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# Standard Specification for 100 Research Octane Number Test Fuel for Automotive Spark-Ignition Engines<sup>1</sup>

This standard is issued under the fixed designation D8076; 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 the requirements of a high octane number fuel suitable for spark-ignition engines to be utilized in ground vehicles that will require 100 research octane number (RON) minimum rated fuel.

1.1.1 The fuels described by this specification are intended for developing technologies that lead to reduced vehicle energy consumption, such as higher compression ratio, higher power density, increased turbocharger boost pressure, smaller swept displacement volume, and operation at lower engine speeds.

1.1.2 The fuels described in this test fuel specification may or may not meet all of the performance or regulatory requirements for use in vehicles using commercial gasoline.

1.2 The fuels covered in this specification may contain oxygenates, such as alcohols and ethers, at up to 50 % by volume. This specification covers fuels that may contain both fossil and bio-derived components.

1.2.1 Fuels containing methanol are not included in this specification.

1.3 This specification provides a description of high RON fuel for automotive spark-ignition engines that are not currently in the marketplace but are being developed and require a defined standard test fuel. The high RON fuel could become available in the marketplace if/when such engines are introduced in commerce. The specification is under continuous review, which can result in revisions based on changes in fuel, automotive requirements, or test methods, or a combination thereof. All users of this specification, therefore, should refer to the latest edition.

NOTE 1—If there is any doubt as to the latest edition of Specification D8076, contact ASTM International Headquarters.

1.4 The values stated in SI units are the standard.

1.4.1 *Exception*—Non-SI values are provided for information only. U.S. federal regulations frequently specify non-SI units.

<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.A0.01 on Gasoline and Gasoline-Oxygenate Blends.

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1.5 *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>

D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

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

D381 Test Method for Gum Content in Fuels by Jet Evaporation

D525 Test Method for Oxidation Stability of Gasoline (Induction Period Method)

D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

D2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel

D2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel

D3120 Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry

D3237 Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy

D3831 Test Method for Manganese in Gasoline By Atomic Absorption Spectroscopy

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

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

<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.

- 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
- D4815** Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C<sub>1</sub> to C<sub>4</sub> Alcohols in Gasoline by Gas Chromatography
- D4953** Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
- D5059** Test Methods for Lead in Gasoline by X-Ray Spectroscopy
- D5191** Test Method for Vapor Pressure of Petroleum Products (Mini Method)
- D5453** Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
- D5482** Test Method for Vapor Pressure of Petroleum Products (Mini Method—Atmospheric)
- D5599** Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection
- D5842** Practice for Sampling and Handling of Fuels for Volatility Measurement
- D5845** Test Method for Determination of MTBE, ETBE, TAME, DIPE, Methanol, Ethanol and *tert*-Butanol in Gasoline by Infrared Spectroscopy
- D5854** Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D5983** Specification for Methyl Tertiary-Butyl Ether (MTBE) for Downstream Blending for Use in Automotive Spark-Ignition Engine Fuel
- D6378** Test Method for Determination of Vapor Pressure (VP<sub>x</sub>) of Petroleum Products, Hydrocarbons, and Hydrocarbon-Oxygenate Mixtures (Triple Expansion Method)
- D6920** Test Method for Total Sulfur in Naphthas, Distillates, Reformulated Gasolines, Diesels, Biodiesels, and Motor Fuels by Oxidative Combustion and Electrochemical Detection
- 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
- D7220** Test Method for Sulfur in Automotive, Heating, and Jet Fuels by Monochromatic Energy Dispersive X-ray Fluorescence Spectrometry
- D7319** Test Method for Determination of Existent and Potential Sulfate and Inorganic Chloride in Fuel Ethanol and Butanol by Direct Injection Suppressed Ion Chromatography
- D7328** Test Method for Determination of Existent and Potential Inorganic Sulfate and Total Inorganic Chloride in Fuel Ethanol by Ion Chromatography Using Aqueous Sample Injection
- D7667** Test Method for Determination of Corrosiveness to Silver by Automotive Spark-Ignition Engine Fuel—Thin Silver Strip Method
- D7671** Test Method for Corrosiveness to Silver by Automotive Spark-Ignition Engine Fuel—Silver Strip Method
- D7862** Specification for Butanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- 2.2 *Government Regulations:*  
**CFR Title 40** Protection of Environment<sup>3</sup>  
**CCR Title 17—Public Health—Section 60100–60114** Description of California Air Basins<sup>4</sup>
- 2.3 *Technical Report:*  
**CRC Report No. 660** Fuel Antiknock Quality—Engine Response to RON Versus MON Scoping Tests, Final Report, May 2011<sup>5</sup>

### 3. Terminology

3.1 For general terminology, refer to Terminology **D4175**.

3.2 *Definitions:*

3.2.1 *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**

3.2.2 *gasoline, n*—a volatile mixture of liquid hydrocarbons, generally containing small amounts of additives, suitable for use as a fuel in spark-ignition, internal combustion engines. **D4814**

3.2.3 *gasoline-oxygenate blend, n*—a fuel consisting primarily of gasoline along with a substantial amount (more than 0.35 % by mass oxygen) of one or more oxygenates. **D4814**

3.2.4 *octane sensitivity (S), n*—the mathematical difference between RON and MON ( $S = \text{RON} - \text{MON}$ ).

3.2.5 *oxygenate, n*—an oxygen-containing, ashless, organic compound, such as an alcohol or ether, which can be used as a fuel or fuel supplement. **D4814**

### 4. Ordering Information

4.1 The volatility of the fuel shall be agreed upon between buyer and seller.

4.2 State the concentration and types of oxygenates present as agreed upon between buyer and seller.

<sup>3</sup> Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

<sup>4</sup> Available from Barclays, 50 California Street, San Francisco, CA 94111.

<sup>5</sup> Available from Coordinating Research Council, 5755 North Point Parkway, Suite 265, Alpharetta, GA 30022, <http://www.crcrao.org>.

**5. Performance Requirements for High Octane Number Test Fuel**

5.1 High octane number test fuel shall conform to the requirements of **Table 1**, and meet the volatility requirements of **Table 2**. The significance of each of the properties of this specification is shown in **Appendix X1**.

5.1.1 The user is advised to review applicable national, state, provincial, or local fuel requirements.

5.1.1.1 In the United States there may be additional Clean Air Act requirements that must be fulfilled prior to introduction of the high octane number fuel into commerce. See Appendix X3 in Specification **D4814** for information on U.S. Environmental Protection Agency (EPA) regulations for spark-ignition engine fuels.

5.1.2 The following applies to all specified limits in this specification: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded to the nearest unit in the right-most significant digit used in expressing the specification limit, in accordance with the rounding method of Practice **E29**. For a specification limit expressed as an integer, a trailing zero is significant only if the decimal point is specified. For a specified limit expressed as an integer, and the right-most digit is non-zero, the right-most digit is significant without a decimal point being specified. This convention applies to specified limits in **Tables 1 and 2**.

5.2 RON and octane sensitivity are critical performance parameters for the fuels described in this specification. Engine knock and laboratory octane number are described in **X1.2** and **X1.3**, respectively.

5.2.1 For engines with increased compression ratio, higher boost pressure, operating at slower speeds, and smaller swept displacement volume, a high RON, combined with high octane sensitivity, are well correlated with knock resistance.

5.2.2 Octane sensitivity is the mathematical difference between the research and motor octane numbers and is considered a measure of the autoignition temperature sensitivity of a fuel. In high compression ratio, highly boosted engines operating at low engine speeds, if RON is held constant, a fuel with greater octane sensitivity (all other factors being equal) will provide greater knock resistance.

**TABLE 2 Vapor Pressure and Distillation Requirements<sup>A</sup>**

Property	Vapor Pressure/ Distillation	ASTM Test Methods
Vapor pressure, at 37.8 °C (100 °F), kPa (psi), max	62 (9.0)	D4953, D5191, D5482, or D6378
Distillation temperatures, °C (°F), at % evaporated and 101.3 kPa pressure (760 mm Hg)		
10 % by volume, max	70. (158)	
50 % by volume		D86
min	66 (150.)	
max	121 (250.)	
90 % by volume, max	190. (374)	
End point, max	225 (437)	
Distillation residue, % by volume, max	2	D86

<sup>A</sup> See 5.1.2 for determining conformance with numerical specification limits in this table.

5.2.3 A minimum motor octane number (MON) is required to ensure antiknock performance for all engines at high ambient temperature and certain other conditions (see CRC Report No. 660).

5.3 Volatility requirements for the high octane number test fuel are specified in **Table 2**. Different limits on dry vapor pressure equivalent (DVPE), T50, and other volatility parameters may be agreed upon between buyer and seller. For guidance on volatility requirements for specific climatic conditions, consult section 5.2.1 of Specification **D4814**.

**5.4 Oxygenate Blendstock Requirements:**

5.4.1 Denatured fuel ethanol used in blending high octane number fuel shall conform to the requirements of Specification **D4806**.

5.4.2 Butanol used in blending high octane number fuel shall conform to the requirements of Specification **D7862**.

5.4.3 Methyl *tert*-butyl ether (MTBE) used in blending high octane number fuel shall conform to the requirements of Specification **D5983**.

5.5 Deposit control additives are added to spark-ignition engine fuel to help keep fuel injectors and intake valves clean.

5.5.1 In the United States, deposit control additives used in gasoline are required to be certified by the EPA. As this specification is for a test fuel, requirements for deposit control additives have not been determined.

**TABLE 1 High Octane Number Test Fuel Specifications<sup>A</sup>**

Property	Limit	ASTM Test Method
Research octane number, min	100.	D2699
Motor octane number, min	86	D2700
Sensitivity, min	8	D2699, D2700
Inorganic chloride, mg/kg, max	1	D7319 or D7328 as modified in 7.1.12
Lead content, g/L (g/U.S. gal), max	0.013 (0.05)	D3237 or D5059
Sulfur, mg/kg, max	10	D1266, D2622, D3120, D5453, D6920, or D7039
Manganese content, mg/L (mg/U.S. gal), max <sup>B</sup>	See 6.3	D3831
Copper strip corrosion, max	No. 1	D130
Silver strip corrosion, max	No. 1	D7667 or D7671
Solvent-washed gum content, mg/100 mL, max	5	D381
Oxidation stability, minutes, min	240.	D525

<sup>A</sup> See 5.1.2 for determining conformance with numerical specification limits in this table.

<sup>B</sup> See **Appendix X2** for information on U.S. EPA and California Air Resources Board regulations for manganese in gasoline.