SLOVENSKI STANDARD
SIST EN 15195:2023

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Nadomešča:
SIST EN 15195:2015

Tekoči naftni proizvodi - Ugotavljanje zakasnitve vžiga in izpeljanega cetanskega števila (DCN) srednjih destilatov s sežigom v komori s stalno prostornino

Liquid petroleum products - Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels by combustion in a constant volume chamber

Flüssige Mineralölerzeugnisse - Bestimmung des Zündverzugs und der abgeleiteten Cetanzahl (ACZ) von Kraftstoffen aus Mitteldestillaten in einer Verbrennungskammer mit konstantem Volumen

Produits pétroliers liquides - Détermination du délai d'inflammation et de l'indice de cétane dérivé (ICD) des distillats moyens par combustion dans une chambre à volume constant

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EUROPEAN STANDARD

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English Version

Liquid petroleum products - Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels by combustion in a constant volume chamber

Produits pétroliers liquides - Détermination du délai d'inflammation et de l'indice de cétane dérivé (ICD) des distillats moyens par combustion dans une chambre à volume constant

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This European Standard was approved by CEN on 13 February 2023.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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EN 15195:2023 (E)

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EN 15195:2023 (E)

European foreword

This document (EN 15195:2023) has been prepared by Technical Committee CEN/TC 19 "Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2023, and conflicting national standards shall be withdrawn at the latest by September 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15195:2014.

The main changes compared to the previous edition are listed below:

— the Scope has been extended to paraffinic diesel from synthesis or hydrotreatment, in line with the outcome of the interlaboratory study organized by CEN/TC 19 in 2013 [1];

— based on a review of PT data from EI and NEG correlation schemes, the lower end of the ignition delay range has been expanded up to 2,58 ms (76,8 *DCN*), where it used to be up to 2,8 ms (71 *DCN*);

— the Introduction has been updated with historical information on the method development;

— Annex D on equation outside the method scope range has been removed.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

This document is derived from joint standardization work in the Energy Institute and ASTM International. It was originally based on IP 498/06 [2] published by the Energy Institute and harmonized with the equivalent ASTM standard test method [3].

The described method is an alternative quantitative determination of the cetane number of middle distillate fuels intended for use in compression ignition engines. Correlation studies between this method and EN ISO 5165 have been done and the results of this are incorporated in this document.

The basis of this method is the derived cetane number correlation equation as given in Clause 12. The equation that relates ignition delay to derived cetane number, originally developed in 1997 [4], was: $DCN = 83,99(ID\text{-}1,512)^{(-0,658)} + 3,547$. This equation was derived from a correlation test programme, comprising ASTM National Exchange Group (NEG) check fuels, heptamethylnonane, cetane and in-house check fuel. In 2005, the equation was re-evaluated by the EI and ASTM through the correlation of cetane number data from the IP and the National Exchange Group (NEG) Diesel Fuel Engine Correlation Schemes and ignition delay data on the same samples from the IP and NEG IQT Correlation Schemes collected over a number of years [5]. In 2006, another ASTM evaluation [6] led to the actual equation, which showed an optimal fit over the range of the scope.

On 13 July 2021 ASTM International granted usage of its national Diesel Exchange group program data which enabled the lower end of the ignition delay scope to be expanded from 2,8 ms to 2,58 ms (from 71 *DCN* up to 76,8 *DCN*). The relevant subcommittee ASTM D02.01 has not endorsed this scope expansion and therefore did not adopt the conclusions for its equivalent standard [3]. Supporting data have been filed at CEN/TC 19 Secretariat.

The on-going validation of the equation as in Formula (1) is monitored and evaluated through the existing monthly American and European fuel exchange programs. The validation data will be reviewed by CEN/TC 19 with a frequency of at least every two years. As a result of that review, CEN/TC 19 decides to, if necessary, modify the existing equation/correlation or develop a new one. As part of that review, the sample types will be examined, and if certain types are underrepresented, further steps may be taken to evaluate how they perform.

For the moment, the basics of one type of apparatus are described. Once more correlation data on different types of derived cetane number testing equipment is available, CEN/TC 19 will consider revising this document.

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1 Scope

This document specifies a test method for the quantitative determination of ignition delay of middle distillate fuels intended for use in compression ignition engines. The method utilizes a constant volume combustion chamber designed for operation by compression ignition, and employing direct injection of fuel into compressed air that is controlled to a specified pressure and temperature. An equation is given to calculate the derived cetane number (*DCN*) from the ignition delay measurement.

This document covers the ignition delay range from 2,58 ms to 6,34 ms (76,8 *DCN* to 33,9 *DCN*). The combustion analyser can measure shorter or longer ignition delays, but precision is not known.

This document is applicable to diesel fuels, including those containing fatty acid methyl esters (FAME) up to 30 % (*V/V*). The method is also applicable to middle distillate fuels of non-petroleum origin, oil-sands based fuels, blends of fuel containing biodiesel material, diesel fuel oils containing cetane number improver additives and low-sulfur diesel fuel oils. Furthermore, the method is applicable to paraffinic diesel from synthesis or hydrotreatment, containing up to a volume fraction of 7 % FAME [1]. However, users applying this document especially to unconventional distillate fuels are warned that the relationship between derived cetane number and combustion behaviour in real engines is not yet fully understood.

The test method is also applicable to the quantitative determination of the ignition characteristics of FAME, especially the ignition delay. However, analysis of the data available, regarding correlation with EN ISO 5165, is inconclusive. So the determination of derived cetane number for FAME fuel, also known as B100, has not been included in the precision determination as in Clause 12.

NOTE   For the purpose of this document, the expression "% (*V/V*)" is used to represent the volume fraction and "% (*m/m*)" the mass fraction.

WARNING — The use of this document may involve hazardous materials, operations and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 3170, *Petroleum liquids - Manual sampling (ISO 3170)*

EN ISO 3171, *Petroleum liquids - Automatic pipeline sampling (ISO 3171)*

EN ISO 3696, *Water for analytical laboratory use - Specification and test methods (ISO 3696)*

ISO 1998-2:1998, *Petroleum industry — Terminology — Part 2: Properties and tests*

ISO 4010, *Diesel engines — Calibrating nozzle, delay pintle type*

IP 537, *Determination of the purity of Derived Cetane Number reference materials — Gas chromatography method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1998-2:1998 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
cetane number
CN
measure of the ignition performance of a diesel fuel in a standardized engine test [7] on a scale defined by reference fuels

Note 1 to entry: It is expressed as the percentage by volume of hexadecane (cetane) in a reference blend having the same ignition delay as the fuel for analysis. The higher the cetane number, the shorter the ignition delay.

Note 2 to entry: ISO 1998-2 expresses it as "number on a conventional scale, indicating the ignition quality of a diesel fuel under standardized conditions", but for this document the definition as given is chosen as with new equipment on the market since 1998 the reference to an engine has become essential.

3.2
ignition delay
ID
period of time, in milliseconds, between the start of fuel injection and the start of combustion

Note 1 to entry: In the context of this document, this period is determined by movement and pressure sensors in the instrument.

Note 2 to entry: In the context of this document, a significant and sustained increase in rate-of-change in pressure, ensuring that combustion is in progress, identifies the start of the combustion.

3.3
derived cetane number
DCN
number calculated by using an equation that correlates a combustion analyser's ignition delay to the cetane number

3.4
accepted reference value
ARV
value agreed upon as a reference for comparison

Note 1 to entry: The value is derived as (1) a theoretical or established value, based in 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.

3.5
quality control sample
QC
stable and homogenous material(s) similar in nature to the materials under test, properly stored to ensure integrity, and available in sufficient quantity for repeated long-term testing

3.6
calibration reference fluid
stable and homogenous fluid used to calibrate the performance of the combustion analyser

3.7
verification reference fluid
stable and homogenous fluid used to verify the performance of the combustion analyser

4 Principle

A test portion of the material under test is injected into a heated temperature- and pressure-controlled constant volume combustion chamber which has previously been charged with compressed air. Sensors detect the start of injection and the start of combustion for each single-shot cycle. A complete test sequence consists of 15 preliminary combustion cycles to ensure apparatus equilibrium and 32 subsequent test cycles to obtain ignition delay values. The average ignition delay (ID) of these 32 cycles is inserted into an equation to obtain the derived cetane number (DCN). The DCN obtained by this procedure is an estimate of the cetane number (CN) obtained from the conventional large-scale engine test EN ISO 5165.

5 Reagents and materials

5.1 Water, unless otherwise specified, meeting the requirements for grade 3 of EN ISO 3696.

5.2 Coolant system fluid, 50:50 (V/V) mixture of commercial grade radiator antifreeze (aluminium-compatible, ethylene glycol-type) with water (5.1).

NOTE   This mixture meets the boiling point requirements and gives adequate protection of the coolant system against corrosion and mineral scale that can alter heat transfer and rating results. See the manufacturer's manual for the correct ethylene glycol-type antifreeze quality.

5.3 Calibration reference fluid, n-heptane of a purity of minimum 99,5 % (m/m) to be used as the designated 3,78 ms ignition delay accepted reference value material.

If the initial purity is not known, the purity shall be checked in accordance with IP 537.

5.4 Verification reference fluid, methylcyclohexane of a purity of minimum 99,0 % (m/m) to be used as the designated 10,4 ms ignition delay accepted reference value material.

If the initial purity is not known, the purity shall be checked in accordance with IP 537.

Even if the verification reference fluid meets the purity specification, it may not meet the Ignition Delay requirements (see Table 2). It is recommended to either pass the suspect MCH through a filter column to remove peroxide based impurities or to test a bottle of MCH that has been shown to meet the ID requirements. It is recommended that each bottle of MCH is tested prior to its use as a verification reference fluid to confirm it is of acceptable quality.

5.5 Quality control sample, stable and homogeneous material(s), similar in nature to the materials under test (see 3.5).

5.6 Combustion charge air, of oxygen content 20,9 % (V/V) ± 1,0 % (V/V), and containing less than 0,003 % (V/V) hydro-carbons and less than 0,025 % (V/V) water.

NOTE 1   Oxygen content of combustion charge compressed air can vary between batches (cylinders). Significant variation will lead to changes in ignition delay (higher oxygen content leads to a shorter ignition delay).

NOTE 2   The effects of oxygen concentration have been investigated [8].

5.7 Actuating air, oil-free compressed air containing less than 0,1 % (*V/V*) water supplied at a minimum sustained pressure of 1,5 MPa.

5.8 Compressed nitrogen, of minimum purity 99,9 % (*V/V*).

6 Apparatus

6.1 Combustion analyser

The apparatus is described in more detail in Annex A. For the installation and set-up procedures, and for detailed system description, refer to the manufacturer's manual.

The system described in this document comprises: an insulated heated, constant volume combustion chamber (see 6.1.2) with fluid cooling of designated areas; external, pneumatically actuated, chamber inlet and exhaust valves, and associated piping; a heated, pneumatically-actuated, fuel injection pump; a constant pressure fuel delivery system; a re-circulating coolant system; solenoids; sensors; controls; connection fittings for the compressed gas utilities; and a computer to control test sequencing. Figure 1 gives a schematic outline of the analyser.

6.1.2 Combustion chamber, steel combustion chamber of capacity 0,213 l ± 0,002 l, further detailed in Annex A.

6.2 Filter medium, with a nominal pore size 3 μm to 5 μm, made of glass fibre, polytetrafluorethylene (PTFE) or polyamide 6.6, of a size appropriate to the apparatus being used for sample filtration (see 7.5).