Designation: D6890 – 21

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

This standard is issued under the fixed designation D6890; 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.

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, hydrocarbon oils, blends of fuel containing biodiesel material, diesel fuel oils containing cetane number improver additives, and is applicable to products typical of ASTM Specification D975 grades No. 1-D S15, No. 1-D S500, and No. 1-D S5000, and grades No. 2-D S15, No. 2-D S500, and No. 2-D S5000 diesel fuel oils, European standard EN 590, and Canadian standards CAN/CGSB-3.517 and 3.520. 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 of a diesel fuel injected directly into a constant volume combustion chamber containing heated, compressed air. An equation correlates an ignition delay determination to cetane number by Test Method D613, resulting in a derived cetane number (DCN).

1.3 This test method covers the ignition delay range from 2.64 ms to 6.90 ms (75.1 DCN to 31.5 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.

1.4 For purposes of determining conformance with the parameters of this test method, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the parameter, in accordance with the rounding method of Practice E29.

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

1.6 *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.*

1.7 *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]

D613 Test Method for Cetane Number of Diesel Fuel Oil
D975 Specification for Diesel Fuel
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, Liquid Fuels, and Lubricants
D6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that

[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.

Current edition approved July 1, 2021. Published July 2021. Originally approved in 2003. Last previous edition approved in 2018 as D6890 – 18. DOI: 10.1520/D6890-21.

[2] 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.

[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**

Purport to Measure the Same Property of a Material
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E456 Terminology Relating to Quality and Statistics
2.2 *ISO Standards:*[4]
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[5]
2.4 *Energy Institute Standard:*
IP 41 Ignition Quality of Diesel Fuels—Cetane Engine Test Method[6]
2.5 *Canadian Standards:*[7]
CAN/CGSB-3.517 Diesel Fuel
CAN/CGSB 3.520 Diesel Fuel Containing Low Levels of Biodiesel (B1–B5)

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. **E456**

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 *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 test method, cetane number is that defined by Test Method D613/IP 41.

3.1.5 *check standard, n—in QC testing*, 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 *hydrocarbon oil, n*—a homogeneous mixture with elemental composition primarily of carbon and hydrogen that may also contain sulfur, oxygen, or nitrogen from residual impurities and contaminants associated with the fuel's raw materials and manufacturing processes and excluding added oxygenated materials.

3.1.6.1 *Discussion*—Neither macro nor micro emulsions are included in this definition since neither are homogeneous mixtures.

3.1.6.2 *Discussion*—Examples of excluded oxygenated materials are alcohols, esters, ethers, and triglycerides.

3.1.6.3 *Discussion*—The hydrocarbon oil may be manufactured from a variety of raw materials, for example petroleum (crude oil), oil sands, natural gas, coal, and biomass.

3.1.7 *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*—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*—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 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.

[4] Available from American National Standards Institute, 25 W. 43rd St., 4th floor, New York, NY 10036.
[5] Available from European Committee for Standardization. Central Secretariat: rue de Stassart, 36, B-1050 Brussels, Belgium.
[6] Available from Institute of Petroleum, 61 New Cavendish St., London, W1G 7AR, U.K.
[7] 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.