Designation: D2885 – 21

Standard Test Method for Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique[1]

This standard is issued under the fixed designation D2885; 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 test method covers the quantitative online determination by direct comparison of the difference in knock rating or delta octane number of a stream sample of spark-ignition engine fuel from that of a comparison reference fuel.

1.2 This test method covers the methodology for obtaining an octane number using the measured delta octane number and the octane number of the comparison reference fuel.

1.3 The comparison reference fuel is required to be of essentially the same composition as the stream sample to be analyzed and can be a secondary fuel termed standard fuel or a tertiary fuel termed prototype fuel.

1.4 The test method utilizes a knock testing unit/automated analyzer system that incorporates computer control of a standardized single-cylinder, four-stroke cycle, variable compression ratio, carbureted, CFR engine with appropriate auxiliary equipment using either Test Method D2699 Research method or Test Method D2700 Motor method operating conditions.

1.4.1 Knock measurements are based on operation of both fuels at the fuel-air ratio that produces maximum knock intensity for that fuel.

1.4.2 Measured differences in knock intensity are scaled to provide a positive or negative delta octane number of the stream sample from the comparison reference fuel when the fuels are compared at the same compression ratio.

1.4.3 Measured differences in compression ratio are scaled from the appropriate guide table to provide a positive or negative delta octane number of the stream sample from the comparison reference fuel when the fuels are compared at the same knock intensity.

1.5 This test method is limited to testing 78 to 102 octane number spark-ignition engine fuels using either research or motor method conditions.

1.6 The octane number difference between the stream sample and the applicable comparison reference fuel is self-limiting by specifications imposed upon the standard and prototype fuels.

1.7 Specifications for selection, preparation, storage, and dispensing of standard and prototype fuels are provided. Detailed procedures for determination of an appropriate assigned octane number for both standard and prototype fuels are also incorporated.

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

1.9 *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 more specific warning statements, see Section 8 and Annex A1.

1.10 *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:*[2]

D1193 Specification for Reagent Water

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

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

[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] 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**

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
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
D6624 Practice for Determining a Flow-Proportioned Average Property Value (FPAPV) for a Collected Batch of Process Stream Material Using Stream Analyzer Data
D7453 Practice for Sampling of Petroleum Products for Analysis by Process Stream Analyzers and for Process Stream Analyzer System Validation
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E456 Terminology Relating to Quality and Statistics

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 value, based on experimental work of some national or international organization, or (*3*) a consensus value, based on collaborative experimental work under the auspices of a scientific or engineering group. **E456/E177**

3.1.1.1 *Discussion*—In the context of this test method, accepted reference value is understood to apply to standard fuel or check fuel average research or motor octane numbers determined under reproducibility conditions by a recognized exchange testing organization having a minimum of 16 participants.

3.1.2 *analytical measurement system, n*—a collection of one or more components or subsystems, such as a sampler, test equipment, instrumentation, display devices, data handler, and printout or output transmitters that is used to determine a quantitative value of a specific property for an unknown sample. **D6299**

3.1.2.1 *Discussion*—In the context of this test method, the analytical measurement system is comprised of the knock testing unit, automated analyzer system, and any auxiliary equipment required for the safe operation of the engine.

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 machine surface of the crankcase. **D2699/D2700**

3.1.4 *determinability, n*—quantitative measure of the variability associated with the same operator in a given laboratory obtaining successive determined values using the same apparatus for a series of operations leading to a single result; it is defined as that difference between two such single determined values as would be exceeded in the long run in only one case in 20 in the normal and correct operation of the test method. **D6300**

3.1.5 *detonation meter, n—for knock testing*, the signal conditioning instrument that accepts the electrical signal from the detonation pickup and provides an output signal for display. **D2699/D2700**

3.1.6 *detonation pickup, n—for knock testing*, 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. **D2699/D2700**

3.1.7 *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. **D2699/D2700**

3.1.8 *fuel-air ratio for maximum knock intensity, n—for knock testing*, that proportion of fuel to air which produces the highest knock intensity for each fuel in the knock testing unit, provided this occurs within the specified carburetor fuel level limits. **D2699/D2700**

3.1.8.1 *Discussion*—In the context of this test method, the fuel-air ratio for maximum knock intensity can be determined manually or by the automated analyzer system.

3.1.8.1 *dynamic fuel-air ratio for maximum knock, n—for knock testing*, the changing of the mixture of fuel and air for engine combustion determined by continually varying fuel level in the carburetor delivery components, through the maximum knock intensity so that the observed peak knock intensity value can be selected as maximum knock intensity reading.

3.1.8.2 *equilibrium fuel-air ratio for maximum knock, n—for knock testing*, the changing of the mixture of fuel and air for engine combustion determined by making incremental step changes in fuel-air ratio, observing the equilibrium knock intensity for each step and selecting the fuel-air ratio which produces the highest knock meter reading.

3.1.9 *guide tables, n—for knock testing*, the specific relationship between cylinder height (compression ratio) and octane number at standard knock intensity for specific primary reference fuel blends tested at standard or other specified barometric pressure. **[D02.01] D2699/D2700**

3.1.10 *knock, n—in a spark-ignition engine*, abnormal combustion, often producing audible sound, caused by autoignition of the air/fuel mixture. **D4175**

3.1.11 *knock intensity, n—for knock testing*, a measure of the level of knock. **D2699/D2700**

3.1.11.1 *Discussion*—In the context of this test method, the knock intensity signal may also be displayed using digital or recording instrumentation.

3.1.12 *knockmeter, n—analog*, the 0 to 100 division analog indicating meter that displays the knock intensity signal from the analog detonation meter. **[D02.01] D2699/D2700**

3.1.13 *knockmeter, n—digital*, the 0 to 999 division digital indicating meter that displays the knock intensity signal from the digital detonation meter. **[D02.01] D2699/D2700**

3.1.14 *motor octane number, n—for spark-ignition engine fuel*, the numerical rating of knock resistance obtained by comparison of the fuel's knock intensity with that of primary reference fuel blends when both are tested in a standardized CFR engine operating under the conditions specified in Test Method D2700.

3.1.15 *repeatability conditions, n*—conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time. **E456**

3.1.15.1 *Discussion*—In the context of this test method, application of repeatability conditions is primarily applied to the determination of variability of delta octane numbers generated by repeating the comparison measurements within a short time, by the same operator, using the same comparator, on the same fuel pair.

3.1.16 *reproducibility conditions, n*—conditions where test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment. **E456**

3.1.17 *research octane number, n—for spark-ignition engine fuel*, the numerical rating of knock resistance obtained by comparison of the fuel's knock intensity with that of primary reference fuel blends when both are tested in a standardized CFR engine operating under the conditions specified in Test Method D2699.

3.1.18 *site assigned value, n*—a value that serves as an agreed-upon reference for comparison, determined from multiple test results.

3.1.18.1 *Discussion*—In the context of this test method, site assigned value is understood to apply to prototype fuel average research or motor octane number determined using direct comparison delta octane number cycles comparing the prototype fuel to a standard fuel having an accepted reference value octane number.

3.1.19 *site precision conditions, n*—conditions under which test results are obtained by one or more operators in a single location practicing the same test method on a single measurement system using test specimens taken at random from the same sample of material over an extended period of time spanning at least a 15 day interval. **D6299**

3.1.19.1 *Discussion*—In the context of this test method, application of site precision conditions is primarily applied to the determination of the variability of delta octane average results, obtained by different operators, over different days, for the same fuel pair, using the same comparator. Each delta octane average result is obtained from repetitive comparisons of the same fuel pair under repeatability conditions.

3.1.20 *spread, n—in knock measurement*, the sensitivity of the detonation meter expressed in knockmeter divisions per octane number. **D2699/D2700**

3.1.21 *stream sample, n*—the material to be evaluated by an analytical measurement system, typically drawn from a flowing stream of either blended spark-ignition engine fuel or process unit material.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *comparison reference fuel, n—for direct comparison knock testing*, a spark-ignition engine fuel having an assigned octane number that is the reference for the determination of the delta octane number of stream samples.

3.2.1.1 *standard fuel, n—for direct comparison knock testing*, a spark-ignition engine fuel having an octane number accepted reference value (RON_{ARV} or MON_{ARV}) which is used as a secondary comparison reference fuel for (*1*) determination of the octane number site assigned value (RON_{SAV} or MON_{SAV}) of prototype fuels, (*2*) determination of the ΔO.N. of a stream sample, or (*3*) pairing with another standard fuel for analytical measurement system qualification checkout.

3.2.1.2 *prototype fuel, n—for direct comparison knock testing*, a spark-ignition engine fuel or process unit material having an octane number site assigned value (RON_{SAV} or MON_{SAV}) referenced to an appropriate standard fuel, which is used as a tertiary comparison reference fuel for determination of the ΔO.N. of a stream sample.

3.2.2 *delta octane number, n—for direct comparison knock testing*, the algebraic difference in octane number between two fuels under research or motor engine conditions, when determined by the direct comparison technique.

3.2.3 *paired check fuels (A and B), n—for on-line knock testing system qualification checkout*, two standard fuels used for system qualification checkout of a analytical measurement system.

3.2.3.1 *expected difference O.N., n—for on-line knock testing system qualification checkout*, the absolute octane number difference between paired check fuels (A–B) based on the $O.N._{ARV}$ for both fuels.

3.2.4 *paired quality control fuels, n—for on-line system quality control*, a pair of fuels, one of which is a comparison reference fuel, to be used in the repetitive testing for ΔO.N. as a quality control check of the analytical measurement system.

3.2.5 *span, n—for direct comparison knock testing*, a measure of the overall sensitivity of the analyzer measurement expressed as the ratio of the change in delta octane produced by a given change in either compression ratio or knock intensity.

3.3 *Acronyms:*

3.3.1 *AMS*—analytical measurement system

3.3.2 *ARV*—accepted reference value

3.3.3 RON_{ARV}—research octane number accepted reference value

3.3.4 MON_{ARV}—motor octane number accepted reference value

3.3.5 *SAV*—site assigned value

3.3.6 RON_{SAV}—research octane number site assigned value

3.3.7 MON_{SAV}—motor octane number site assigned value

3.3.8 *C.R.*—compression ratio