SLOVENSKI STANDARD
SIST EN 17155:2018

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Tekoči naftni proizvodi - Določevanje označenega cetanskega števila (ICN) srednjih destilacijskih goriv - Osnovna referenčna metoda kalibracije goriv z uporabo komore s konstantno prostornino

Liquid petroleum products - Determination of indicated cetane number (ICN) of middle distillate fuels - Primary reference fuels calibration method using a constant volume combustion chamber

Flüssige Mineralölerzeugnisse - Bestimmung der generischen Cetanzahl (GCZ) von Kraftstoffen aus Mitteldestillaten - Verfahren zur Kalibrierung mit primären Bezugskraftstoffen unter Verwendung einer Verbrennungskammer mit konstantem Volumen

Produits pétroliers liquides - Détermination de l'indice de cétane indicative (ICI) des distillats moyens - Méthode du calibration par combustibles du reference primaire et combustion dans une chambre à volume constant

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75.160.20	Tekoča goriva	Liquid fuels

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Liquid petroleum products - Determination of indicated cetane number (ICN) of middle distillate fuels - Primary reference fuels calibration method using a constant volume combustion chamber

Produits pétroliers liquides - Détermination de l'indice de cétane indiqué (ICI) des distillats moyens - Méthode d'étalonnage avec carburants de référence primaires et chambre de combustion à volume constant

Flüssige Mineralölerzeugnisse - Bestimmung der indizierten Cetanzahl (ICZ) von Kraftstoffen aus Mitteldestillaten - Verfahren mittels Kalibrierung mit primären Bezugskraftstoffen unter Verwendung einer Verbrennungskammer mit konstantem Volumen

This European Standard was approved by CEN on 20 April 2018.

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

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European foreword

This document (EN 17155:2018) 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of an identical text or by endorsement, at the latest by January 2019, and conflicting national standards shall be withdrawn at the latest by January 2019.

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

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

Introduction

This document is derived from standardization work within the Energy Institute (IP 617) and ASTM International. A similar technically equivalent test method is under development by ASTM International.

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 [1] is fully reported in Research Report IP 617 ILS [2].

This method is based on calibration by blends of primary reference fuels on a scale of 0 (1-Methylnaphthalene) and 100 (n-hexadecane) with the units of measurement being designated Indicated Cetane Number (ICN). The on-going performance of this test method will be monitored and evaluated through the existing European and American fuel exchange programmes.

The ICN value determined by this test method can provide a measure of the ignition characteristics of middle distillate fuels 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 middle distillate fuels.

For the purpose of this standard, the abbreviation ICN (Indicated Cetane Number) is being used to discriminate it from other techniques.

For the moment the basics of one type of apparatus are described. Once more correlation data on different types of indicated 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 the indicated cetane number (ICN) of middle distillate fuels and blending components, intended for use in compression ignition engines. The test method utilizes a constant volume combustion chamber with direct fuel injection into heated compressed air. Calibration of the apparatus using blends of primary reference materials over a scale of 0 to 100 enables fuel ignition delays, measured from the resulting pressure increase, to be used to determine and report ICN results.

This European Standard is applicable to middle distillate fuels of both petroleum and non-petroleum origin, hydrocarbon oils, oil-sands based fuels, blending components, fatty acid methyl esters (FAME), blends of fuel containing biodiesel material, diesel fuel oils containing cetane number improver additives, low-sulfur diesel fuel oils, aviation turbine fuels and polyoxymethylene dimethyl ether (OME). However, users applying this standard especially to unconventional distillate fuels are warned that the relationship between cetane number and combustion behaviour in real engines is not yet fully understood.

This European Standard covers the calibrated range of 35 ICN to 85 ICN.

NOTE 1 The analyser can measure ICN outside the calibrated range, but precision has not been determined.

NOTE 2 For the purpose of this standard, the expression "% (*V/V*)" is used to represent the volume fraction.

WARNING — The use of this standard can 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 users of this standard to take appropriate measures to ensure the safety and health of personnel prior to application of the standard, and fulfil statutory and regulatory requirements for this purpose.

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.

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

ASTM D3703, *Hydroperoxide Number of Aviation Turbine Fuels, Gasoline and Diesel Fuels*

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 diesel fuel oil obtained by comparing it to reference fuels in a standardized engine test

Note 1 to entry: Ignition performance is understood to mean the ignition delay of the fuel as determined when the standard test engine is operated under controlled conditions of fuel flow rate, injection timing and compression ratio.

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 it is the mean of ID0 and ID150.

3.2.1
Ignition delay – 0 kPa pressure recovery
ID_0
period of time, in milliseconds (ms), between the start of fuel injection and the point where the relative pressure recovers to 0 kPa

Note 1 to entry: See Figure B.1 for visual explanation.

3.2.2
ignition delay – 150 kPa threshold
ID_{150}
period of time, in milliseconds (ms), between the start of fuel injection and the point where the relative pressure reaches 150 kPa

Note 1 to entry: See Figure B.1 for visual explanation.

Note 2 to entry: In the context of this test method, the start of fuel injection is interpreted as the start of the electronic signal that opens the piezoelectric injector; timings for the ID_0 and ID_{150} ignition delays commence at this start point.

3.3
indicated cetane number
ICN
measure of the ignition performance of a middle distillate fuel obtained by comparing it to primary reference fuels that have been blended to a scale; where 0 and 100 are represented by 1-methylnaphthalylene and n-hexadecane respectively to create a calibration curve

Note 1 to entry: It is in principle a number indicated from a calibration curve that has been generated on the analyser under test using primary reference fuel blend calibration points. The calibration curve, ICN = function of ignition delay (ID); details and examples of the equation are given in the research report.

3.4
quality control sample
QC sample
stable and homogenous material(s) similar in nature to the materials under test, stored to ensure integrity, and available in sufficient quantity for repeated long term testing

3.5
primary reference fuels
PRF
n-hexadecane (n-cetane) and 1-methylnaphthalene(1-MN)

Note 1 to entry: Volumetrically proportioned blends, at 20 °C, of these materials define the indicated cetane number by the relationship shown in Formula (1):

indicated cetane number (ICN) = percentage n-hexadecane (V/V) (1)

3.6
calibration and verification fluids
blends of n-hexadecane and 1-methylnaphthalene

Note 1 to entry: These define the indicated cetane number in specific volume ratios according to the relationship shown in Formula (1).

4 Principle

The indicated cetane number (ICN) of a diesel fuel is determined by comparing its ignition performance with blends of primary reference fuels of known ICN under standard operating conditions.

A test portion of the material under test is automatically drawn from a sample vial located in the auto-sampler carousel, heated during pressurization, and then, at the start of a combustion cycle, a sub-portion is injected into a temperature and pressure controlled, constant volume combustion chamber, which has previously been charged with compressed air of a specified quality. Each injection, and its resulting combustion, causes a rapid pressure rise in the combustion chamber that is detected by the dynamic pressure sensor.

The test sequence, using the test portion, comprises a cleaning stage and combustion cycles to obtain ignition delay (ID) values. The ICN result is determined using the mean of the combustion cycles' IDs and the primary reference fuel (PRF) blends calibration curve.

Each analyser is calibrated with seven fluids created from blends of PRFs, with known ICN calculated from Formula (1); this links test results to those obtained using EN ISO 5165 [1]. Test results outside the calibration range are determined by extrapolation using the calibration curve but are subject to increased uncertainty.

5 Reagents and materials

5.1 Primary reference fuels (PRF) and blended fluids

CAUTION — When blending PRFs take appropriate safety precautions in keeping with the relevant safety data sheets, such as using a fume hood.

5.1.1 n-hexadecane, minimum purity of 99,0 % (*V/V*), the designated 100 ICN component, required for blending the calibration and verification fluids.

5.1.1.1 Store n-hexadecane in a dark cool place to avoid possible UV light and temperature effects. n-hexadecane solidifies at temperatures below approximately 18 °C and can require gentle warming before use.

5.1.1.2 The hydroperoxide level, measured immediately before blending, shall be ≤ 1,0 mg/kg measured using ASTM D3703 or an equivalent national standard. C.2.1 and the instrument manufacturer's instructions give advice on the use of a molecular sieve if the hydroperoxide level is too high. Alternatively a new batch of the material may be obtained and tested for hydroperoxide level.

5.1.2 1-methylnaphthalene, minimum purity of 97,0 % (*V/V*), the designated 0 ICN component, required for blending the calibration and verification fluids.

5.1.2.1 Store 1-methylnaphthalene in a dark cool place to avoid possible UV light and temperature effects.

5.1.2.2 The hydroperoxide level, measured immediately before blending, shall be ≤ 1,0 mg/kg measured using ASTM D3703 or an equivalent national standard. C.2.1 and the instrument manufacturer's instructions give advice on the use of a molecular sieve if the hydroperoxide level is too high. Alternatively a new batch of the material may be obtained and tested for hydroperoxide level.

5.1.3 Calibration fluids, 7 volumetric blends of n-hexadecane and 1-methylnaphthalene in accordance with Formula (1) and Table 1 with values within 0,5 ICN of the required values to an accuracy of ± 0,01 ICN.

5.1.3.1 Calibration fluids shall be stored in sealed containers (6.7.1) of 40 ml to 100 ml in volume under an inert gas (5.7), in a dark cool place to avoid possible effects of UV light. 40 ml is required for the test.

Table 1 — ICN of calibration fluids

ICN	35,00	40,00	46,00	53,00	60,00	70,00	85,00

5.1.3.2 Calibration fluids are available commercially or may be made up locally. Annex C outlines a recommended procedure.

5.1.3.3 The ICN number of the blend is calculated using Formula (1). The precise ICN of the blend shall be determined by mass measurements and density to provide volumetric equivalence. The volumes of PRFs used shall be accurately dispensed and recorded so that the validity of the ICN determination can be checked. See Annex C.

5.1.4 Verification fluid, a volumetric blend of n-hexadecane and 1-methylnaphthalene in accordance with Formula (1) with a known ICN to an accuracy of ± 0,01 ICN. The ICN shall be different to those shown in Table 1, by at least 1 ICN, and be made from different batches of PRFs.

5.1.4.1 Verification fluids shall be stored in sealed containers of 40 ml to 100 ml in volume under an inert gas (5.7), in a dark cool place to avoid possible effects of UV light. 40 ml is required for the test.

5.1.4.2 Verification fluids are available commercially or may be made up locally. See Annex C for additional information.

5.1.4.3 The ICN number of the blend shall be determined by mass measurements and density to provide volumetric equivalence. The volumes of PRFs used shall be accurately dispensed and recorded so that the validity of the ICN determination can be checked. See Annex C for additional information.

5.2 Quality control (QC) sample, stable and homogenous distillate fuel, similar in nature to the materials under test. For sampling and handling see Clause 8.

5.3 Combustion charge air, compressed air containing (20,9 ± 0,5) % (*V*/*V*) oxygen with the balance nitrogen, less than 0,003 % (*V*/*V*) hydrocarbons, and less than 0,025 % (*V*/*V*) water and capable of delivering a regulated pressure of 2,5 MPa to 3,0 MPa.

5.3.1 Air compressed locally can meet the above requirements. Follow the manufacturer's instructions regarding filtration and cleanliness of the air.

NOTE The oxygen content of combustion charge air can vary between batches (cylinders). Significant variation can lead to changes in ignition delay (higher oxygen content leads to shorter ignition delays). Combustion charge air produced locally by a compressor can minimize variations.

5.4 Cleaning fluid, 1-decanol, minimum purity 99,0 %, filtered through a 0,45 micrometre, or less, PTFE media filter.