SLOVENSKI STANDARD
oSIST prEN 16715:2014

01-maj-2014

Tekoči naftni proizvodi - Ugotavljanje zakasnitve vžiga in izpeljanega cetanskega števila (DCN) v srednje destilatnih gorivih - Določevanje zakasnitve vžiga in sežiga z uporabo konstantne prostornine z direktnim injiciranjem goriva

Liquid petroleum products - Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels - Ignition delay and combustion delay determination using a constant volume combustion chamber with direct fuel injection

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

Produits pétroliers liquides - Détermination due délai d'inflammation et de l'indice de cétane dérivé (ICD) des distillatsmoyens - Détermination due délai d'inflammation et de combustion par utiliser in une une chambre à volume constant avec injection direct de gazole

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 19.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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Foreword

This document (prEN 16715:2014) 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 document is currently submitted to the CEN Enquiry.

Introduction

This document is derived from joint standardization work in the Energy Institute and ASTM International. It is based on and technically equivalent with ASTM D7668 [1].

The described method is an alternative quantitative determination of the cetane number of middle distillate fuels intended for use in compression ignition engines. A correlation study between this method and EN ISO 5165:1998 [2] has been done and the results of this are incorporated in this European Standard (see Research Report RR: D02-xxxx [3]).

The basis of this method is the derived cetane number correlation equation as given in Clause 11. The on-going validation of the equation is monitored and evaluated through the existing 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 the review, CEN/TC 19 may make the decision to, if necessary, modify the existing equation/correlation or develop a new one. As part of this review, the sample types will be examined, and if certain types are underrepresented, further steps may be taken to evaluate how they perform.

The ID and CD values and the DCN value determined by this test method can provide a measure of the ignition characteristics of diesel fuel oil used in compression ignition engines. This test is for use by engine manufacturers, petroleum refiners and marketers, and in commerce as a specification aid to relate or match fuels and engines. This test is also applicable to non-conventional diesel fuels.

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 European Standard.

1 Scope

This European Standard 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 with direct fuel injection into heated, compressed synthetic air. A dynamic pressure wave is produced from the combustion of the product under test. An equation converts the ignition delay and combustion delay determined from the dynamic pressure curve to the derived cetane number (DCN). This method is applicable to diesel fuels, FAME and blends of diesel fuels and FAME.

The method is also applicable to middle distillate fuels of nonpetroleum origin, although users applying this standard are warned that the relationship between ignition characteristics and engine performance in unconventional fuels is not yet fully understood. The standard covers the ignition delay range from 1,9 ms to 25 ms and combustion delay from 2,5 ms to 160 ms (70 DCN to 30 DCN). However the precision stated only covers the range of 67 to 39 DCN.

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

WARNING — The use of this standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems 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 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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)*

3 Terms and definitions

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

3.1
cetane number
CN
measure of the ignition performance of a fuel in a standardized engine test 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.

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

Note 1 to entry: In the context of this test method, the start of fuel injection is interpreted as the rise in the electronic signal that opens the injector and the combustion start is interpreted as the first increase of the chamber pressure during the combustion cycle, as measured by a pressure sensor in the combustion chamber.

3.3
combustion delay
CD
period of time, in milliseconds (ms), between the start of fuel injection and mid-point of the combustion pressure curve.

Note 1 to entry: In the context of this test method, the start of fuel injection is interpreted as the rise in the electronic signal that opens the injector and the combustion pressure curve mid-point is interpreted as the part of the pressure curve midway between the initial chamber pressure and the maximum pressure generated during the combustion cycle, as measured by a pressure sensor in the combustion chamber. The combustion delay CD measures the time between the injection of the sample and phase of combustion controlled by the diffusive mixing of the air and fuel.

3.4
derived cetane number
DCN
calculated value using an equation that correlates a combustion analyser ignition delay result and a combustion delay result to the cetane number

3.5
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.

3.6
quality control sample
QC sample
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

3.7
calibration reference fluid
stable and homogenous fluid used to calibrate the performance of the combustion analyzer

3.8
verification reference fluid
stable and homogenous fluid used to verify the performance of the combustion analyzer

4 Principle

A small specimen of sample is injected into a heated, temperature-controlled, constant volume combustion chamber, which has previously been charged with compressed air of a specified quality. Each injection produces a compression ignition combustion cycle detected using a pressure sensor. The ignition delay and combustion delay are measured from the rise of the electronic signal that activates the injector solenoid to two specific points along the combustion pressure wave produced by the combustion cycle.

A complete sequence comprises 5 preliminary injection cycles and 15 subsequent injection cycles used for the sample analysis. The ID and CD measurements for the last 15 injection cycles are statistically reviewed and the outlying ID's and CD's are eliminated using Peirce's Criterion [4]. The remaining ID's and CD's are averaged to produce the ID and CD results. An equation converts the average ID result and the average CD result into a 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 [2].

5 Reagents and materials

CAUTION — Minimize exposure of sample fuels, calibration reference fluids, verification fluids and QC samples to sunlight or fluorescent lamp UV emissions to minimize induced chemical reactions that can affect the ignition delay measurements. Exposure of these fluids to UV wavelengths shorter than 550 nm for a short period of time can significantly affect ignition delay measurements.

5.1 Calibration reference fluid, 40:60 mixture by weight of hexadecane and 2,2,4,4,6,8,8-heptamethylnonane, respectively, measured with an accuracy of 0,01 percent.

5.1.1 Hexadecane, minimum purity of 99,0 % (*V/V*).

5.1.2 2,2,4,4,6,8,8-Heptamethylnonane, minimum purity of 98,0 % (*V/V*).

5.1.3 For peroxide-free material the assigned ID_{ARV} is 2,96 ms and the assigned CD_{ARV} is 4,90 ms.

IMPORTANT —Hydrocarbons can form peroxides and other free radically formed contaminants that can influence the ID and CD. Experience has found some 40:60 blends of hexadecane and 2,2,4,4,6,8,8-heptamethylnonane meeting the purity specification can contain peroxides and other free radically form contaminants. Typically, the peroxides and other free radically formed contaminants can be removed from the 40:60 mixture of hexadecane and 2,2,4,4,6,8,8-heptamethylnonane by subjecting the blend to activated 4Å molecular sieves.

5.2 Verification reference fluid, methylcyclohexane (MCH) of a purity of minimum 99,0 % (*m/m*) to be used as the designated 11,0 ms ignition delay (ID_{ARV}) and the designated 17,0 ms combustion delay (CD_{ARV}) assigned accepted reference value material.

NOTE If the initial purity is not known and during a long-time stored reference fluid, it is advised to check the purity in accordance with IP 537 [5].

IMPORTANT —Hydrocarbons can form peroxides and other free radically formed contaminants that can influence the ID and CD. Experience has found some MCH meeting the purity specification but which does not meet the ID_{ARV} or CD_{ARV}. It is recommended that new material be qualified prior to use.

5.3 Quality control sample, stable and homogenous distillate fuel, similar in nature to the materials under test (see 3.6)

5.4 Charge air, a compressed synthetic air mixture containing (20,0 ± 0,5) % (V/V) oxygen with the balance nitrogen, less than 0,003 % (V/V) hydrocarbons, and less than 0,025 % (V/V) water. It is recommended that a quality control test be performed after an air cylinder has been changed.

5.5 Heptane, (n-Heptane) with a minimum purity of 99,5 % (*V/V*).

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

5.7 Coolant system fluid, 50:50 volumetric mixture of commercial grade ethylene glycol-type radiator antifreeze with water (5.6).

6 Apparatus

6.1. Combustion analyzer

6.1.1. General

An integrated compression ignition apparatus to measure the ignition and combustion characteristics of distillate fuel. Figure 1 is a schematic of the instrument used in this document. 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 standard system consists of a heated combustion chamber (6.1.2) with fluid cooling of designated areas, external chamber inlet and exhaust valves and associated piping, an electronically controlled fuel injection system, a fuel delivery system, a recirculating coolant system, solenoids, sensors, controls and connection fittings for the compressed gas utilities. Figure 1 gives a schematic outline of the analyser.

6.1.2 Combustion chamber, a steel combustion chamber of capacity 0,473 l ± 0,05 l. Annex A gives further details.

6.1.3 Filter medium, A removable Teflon® filter with a 5µ pore size is placed downstream from the sample vessel to filter particulate matter from the sample .s

7 Sampling

7.1 Unless otherwise specified, obtain samples in accordance with the procedures given in EN ISO 3170 or EN ISO 3171.

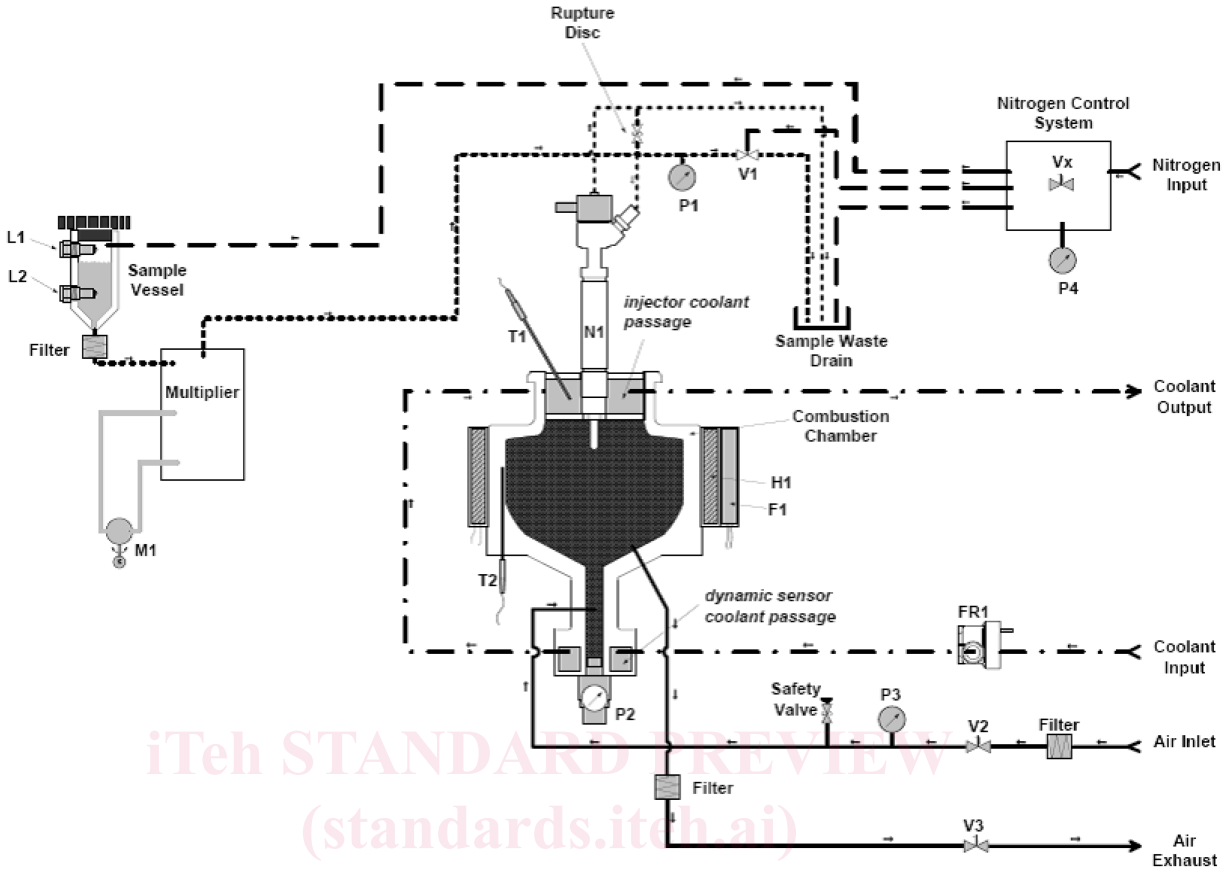
7.2 Collect and store samples in dark brown bottle, metal can or non-reactive plastic container to minimize exposure to UV emissions that can induce chemical reactions, which may affect ignition delay measurements. If the sample is not to be analyzed within 24 h, retain in a dark, cool/cold environment, and preferably under an inert gas (e.g. nitrogen).

NOTE 1 Exposure of petroleum fuels to UV wavelengths of less than 550 nm for even a short period of time has been shown to affect ignition delay [6] and combustion delay.

NOTE 2 The formation of peroxides and radicals, which affect the ignition delay and the combustion delay, is minimized when the sample is stored in the dark, under a nitrogen blanket and in a cold (below 10 °C) environment.

7.3 Condition the diesel fuel oil sample before opening the storage container, so that it is at room temperature, typically 18 °C to 32 °C.

7.4 Inspect the sample for wax precipitation. If precipitants are present, bring the test sample to a temperature of at least 14 °C above the expected cloud point of the material being tested, taking care not to lose any lower boiling range components. Agitate the sample to return precipitants back in to the solution, ensuring the sample is homogeneous before proceeding.



Key

Digital signals
L1: upper level sensor
L2: lower level sensor
F1: thermal fuse
M1: hydraulic pump
N1: injector
V1: flush valve)
V2: air inlet valve
V3: exhaust valve
Vx: nitrogen circuit valves

Analogue signals
T1: coolant temperature
T2: inner wall temperature
P1: fuel pressure
P2: chamber dynamic pressure
P3: chamber static pressure
P4: nitrogen pressure
FR1: coolant flow rate

Figure 1 — Schematic overview of combustion analyser

8 Apparatus assembly and installation

8.1 General settings

Operation of the combustion analyzer, associated equipment, instrumentation, and computer system requires setting a series of testing variables to prescribed specifications. Some of these settings are established by component specifications, others are operating conditions that are monitored or controlled by the computer software or by operator adjustment.