied petroleum gas (LPG). This specification is for use by manufacturers of dimethyl ether, by engine developers of purpose-built engines, in contracts for the purchase of DME for fuel purposes, and for the guidance of consumers of this type of fuel.

NOTE 1—The generation and dissipation of static electricity can create problems in the handling of DME. For more information on the subject, see Guide [D4865](#).

1.2 The values stated in SI units are to be regarded as standard. Units in parentheses are for information only.

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:<sup>2</sup>

- [D1265 Practice for Sampling Liquefied Petroleum \(LP\) Gases, Manual Method](#)
- [D1267 Test Method for Gage Vapor Pressure of Liquefied Petroleum \(LP\) Gases \(LP-Gas Method\)](#)
- [D1838 Test Method for Copper Strip Corrosion by Liquefied Petroleum \(LP\) Gases](#)
- [D2158 Test Method for Residues in Liquefied Petroleum \(LP\) Gases](#)
- [D2163 Test Method for Determination of Hydrocarbons in Liquefied Petroleum \(LP\) Gases and Propane/Propene Mixtures by Gas Chromatography](#)
- [D3700 Practice for Obtaining LPG Samples Using a Floating Piston Cylinder](#)
- [D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems](#)
- [D6667 Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases by Ultraviolet Fluorescence](#)
- [D6897 Test Method for Vapor Pressure of Liquefied Petroleum Gases \(LPG\) \(Expansion Method\)](#)
- [D7756 Test Method for Residues in Liquefied Petroleum \(LP\) Gases by Gas Chromatography with Liquid, On-Column Injection](#)
- [D7828 Test Method for Determination of Residue Composition in Liquefied Petroleum Gas \(LPG\) Using Automated Thermal Desorption/Gas Chromatography \(ATD/GC\)](#)

#### 2.2 Other Documents:

- [NFPA 77 Recommended Practice on Static Electricity](#)<sup>3</sup>
- [ISO/DIS 17196 Dimethyl ether \(DME\) for fuels—Determination of impurities—Gas chromatographic method](#)<sup>4</sup>
- [ISO 17197 Dimethyl ether \(DME\) for fuels—Determination of water content—Karl Fischer titration method](#)<sup>4</sup>

### 3. Terminology

#### 3.1 Abbreviations:

- 3.1.1 *DME*—dimethyl ether, the chemical compound ( $\text{CH}_3\text{OCH}_3$ ).

<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.H0](#) on Liquefied Petroleum Gas.

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<sup>2</sup> 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.

<sup>3</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, [http://www.nfpa.org](#).

<sup>4</sup> Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, [http://www.iso.org](#).

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

3.1.2 *LPG*—liquefied petroleum gas.

#### 4. Chemical Composition and Other Requirements

4.1 The DME fuel for purpose-built engines and for blending with liquefied petroleum gas shall conform to the requirements prescribed in **Table 1**.

NOTE 2—Additional information on the physical and chemical properties of dimethyl ether, which are not considered necessary for fuel specification at this point, are in **Appendix X1** and are given for information of fuel suppliers, OEMs, and users.

4.2 The properties selected for limitation are those for which indications exist from experience with similar techniques and from initial engine developmental work that they are required for obtaining acceptable engine performance.

4.3 The maximum vapor pressure limit shown in **Table 1** is given to limit any high vapor pressure components such as gases [CO and CO<sub>2</sub>] and also to ensure that the same containers (tanks, tank cars, and rail cars) designed for LPG can be used for DME.

NOTE 3—It is expected that additional requirements for specifying dimethyl ether for fuel applications could be required as purpose-built engines and other applications develop for DME and DME – LPG blends, and such additional requirements would be balloted for inclusion into this specification, based on need and technical data.

#### 5. Workmanship, Finish, and Appearance

5.1 DME for fuel use in engines designed for DME and for blending with liquefied petroleum gas shall have a colorless appearance and not contain any components or contaminants that would be detrimental to the intended use of the material.

#### 6. Sampling

6.1 Review all intended test methods prior to sampling to understand the importance and effects of sampling technique, proper containers, and special handling required for each test method.

6.2 Samples shall be representative of the batch of product and shall be collected from an appropriate storage container (typically an aboveground storage tank) or pipeline by a suitable sampling procedure such as Practice **D1265** or Practice **D3700**.

6.3 *Sample Size*—A minimum of 1 litre is recommended.

6.3.1 Follow the same safety procedures when sampling DME as when sampling LPG, and leave an ullage space of at least 20 % in a high pressure sampling cylinder.

#### 7. Test Methods

7.1 The requirements of this specification shall be determined in accordance with the methods listed below. The scopes of some of the test methods listed below do not include dimethyl ether. Refer to the listed test methods to determine applicability or required modifications for use with dimethyl ether. The precision of these test methods can differ from the reported precisions when testing dimethyl ether.

**TABLE 1 Detailed Requirements for Dimethyl Ether for Fuel Purposes**

Property	Test Method	Requirement
Dimethyl Ether, mass %, min. <sup>A</sup>	<b>D2163</b>	98.5
Methanol, mass %, max.	<b>D2163</b>	0.05
Water, mass %, max.	<b>ISO 17197</b>	0.03
Methyl Formate, mass %	<b>D2163</b>	report
Sulfur, mg / kg, max. <sup>B</sup>	<b>D6667</b>	3
Vapor Pressure, kPa (psig), at 37.8 °C (100 °F), max.	<b>D1267, D6897</b>	758 (110)
Corrosion, Copper Strip, at 37.8 °C (100 °F), max.	<b>D1838</b>	No. 1
Residue	<b>D2158</b>	
Residue on evaporation of 100 mL, mL, max.		0.05
Oil stain observation		pass
Lubricity	—	<sup>c</sup>

<sup>A</sup>The The required minimum ensures that DME for fuel purposes will have a minimum estimated cetane number of 55.

<sup>B</sup>The The sulfur limit does not include the sulfur from an odorant such as ethyl mercaptan that might be required by some regulatory agencies in some fuel applications. Note that addition of 1 pound of ethyl mercaptan per 10 000 US gallons will increase the sulfur content of DME by 14 milligrams sulfur per litre of DME or 21 milligrams sulfur per kilogram of DME.

<sup>C</sup> Experience in both laboratory and full scale vehicle testing indicates pure DME has poor natural lubricity. Adequate precautions shall be taken to ensure the lubricity is sufficient to meet the needs of the end use application. At present, no industry accepted test method or limit value is available to define the lubricity of highly volatile liquid fuels such as DME. Until such a test is available, suppliers of DME intended for use as a fuel in compression ignition engines shall consult the engine or vehicle manufacturer for guidance on appropriate lubricity requirements.

7.2 *Composition*—Test Method **D2163**.

7.2.1 Laboratory experience has shown that Test Method **D2163** requires the use of a 150 metre methyl silicone column in order to analyze samples of DME.

7.3 *Water*—**ISO 17197**.

7.4 *Sulfur*—Test Method **D6667** should be used for sulfur determination.

7.5 *Vapor Pressure*—Test Methods **D1267** and **D6897** may be used for vapor pressure determination. In case of dispute, Test Method **D1267** shall be the referee test method.

7.6 *Corrosion*—Test Method **D1838**.

7.7 *Residue*—Test Method **D2158**.

## 8. Keywords

8.1 dimethyl ether; DME

## APPENDICES

(Nonmandatory Information)

### X1. PHYSICAL AND CHEMICAL PROPERTIES OF DIMETHYL ETHER

X1.1 A selection of physical and chemical properties of dimethyl ether, as outlined in **Table X1.1**, has been assembled from a variety of sources. These are believed to be the best available data. The table will be updated as new or more reliable data is developed.

X1.2 Additional information on the properties of dimethyl ether can be found in the “DME Handbook Supplement” [English Edition] [ISBN 978-4-9903839-1-6], published October, 2011.<sup>5</sup>

### X2. SIGNIFICANCE OF ASTM SPECIFICATIONS FOR DIMETHYL ETHER FOR FUEL APPLICATIONS

X2.1 DME is a new fuel that could address environmental and fuel security issues. A fuel specification for DME is necessary for several reasons:

(1) To give manufacturers of DME, intended to be used as a fuel, a specification to meet;

<sup>5</sup> Available from Japan DME Forum (JDF), 3F Shinsei Bldg. 6-5-5, Shinbashi, Minato-ku, Tokyo 105-0004. Tel: +81-3-5403-0035, Fax: +81-3-5403-0038, Email: info@dmeforum.jp, Website: www.dmeforum.jp/

**TABLE X1.1 Physical and Chemical Properties of Dimethyl Ether**

Property	Value
Chemical Formula	CH <sub>3</sub> OCH <sub>3</sub>
CAS No.	115-10-6
Molecular weight, g/mol	46.07
Melting point, °C	-141.5
Boiling point, °C	-25.1
Vapor pressure at 20 °C, kPa	510
Critical temperature, °C	126.85
Critical pressure, MPa	5.37
Critical volume, cm <sup>3</sup> /mol	178
Liquid density at 20 °C, g/cm <sup>3</sup>	0.67
Specific Gravity of DME Vapor (versus Air)	1.59
Color	Colorless
Odor	Faint “ether” smell
Flammability Limits in Air, vol %	3.4 to 17
Estimated Cetane Number	55
Calorific Value, LHV, kcal/L, 20 °C (net heat of combustion)	4600
DME solubility in water, g/100 mL at 18 °C	7
Solubility parameter, (cal/cm <sup>3</sup> ) <sup>0.5</sup>	7.3
Wobbe Index, kJ/m <sup>3</sup>	46198
Acentric factor	0.204