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An American National Standard

## Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber<sup>1, 2</sup>

This standard is issued under the fixed designation D 6890; 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 automated laboratory test method covers the quantitative determination of the ignition characteristics of conventional diesel fuel oil, oil-sands based fuels, blends of fuel containing biodiesel material, diesel fuel oils containing cetane number improver additives, and is applicable to products typical of ASTM Specification D 975 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 and 3.6-2000. The test method may also be applied to the quantitative determination of the ignition characteristics of diesel fuel 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 correlates an ignition delay determination to cetane number by Test Method D 613, resulting in a derived cetane number (DCN).

1.3 This test method covers the ignition delay range from 3.3 to 6.4 ms (61 to 34 DCN). The combustion analyzer can measure shorter and longer ignition delays, but precision may be affected. For these shorter or longer ignition delays the correlation equation for DCN is given in Appendix X2. There is no information about how DCNs outside the 34 to 61 range compare to Test Method D 613 cetane numbers.

1.4

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.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>3</sup>

- D 613 Test Method for Cetane Number of Diesel Fuel Oil
- D 975 Specification for Diesel Fuel Oils
- D 1193 Specification for Reagent Water
- D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products
- D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants
- D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
- D 5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D 6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance
- D 6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products and Lubricants
- D 6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
- E 456 Terminology Relating to Quality and Statistics

#### 2.2 ISO Standards:<sup>4</sup>

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.01 on Combustion Characteristics.

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<sup>2</sup> This test method is based on IP PM CQ/2001, published in the IP Standard Methods for Analysis and Testing of Petroleum and Related Products and British Standard 2000 Parts. Copyrighted by Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK. Adapted with permission of Energy Institute.

<sup>3</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.

<sup>4</sup> Available from American National Standards Institute, 25 W. 43rd St., 4th floor, New York, NY 10036.

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

ISO 4010 Diesel Engines—Calibrating Nozzle, Delay Pintle Type

ISO 4259 Petroleum products—Determination and application of precision data in relation to methods of test

2.3 *EN Standard:*

EN 590 Automotive Fuels—Diesel—Requirements and Test Methods<sup>5</sup>

2.4 *Energy Institute Standard:*

IP 41 Ignition Quality of Diesel Fuels—Cetane Engine Test Method<sup>6</sup>

2.5 *Canadian Standards:*

CAN/CGSB-3.517-2000 Automotive Low Sulfur Diesel Fuel—Specification<sup>7</sup>

CAN/CGSB 3.6-2000 Automotive Diesel Fuel—Specification<sup>7</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *accepted reference value (ARV), n*—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. **E 456**

3.1.1.1 *Discussion*—In the context of this test 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 *cetane number, n*—measure of the ignition performance of a diesel fuel oil obtained by comparing it to reference fuels in a standardized engine test. **D 4175**

3.1.2.1 *Discussion*—In the context of this test method, cetane number is that defined by Test Method D 613/IP 41.

3.1.3 *check standard, n*—in *QC testing*, material having an accepted reference value used to determine the accuracy of a measurement system. **D 6299**

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

3.1.4 *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. **D 6299**

#### 3.2 Definitions of Terms Specific to This Standard:

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

3.2.2 *charge air, n*—compressed air at a specified pressure introduced to 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*—integrated compression ignition apparatus to measure the ignition characteristics of diesel fuel oil.

3.2.5 *derived cetane number (DCN), n*—number calculated using an equation that correlates a combustion analyzer ignition delay result to cetane number by Test Method D 613.

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 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 *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 Abbreviations:

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

<sup>5</sup> Available from European Committee for Standardization. Central Secretariat: rue de Stassart, 36, B-1050 Brussels, Belgium.

<sup>6</sup> Available from Institute of Petroleum, 61 New Cavendish St., London, W1G 7AR, U.K.

<sup>7</sup> Available from the Canadian General Standards Board, Gatineau, Canada, K1A 1G6.