



Designation: D7901 – 23

## 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

### 1. 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, health, and environmental 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:<sup>2</sup>

- D1265 Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method
- D1267 Test Method for Gauge Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method)
- D1838 Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases

<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.

Current edition approved Oct. 1, 2023. Published November 2023. Originally approved in 2014. Last previous edition approved in 2020 as D7901 – 20. DOI: 10.1520/D7901-23.

<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.

- 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) (Withdrawn 2021)<sup>3</sup>

#### 2.2 Other Documents:

- NFPA 77 Recommended Practice on Static Electricity<sup>4</sup>
- ISO 17196 Dimethyl ether (DME) for fuels—Determination of impurities—Gas chromatographic method<sup>5</sup>
- ISO 17197 Dimethyl ether (DME) for fuels—Determination of water content—Karl Fischer titration method<sup>5</sup>

### 3. Terminology

#### 3.1 Abbreviations:

- 3.1.1 DME—dimethyl ether, the chemical compound ( $\text{CH}_3\text{OCH}_3$ ).
- 3.1.2 LPG—liquefied petroleum gas.

### 4. Hazards

4.1 **Warning**—Dimethyl ether is a highly flammable, colorless gas with a faint ether-like odor. It is shipped and stored in

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

<sup>5</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

a pressurized, liquefied state, much like LPG. Unlike LPG, dimethyl ether has a wide flammability range and a low autoignition temperature. Further, dimethyl ether in this specification is intended for use in a diesel (compression-ignition) engine. Many users of diesel engines are familiar with the relative safety of storing and handling diesel fuel. However, dimethyl ether has significantly higher flammability hazards than diesel fuel. A leak of dimethyl ether could result in a dangerous fire or explosive situation, but the intrinsic ether-like odor is mild and not alarming, as is the case with odorized natural gas or LP gases. Users of dimethyl ether are advised to determine proper odorization or alternative leak detection precautions.

4.2 Consult a Material Safety Data Sheet for dimethyl ether for additional hazards.

## 5. Chemical Composition and Other Requirements

5.1 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.

5.2 The properties selected for limitation are chosen from other specifications for DME which have relevance to engine operation and to related experience (for example, LPG).

5.3 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.

## 6. Workmanship, Finish, and Appearance

6.1 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.

## 7. Sampling

7.1 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.

7.2 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**.

7.3 *Sample Size*—A minimum of 1 L is recommended.

7.3.1 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.

## 8. Test Methods

8.1 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.

8.2 *Sample Introduction*—For all test methods, ensure the sample to be tested is representative of the liquid DME product and is not a vapor phase sample that could have a different composition from a liquid phase sample.

8.3 *Composition*—Test Method **D2163**.

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

8.3.2 ISO 17196 is the preferred test method for methanol and methyl formate analysis, as Test Method **D2163** lacks reference to oxygenate testing requirements.

8.4 *Water*—ISO 17197. While ISO 17197 is written for both coulometric and volumetric Karl Fischer reagents, only coulometric Karl Fischer reagents shall be used for DME testing due to the low water concentration levels present in DME.

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

**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> ,<br>ISO 17196 | 0.05        |
| Water, mass %, max.                                      | <b>ISO 17197</b>            | 0.03        |
| Methyl Formate, mass %                                   | <b>D2163</b> ,<br>ISO 17196 | report      |
| Sulfur, mg / kg, max. <sup>B</sup>                       | <b>D6667</b>                | 3           |
| Vapor Pressure, kPa (psig),<br>at 37.8 °C (100 °F), max. | <b>D1267, D6897</b>         | 758 (110)   |
| Corrosion, Copper Strip,<br>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                                                | —                           | C           |

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

<sup>B</sup> 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 lb of ethyl mercaptan per 10 000 US gallons will increase the sulfur content of DME by 14 mg sulfur per litre of DME or 21 mg 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.