



Designation: D2699 – 24a

Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel¹

This standard is issued under the fixed designation D2699; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This laboratory test method covers the quantitative determination of the knock rating of liquid spark-ignition engine fuel in terms of Research O.N., including fuels that contain up to 25 % v/v of ethanol. However, this test method may not be applicable to fuel and fuel components that are primarily oxygenates.² The sample fuel is tested using a standardized single cylinder, four-stroke cycle, variable compression ratio, carbureted, CFR engine run in accordance with a defined set of operating conditions. The O.N. scale is defined by the volumetric composition of PRF blends. The sample fuel knock intensity is compared to that of one or more PRF blends. The O.N. of the PRF blend that matches the K.I. of the sample fuel establishes the Research O.N.

1.2 The O.N. scale covers the range from 0 to 120 octane number but this test method has a working range from 40 to 120 Research O.N. Typical commercial fuels produced for spark-ignition engines rate in the 88 to 101 Research O.N. range. Testing of gasoline blend stocks or other process stream materials can produce ratings at various levels throughout the Research O.N. range.

1.3 The values of operating conditions are stated in SI units and are considered standard. The values in parentheses are the historical inch-pound units. The standardized CFR engine measurements continue to be in inch-pound units only because of the extensive and expensive tooling that has been created for this equipment.

1.4 For purposes of determining conformance with all specified limits in this standard, an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand digit used in expressing the specified limit, in accordance with the rounding method of Practice E29.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see Section 8, 14.4.1, 15.5.1, 16.6.1, Annex A1, A2.2.3.1, A2.2.3.3 (6) and (9), A2.3.5, X3.3.7, X4.2.3.1, X4.3.4.1, X4.3.9.3, X4.3.11.4, and X4.5.1.8.

1.6 *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:³

- D1193 Specification for Reagent Water
- D2268 Test Method for Analysis of High-Purity *n*-Heptane and Isooctane by Capillary Gas Chromatography
- D2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel
- D2885 Test Method for Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique
- D3703 Test Method for Hydroperoxide Number of Aviation Turbine Fuels, Gasoline and Diesel Fuels
- 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
- D4814 Specification for Automotive Spark-Ignition Engine Fuel
- D5842 Practice for Sampling and Handling of Fuels for Volatility Measurement

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.01 on Combustion Characteristics.

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² Motor O.N., determined using Test Method D2700, is a companion method to provide a similar but typically lower octane rating under more severe operating conditions.

³ 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

- D6299** Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance
- D6300** Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products, Liquid Fuels, and Lubricants
- D6304** Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6708** Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
- D7504** Test Method for Trace Impurities in Monocyclic Aromatic Hydrocarbons by Gas Chromatography and Effective Carbon Number
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E344** Terminology Relating to Thermometry and Hydrometry
- E456** Terminology Relating to Quality and Statistics
- E542** Practice for Gravimetric Calibration of Laboratory Volumetric Instruments
- E1064** Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

2.2 ANSI Standard:⁴

C-39.1 Requirements for Electrical Analog Indicating Instruments

2.3 Energy Institute Standard:⁵

IP 224/02 Determination of Low Lead Content of Light Petroleum Distillates by Dithizone Extraction and Colorimetric Method

3. Terminology

3.1 Definitions:

3.1.1 *accepted reference value, n*—a value that serves as an agreed-upon reference for comparison, and which is derived as: (1) a theoretical or established value, based on scientific principles, (2) an assigned or certified value, based on experimental work of some national or international organization, or (3) a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or engineering group. **E456**

3.1.1.1 *Discussion*—In the context of this test method, accepted reference value is understood to apply to the Research octane number of specific reference materials determined empirically under reproducibility conditions by the National Exchange Group or another recognized exchange testing organization.

3.1.2 *Check Fuel, n—for quality control testing*, a spark-ignition engine fuels of selected characteristics having an octane number accepted reference value (O.N._{ARV}) determined by round-robin testing under reproducibility conditions.

3.1.3 *cylinder height, n—for the CFR engine*, the relative vertical position of the engine cylinder with respect to the piston at top dead center (tdc) or the top machined surface of the crankcase.

3.1.3.1 *digital counter reading, n—for the CFR engine*, a numerical indication of cylinder height, indexed to a basic setting at a prescribed compression pressure when the engine is motored.

3.1.3.2 *dial indicator reading, n—for the CFR engine*, a numerical indication of cylinder height, in thousandths of an inch, indexed to a basic setting at a prescribed compression pressure when the engine is motored.

3.1.4 *detonation meter, analog, n—for knock testing*, the signal conditioning instrumentation that accepts the electrical signal from the detonation pickup and provides an analog output signal to the analog knockmeter.

3.1.4.1 *Discussion*—In the context of this test method, three contemporary generations of apparatus have been developed as detonation meters. These are (year of introduction in parenthesis): the 501T Detonation Meter (1969), the 501C Detonation Meter (1979), and the SSD7000 Detonation Meter (2017).⁶

3.1.5 *detonation meter, digital, n—for knock testing*, the digital signal conditioning instrumentation that accepts the electrical signal from the detonation pickup and provides a digital output for display.

3.1.6 *detonation pickup, n—for knock testing*, a magnetostrictive-type transducer that threads into the engine cylinder and is exposed to combustion chamber pressure to provide an electrical signal that is proportional to the rate-of-change of cylinder pressure.

3.1.7 *dynamic fuel level, n—for knock testing*, test procedure in which the fuel-air ratio for maximum knock intensity for sample and reference fuels is determined using the falling level technique that changes carburetor fuel level from a high or rich mixture condition to a low or lean mixture condition, at a constant rate, causing knock intensity to rise to a maximum and then decrease, thus permitting observation of the maximum knockmeter reading.

3.1.8 *equilibrium fuel level, n—for knock testing*, test procedure in which the fuel-air ratio for maximum knock intensity for sample and reference fuels is determined by making incremental step changes in fuel-air ratio, observing the equilibrium knock intensity for each step, and selecting the level that produces the highest knock intensity reading.

3.1.9 *firing, n—for the CFR engine*, operation of the CFR engine with fuel and ignition.

3.1.10 *fuel-air ratio for maximum knock intensity, n—for knock testing*, that proportion of fuel to air that produces the highest knock intensity for each fuel in the knock testing unit, provided this occurs within specified carburetor fuel level limits.

3.1.11 *guide tables, n—for knock testing*, the specific relationship between cylinder height (compression ratio) and

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

⁶ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1870. Contact ASTM Customer Service at service@astm.org.