



Designation: D7170 – 16

Standard Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils—Fixed Range Injection Period, Constant Volume Combustion Chamber Method¹

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1. Scope*

1.1 This test method covers the quantitative determination of the ignition characteristics of conventional diesel fuel oils, diesel fuel oils containing cetane number improver additives, and is applicable to products typical of Specification D975, Grades No. 1-D and 2-D regular and low-sulfur diesel fuel oils, European standard EN 590, and Canadian standards CAN/CGSB-3.517-2000 and CAN/CGSB 3.6-2000. The test method may also be applied to the quantitative determination of the ignition characteristics of blends of fuel oils containing bio-diesel material, and diesel fuel oil blending components.

1.2 This test method measures the ignition delay and utilizes a constant volume combustion chamber with direct fuel injection into heated, compressed air. An equation converts an ignition delay determination to a derived cetane number (DCN).

1.3 This test method covers the ignition delay range from a minimum value of 35.0 DCN (ignition delay of 4.89 ms) to a maximum value of 59.6 DCN (ignition delay of 2.87 ms). The average DCN result for each sample in the ILS ranged from 37.29 (average ignition delay of 4.5894 ms) to 56.517 (average ignition delay of 3.0281 ms).

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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.*

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. Referenced Documents

2.1 ASTM Standards:²

- D613 Test Method for Cetane Number of Diesel Fuel Oil
 - D975 Specification for Diesel Fuel Oils
 - D1193 Specification for Reagent Water
 - 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
 - D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
 - 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 and Lubricants
 - D6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
 - E456 Terminology Relating to Quality and Statistics
 - E832 Specification for Laboratory Filter Papers
- ### 2.2 EN Standard:³
- EN 590 Automotive Fuels—Diesel—Requirements and Test Methods
- ### 2.3 Energy Institute Standard:⁴
- IP 41 Ignition Quality of Diesel Fuels—Cetane Engine Test Method

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.

³ Available from European Committee for standardization. Central Secretariat: rue de Stassart, 36, B-1050 Brussels, Belgium.

⁴ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

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

2.4 Canadian Standards:⁵

CAN/CGSB-3.517-2000 Regular Sulphur Diesel Fuel—Specification

CAN/CGSB 3.6-2000 Automotive Low-Sulphur Diesel Fuel—Specification

2.5 DIN Standard:⁶

DIN 73372 Einspritzdüsen Grösse T und U

3. Terminology

3.1 Definitions:

3.1.1 *accepted reference value (ARV)*, *n*—a value that serves as an agreed-upon reference for comparison and that 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, such as the U.S. National Institute of Standards and Technology (NIST), or (3) a consensus 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 method, accepted reference value is understood to apply to the ignition delay of specific reference materials determined under reproducibility conditions by collaborative experimental work.

3.1.2 *biodiesel*, *n*—fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100.

3.1.3 *biodiesel blend (BXX)*, *n*—blend of biodiesel fuel with diesel fuel oils.

3.1.3.1 *Discussion*—In the abbreviation, BXX, the XX represents the volume percentage of biodiesel fuel in the blend.

3.1.4 *cetane number (CN)*, *n*—a measure of the ignition performance of a diesel fuel oil obtained by comparing it to reference fuels in a standardized engine test. **D4175**

3.1.4.1 *Discussion*—In the context of this method, cetane number is that defined by ASTM **D613/IP 41**.

3.1.5 *check standard*, *n*—in *QC testing*, a material having an accepted reference value used to determine the accuracy of a measurement system. **D6299**

3.1.5.1 *Discussion*—In the context of this test method, check standard refers to heptane.

3.1.6 *quality control (QC) sample*, *n*—for use in quality assurance programs to determine and monitor the precision and stability of a measurement system, a stable and homogeneous material having physical or chemical properties, or both, similar to those of typical samples tested by the analytical measurement system. The material is properly stored to ensure sample integrity, and is available in sufficient quantity for repeated, long term testing. **D6299**

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *calibration reference material*, *n*—a pure chemical having an assigned ignition delay accepted reference value.

3.2.2 *charge air*, *n*—compressed air at a specified pressure introduced into the combustion chamber at the beginning of each test cycle.

3.2.3 *charge air temperature*, *n*—temperature, in °C, of the air inside the combustion chamber.

3.2.4 *combustion analyzer*, *n*—an integrated compression ignition apparatus to measure the ignition characteristics of diesel fuel oil.

3.2.5 *derived cetane number (DCN)*, *n*—a number calculated using a conversion equation to determine a cetane number.

3.2.5.1 *Discussion*—The conversion equation relates a measured ignition delay or ignition delay and combustion delay from a combustion analyzer to a cetane number.

3.2.6 *ignition delay (ID)*, *n*—that period of time, in milliseconds (ms), between the start of fuel injection and the start of combustion as determined using the specific combustion analyzer applicable for this test method.

3.2.6.1 *Discussion*—In the context of this test method, start of fuel injection is interpreted as the initial movement or lift of the injector nozzle needle as measured by a motion sensor; start of combustion is interpreted as that point in the combustion cycle when a significant (+0.02 MPa above chamber static pressure) and sustained increase in rate-of-change in pressure, as measured by a pressure sensor in the combustion chamber, ensures combustion is in progress.

3.2.7 *injection period (IP)*, *n*—the period of time, in milliseconds (ms), that the fuel injector nozzle is open as determined using the specific combustion analyzer applicable for this test method.

3.2.8 *operating period*, *n*—the time, not to exceed 12 h, between successive calibration or QC testing, or both, of the combustion analyzer by a single operator.

3.3 Acronyms:

3.3.1 *ARV*—accepted reference value

3.3.2 *CN*—cetane number

3.3.3 *DCN*—derived cetane number

3.3.4 *ID*—ignition delay

3.3.5 *QC*—quality control

4. Summary of Test Method

4.1 A small specimen of diesel fuel oil is injected into a heated, temperature-controlled constant volume chamber, which has previously been charged with compressed air. Each injection produces a single-shot, compression ignition combustion cycle. ID is measured using sensors that detect the start of fuel injection and the start of significant combustion for each cycle. A complete sequence comprises 2 preliminary cycles and 25 further cycles. The ID measurements for the last 25 cycles are averaged to produce the ID result. An equation converts the ID result to a DCN.

5. Significance and Use

5.1 The ID and DCN values determined by this test method can provide a measure of the ignition characteristics of diesel fuel oil in compression ignition engines.

⁵ Available from Canadian General Standards Board (CGSB), 11 Laurier St., Phase III, Place du Portage, Gatineau, Quebec K1A 0S5, Canada, <http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb>.

⁶ Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, <http://www.din.de>.