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Diesel fuel — Assessment of lubricity using the high-frequency reciprocating rig (HFRR) —

Part 1: Test method

Carburant diesel — Évaluation du pouvoir lubrifiant au banc alternatif à haute fréquence (HFRR) —
Partie 1: Méthode d'essai

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 12156-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*, in collaboration with ISO/TC 28, *Petroleum products and lubricants*.

This second edition cancels and replaces the first edition (ISO 12156-1:1997), which has been technically revised. It also incorporates the Technical Corrigendum ISO 12156-1:1997/Cor.1:1998.

ISO 12156 consists of the following parts, under the general title *Diesel fuel — Assessment of lubricity using the high-frequency reciprocating rig (HFRR)*:

— *Part 1: Test method*

— *Part 2: Limit*

Introduction

All diesel fuel injection equipment has some reliance on diesel fuel as a lubricant. Wear due to excessive friction resulting in shortened life of engine components, such as diesel fuel injection pumps and injectors, has sometimes been ascribed to lack of lubricity in the fuel.

The relationship of test results to diesel injection equipment component distress due to wear has been demonstrated for some fuel/hardware combinations where boundary lubrication is a factor in the operation of the component.

Test results from fuels tested to this procedure have been found to correlate to many fuel/hardware combinations and provide an adequate prediction of the lubricating quality of the fuel.

Diesel fuel — Assessment of lubricity using the high-frequency reciprocating rig (HFRR) —

Part 1: Test method

WARNING — Application of this part of ISO 12156 may involve the use of hazardous materials, operations and equipment. This part of ISO 12156 does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this part of ISO 12156 to establish appropriate safety and health practices and determine the applicable regulatory limitations prior to use.

1 Scope

This part of ISO 12156 specifies a test method using the high-frequency reciprocating rig (HFRR), for assessing the lubricating property of diesel fuels, including those fuels which may contain a lubricity-enhancing additive.

It applies to fuels used in diesel engines.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO Guide 33:2000, *Uses of certified reference materials*

ISO Guide 34:2000, *General requirements for the competence of reference material producers*

ISO Guide 35:2006, *Reference materials — General and statistical principles for certification*

ISO 683-17:1999, *Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels*

ISO 3290:2001, *Roller bearings — Balls — Dimensions and tolerances*

ISO 4259:1992, *Petroleum products — Determination and application of precision data in relation to methods of test*

ISO 5272:1979, *Toluene for industrial use — Specifications*

ISO 6507-1:2005, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1:2005, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ASTM D 329-02, *Standard Specification for Acetone*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
lubricity
property of the fluid, measured by the wear scar produced on an oscillating ball from contact with a stationary plate immersed in the fluid and operating under closely controlled conditions

3.2
mean wear scar diameter
MWSD
uncorrected mean diameter of the wear scar produced on the test ball

3.3
WS1,4
calculated value of wear scar diameter corrected to the standardized water vapour pressure of 1,4 kPa

3.4
humidity correction factor
HCF
factor for adjusting the wear scar value to account for test conditions which differ from the standardized water vapour pressure of 1,4 kPa

NOTE HCF is expressed in micrometres per kilopascal.

4 Principle

A sample of the fluid under test is placed in a test reservoir which is maintained at the specified test temperature. A fixed steel ball is held in a vertically mounted chuck and forced against a horizontally mounted stationary steel plate with an applied load. The test ball is oscillated at a fixed frequency and stroke length while the interface with the plate is fully immersed in the fluid. The metallurgies of the ball and plate, temperature, load, frequency, and stroke length are specified. The ambient conditions of temperature and humidity during the test are used to correct the size of the wear scar generated on the test ball to a standard set of ambient conditions. The corrected wear scar diameter is a measure of the fluid lubricity.

5 Reagents and materials

5.1 Compressed air, if required for drying the equipment (see 7.1.2), supplied at a pressure of 140 kPa to 210 kPa and containing less than 0,1 ml/m^3 hydrocarbons and less than 50 ml/m^3 water.

WARNING — Use with extreme caution in the presence of combustible material.

5.2 Toluene, in accordance with ISO 5272.

WARNING — Flammable. Harmful if inhaled.

5.3 Acetone, in accordance with ASTM D 329-02.

WARNING — Extremely flammable. Vapours may cause flash fire.

5.4 Reference fluids

WARNING — Flammable.

Two reference fluids, produced in accordance with ISO Guide 34 and ISO Guide 35, shall be used for verifying the performance of the test apparatus. The fluids shall have significantly different lubricity performance, as measured by this part of ISO 12156. They shall be clearly marked with the HFRR value (WS1,4) and its expanded uncertainty, expressed in micrometres, and with the HCF, expressed in micrometres per kilopascal. The two reference fluids shall have a minimum difference in HFRR value of 200 µm, as measured by this part of ISO 12156.[1)]

6 Apparatus

6.1 Test apparatus[2)], (see Figure 1), capable of engaging a steel ball loaded against a stationary steel plate with an applied load and oscillating at a fixed frequency and stroke length while the contact interface is fully immersed in a fluid according to the test conditions given in Table 1.

The fluid reservoir shall be capable of holding a test plate in a rigid manner and shall also contain the test fluid. The temperature of this reservoir, and consequently the test fluid contained in it, should be achieved by means of an electrically controlled heater pad to which the fluid reservoir is closely attached.

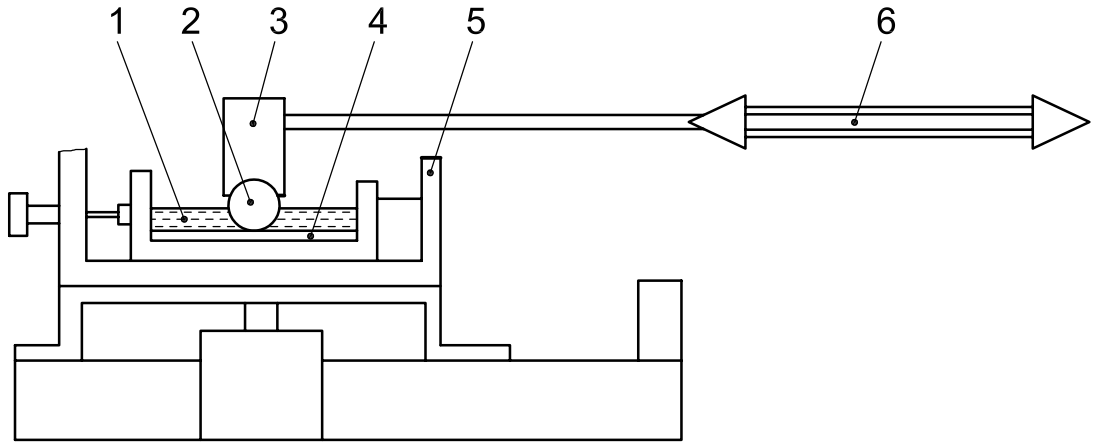
The apparatus control unit for controlling variable parameters shall include provision for electronic data storage and retrieval.

Table 1 — Test conditions

Parameter	Value
Fluid volume, ml	2 ± 0,2
Stroke length, mm	1 ± 0,02
Frequency, Hz	50 ± 1
Laboratory air [a]	See Figure 2
Fluid temperature, °C	60 ± 2
Test mass [b], g	200 ± 1
Test duration, min	75 ± 0,1
Reservoir surface area, mm^2	600 ± 100
[a] Laboratory air conditions as measured between 0,1 m and 0,25 m of the fluid reservoir are to be controlled to the acceptable range of conditions as shown in Figure 2.	
[b] Total mass including fixing elements.	

1) CEC Reference Fluids RF-90-A-92 batch 5 and DF-92-02, and ASTM D 6079 Fluid A have been found to be satisfactory for use as the high-lubricity reference fluid. CEC Reference Fluid DF-70-00 and ASTM D 6079 Fluid B have been found to be satisfactory for use as the low-lubricity reference fluid. The CEC reference fluids may be obtained from Haltermann Products, Schopenstehl 15, D-20095 Hamburg, Germany, and the ASTM reference fluids may be obtained from the ASTM Test Monitoring Centre, 6555 Penn Avenue, Pittsburgh, PA 15026-4489, USA. This information is given for the convenience of users of this part of ISO 12156 and does not constitute an endorsement by ISO of the products named. Equivalent products may be used if they can be shown to lead to the same results.

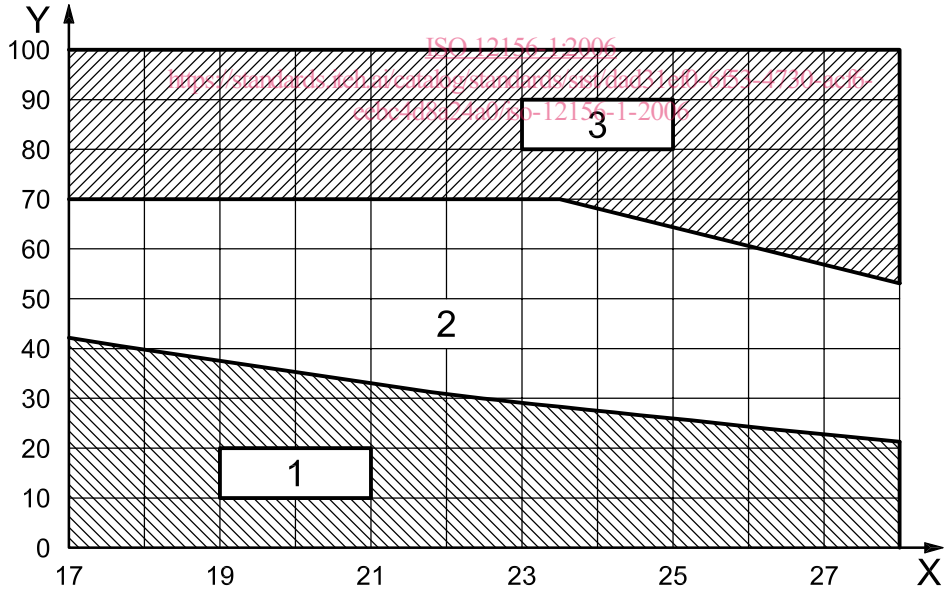
2) HFRR units, HFR2, supplied by PCS Instruments, 78 Stanley Gardens, London W3 7SZ, U.K., have been found satisfactory. This information is given for the convenience of users of this part of ISO 12156 and does not constitute an endorsement by ISO of these products. Equivalent products may be used if they can be shown to lead to the same results.



Key

1 fluid reservoir
2 test ball
3 test mass
4 test plate
5 heating bath
6 oscillating motion

Figure 1 — Example of the high-frequency reciprocating rig



Key

X air temperature, °C
Y relative humidity, %
1 unacceptable range of conditions — too dry
2 acceptable range of conditions
3 unacceptable range of conditions — too moist

Figure 2 — Laboratory air conditions

6.2 Test plate[3], Steel ISO 683-17-100Cr6 machined from annealed rod, having a Vickers hardness "HV 30" scale number of 190 to 210 (according to ISO 6507-1). It shall be lapped and polished to a surface finish of Ra < 0,02 µm.

6.3 Test ball[3], 6,00 mm diameter, grade 28 (G28) according to ISO 3290 of steel ISO 683-17-100Cr6. It shall have a Rockwell hardness “C” scale (HRC) number of 58 to 66 (according to ISO 6508-1).

6.4 Microscope, metallurgical type, suitable for measuring the wear scar on the test ball to the nearest 1 µm.

6.5 Desiccator, containing a drying agent, capable of storing test plates, balls, and hardware.

6.6 Cleaning bath, ultrasonic type, with a seamless stainless steel tank of adequate capacity and a cleaning power of 40 W or greater.

6.7 Fuel containers, of epoxy lined steel, unless it can be shown that alternative materials give equivalent results.

6.8 Time-measuring device, mechanical or electronic, capable of measuring (75 ± 0,1) min.

6.9 Test mass, 200 g, including any attaching apparatus for fixing to the vibrator arm.

7 Preparation and calibration

7.1 Preparation of apparatus

7.1.1 Test plates and balls

Using clean forceps, place a number of plates (6.2) (shiny side up) and balls (6.3) as received into a clean glass container, and cover with toluene (5.2). Leave to soak for a minimum of 8 h, then place the container in the ultrasonic cleaning bath (6.6) for 10 min. Transfer the plates (shiny side up) and balls into a container of fresh toluene, close the container with a cover and store it appropriately in order to avoid contamination.

7.1.2 Hardware

Place the sample holders, screws, and all hardware and utensils that come into contact with the test fluid, together with a plate and ball cleaned in accordance with 7.1.1, in a clean glass beaker and cover with toluene (5.2). Place the beaker in the ultrasonic cleaning bath (6.6) for 10 min, then using clean forceps transfer the hardware and test specimens into a beaker of acetone (5.3). Place in the ultrasonic bath for 2 min. Remove the components, blow dry (5.1), and if not to be used immediately, store in the desiccator (6.5).

7.2 Calibration and correction

7.2.1 Temperature

The temperature control of the fluid reservoir (see Figure 1) shall be checked using a calibrated temperature-measuring device.

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3) Suitable test specimens are available from PCS Instruments, 78 Stanley Gardens, London W3 7SZ, U.K. This information is given for the convenience of users of this part of ISO 12156 and does not constitute an endorsement by ISO of this product. Equivalent products may be used if they can be shown to lead to the same results.