TECHNICAL SPECIFICATION

ISO/TS 16332

First edition
2006-09-15

Diesel engines — Fuel filters — Method for evaluating fuel/water separation efficiency

Moteurs diesels — Filtres à carburant — Méthode d'évaluation de l'efficacité des séparateurs carburant-eau

Reference number
ISO/TS 16332:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 16332 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

Annexes A and B form normative parts of this Technical Specification. Annexes C and D are for information only.

Introduction

Modern fuel injection systems, installed in passenger cars, as well as in heavy duty or off-road vehicle applications, require high and stable separation efficiencies for all insoluble contaminants in the fuel to ensure a prolonged life. Beside solid contamination, undissolved water, in finely or coarsely emulsified form, can also reduce the lifetime of injection systems. Suitable fuel filters, having a high level water separation efficiency, are an absolute necessity for system longevity.

Factors found to affect the separation efficiency of undissolved water in the field are mainly due to the fuel quality, which is strongly influenced by the performance of additives in the fuel itself, as well as the actual characteristics of the fuel/water-emulsion, the specific flow rate of the system, the type of media in the filter element, as well as the size and design of the filter housing itself. To ensure laboratory test results are comparable, these various parameters have to be taken into account in the test method, in order to reduce their influence on the test results.

NOTE A variety of tests were investigated prior and parallel to the preparation of this Technical Specification to specify the required test conditions. Additional work is underway to validate, confirm and if necessary to modify the following parameters:

— test fuel (5.1.1);

— water concentration of 1 500 ppm (6.4);

— volume of fuel (6.1);

— total test duration t_{total} (6.6).

At the time of publication of this Technical Specification, interlaboratory tests are being organized to establish the repeatability and reproducibility of the results.

Diesel engines — Fuel filters — Method for evaluating fuel/water separation efficiency

1 Scope

This Technical Specification specifies a fuel/water separation test with continuous water injection, using an offline water concentration measuring method, for evaluating the ability of a fuel filter to separate either finely or coarsely dispersed undissolved water out of fuel. This test is intended for application to filter elements which are installed upstream or downstream of the low pressure pump, having a rated flow (in litres per hour) between 50 l/h and 900 l/h. By agreement between customer and filter manufacturer, and with some modification, the procedure may be used for fuel filters with higher flow rates.

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 760, *Determination of water — Karl Fischer method (General method)*

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 6889, *Surface active agents — Determination of interfacial tension by drawing up liquid films*

ISO 13320-1, *Particle size analysis — Laser diffraction methods — Part 1: General principles*

ASTM D 1401, *Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids*

CEC RF-06-03:2003 [1)], *CEC Legislative fuel RF-06-03 (reference fuel specification)*

3 Terms and definitions

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

3.1
interfacial tension
IFT
force required to increase the surface area of the interface between two liquids by a unit amount

NOTE Interfacial tension is expressed in millinewtons per metre (mN/m).

1) The reference fuel specification is provided by CEC secretariat services: Interlynk Administrative Services Ltd., PO Box 6475, Earl Shilton, Leicester LE9 9ZB, UK; T +44(0)1455 21993; F +44(0)1455 821994.

3.2
droplet size distribution
DSD
curve of the percentage of the droplet population in different size ranges

See Figure B.1.

3.3
base water concentration
concentration of water in water saturated fuel

3.4
undissolved water
difference between total and base water concentration

3.5
test time
t
"point of time" when a test or a measurement is started or running respectively

NOTE In contrast to the total test duration t_{total}, see 6.6.

4 Symbols

Graphical symbols used in this Technical Specification for fluid power system components are in accordance with ISO 1219-1.

5 Test equipment

5.1 Test fluids

5.1.1 Test fuels

The test fuel shall be according to CEC RF-06-03 [2)] and processed to achieve the following requirements by adding a multifunctional fuel additive (see Note 1):

a) IFT

15 mN/m ± 3 mN/m measured according to ISO 6889 after 60 s;

b) water separability

270 s ± 30 s, when 75 % of test fuel is separated (sedimentation test according to ASTM D 1401 at 25 °C). Within this document, the water separability is defined through the point of time, when 75 % of the test fuel is separated.

NOTE 1 Fundamental tests lead to a mass fraction of approximately 0,1 % of the multifunctional fuel additive HiTEC 4620 [2)] to reach the required values.

The test fuel shall be stored protected from humidity, dust and light.

The batch of test fuel shall be changed when the fuel no longer meets the specified requirements.

---

2) Suitable products are available commercially. Details may be obtained from the Secretariat of Technical Committee ISO/TC22 or from the ISO Central Secretariat.

Optionally, if agreed between customer and filter manufacturer, the test can be performed with a fuel used in the application, but the deviations of the relevant fuel parameters shall be recorded in the test report.

NOTE 2 By using other fuel qualities (e.g. fuels used in application), the test results may not be comparable with the results obtained with the test fuel according to 5.1.1.

5.1.2 Test water

Clean, distilled, or deionized water with a surface tension of at least 70 mN/m, measured at 20 °C ± 1,5 °C.

5.2 Laboratory equipment

5.2.1 General

All laboratory equipment and glassware, required to determine the water concentration, shall be according to ISO 760.

5.2.2 Sampling bottles and glassware, 100 ml sampling bottles with 45 mm screw caps carefully rinsed with clean petroleum ether and dried in an oven.

5.2.3 Karl Fischer titration system [3], as commercially available and validated according to 8.2.3.

Recommended equipment should be composed of a coulometric, diaphragmless titration cell and a codistillation unit.

Humidity is probably the largest source of error during the titration process. Special precautions should be taken during setup and testing. The recommended amount of water per sample should be ⩾ 50 µg to reach a good relation between titration time and accuracy.

5.2.4 Analytical balance, with an accuracy of ± 1 mg.

5.2.5 Sampling syringe, with a volume of 1 ml ± 0,1 ml.

5.2.6 High-speed mixer

Mixer of the ULTRA-TURRAX type [3] with

— a stator of 18 mm ± 1 mm,

— a rotor of 12,5 mm ± 1 mm, and

— a rotational speed of 15 000 min^{-1} ± 500 min^{-1}.

5.3 Test stand

5.3.1 General

The test stand, shown diagrammatically in Figure 1, shall comprise a filter test circuit as described in 5.3.2.

3) This equipment has been found satisfactory. This information is given for the convenience of users of this Technical Specification and does not constitute an endorsement by ISO. Details may be obtained from the Secretariat of Technical Committee ISO/TC22 or from the ISO Central Secretariat.

5.3.2 Filter test circuit (see Figure 1)

5.3.2.1 Fuel sump (1) [4] : conical bottom, stainless steel or corrosion resistant container with a fuel outlet at the bottom of the container.

The container shall be able to contain the volume as specified in 6.1. The fuel sump has to be covered with a non transparent cover to protect the fuel from light.

5.3.2.2 Water sump (6): stainless steel or corrosion resistant container with approximate capacity of 30 l.

NOTE Instead of the container, continuous water supply may be used.

5.3.2.3 Test pump (2) which does not exhibit pressure pulsation with an amplitude greater than 10 % of the average pressure at the inlet of the water emulsifying device.

5.3.2.4 Adjustable water injection pump (7) [5], capable of delivering a water flow between 0,15 % and 2 % of the fuel flow.

5.3.2.5 Fuel flow meter (5a), capable of measuring with an accuracy as specified in Table 1.

5.3.2.6 Water flow meter (5b) [5], capable of measuring with an accuracy as specified in Table 1.

5.3.2.7 Injection device (8), with a maximum inner diameter of the injection pipe of 1 mm.

5.3.2.8 Water emulsifying device (9): fixture with an exchangeable orifice plate, as described in Annex A.

5.3.2.9 Upstream (12) and **downstream** (17) **sampling devices**, as shown in Figure 3.

5.3.2.10 Temperature indicator (13) with an accuracy as specified in Table 1.

5.3.2.11 Pressure gauge (10) with an accuracy as specified in Table 1.

5.3.2.12 Differential pressure gauges (11) with an accuracy as specified in Table 1.

5.3.2.13 Water drainage system (15): closed collector (e.g. laboratory measuring cylinder), located directly below the test filter (water separator) (14) and capable to collect the injected amount of water; it is connected to the water outlet of the test filter with pressure-tight fittings.

The internal diameter of the connecting pipe between the test filter and the closed collector shall be of at least 10 mm.

5.3.2.14 Test stand pipes shall be made of stainless steel; painted or coated pipes are not allowed. For the adaptation of the test filter (14) to the test stand piping, flexible lines are allowed.

The piping shall be designed with a minimum number of flanges or fittings and grounded upstream near the test filter (potential difference < 10 V between each point).

The test stand pipes inner diameter d_i between injection device (8) and downstream sampling point (17) (see Figure 2) should allow a flow velocity $\geqslant$ 0,75 m/s.

The pipes, outside of Figure 2, shall be as short as possible.

5.3.2.15 Inline static mixer (16) to provide a representative sample at the downstream sampling point (17).

NOTE Using a water emulsifying device (see 5.3.2.8) has been proven to be suitable as a static mixer.

---

4) The numbers in brackets refer to the key numbers in Figure 1.

5) Suitable products are available commercially. Details may be obtained from the Secretariat of Technical Committee ISO/TC22 or from the ISO Central Secretariat.

5.3.2.16 Optional: **three-way ball valve** (18) and **collecting sump** (19), if the test stand is used to run as a single pass system (open test circuit).

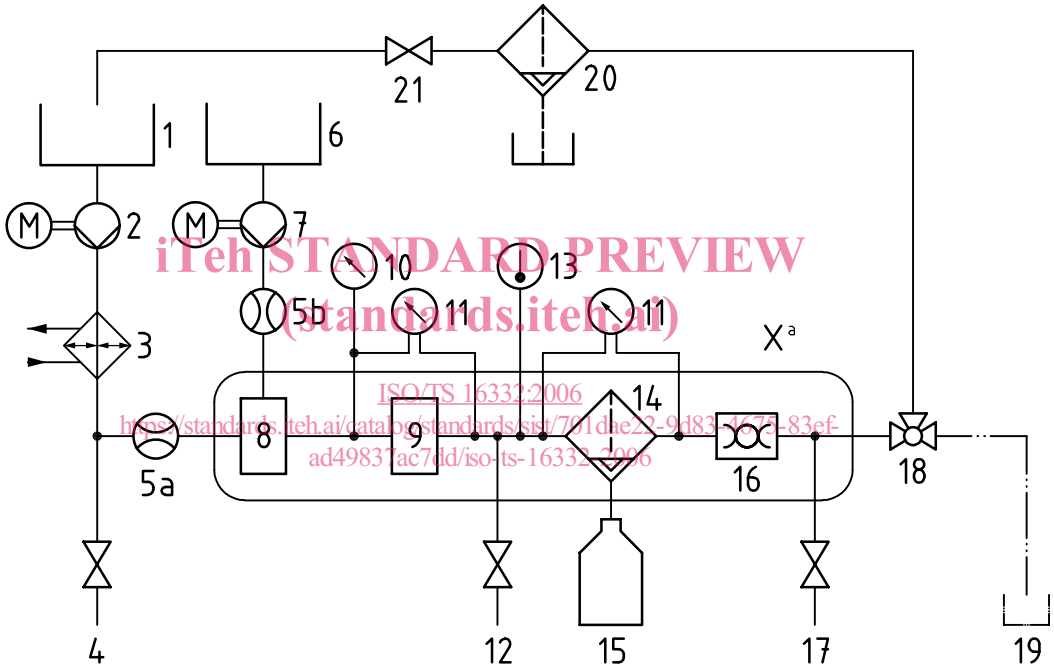
5.3.2.17 **Final water separator assembly** (20),

— with a suitable container in which to drain the water, and

— such that not more than 30 ppm by volume of undissolved water is recycled on an average basis under test conditions.

5.3.2.18 **Back pressure regulating valve** (21) to ease test filter venting and optionally to control the test flow rate Q_T.

5.3.2.19 **Heat exchanger** (3), capable of maintaining the test temperature T within the tolerances given in Table 1.

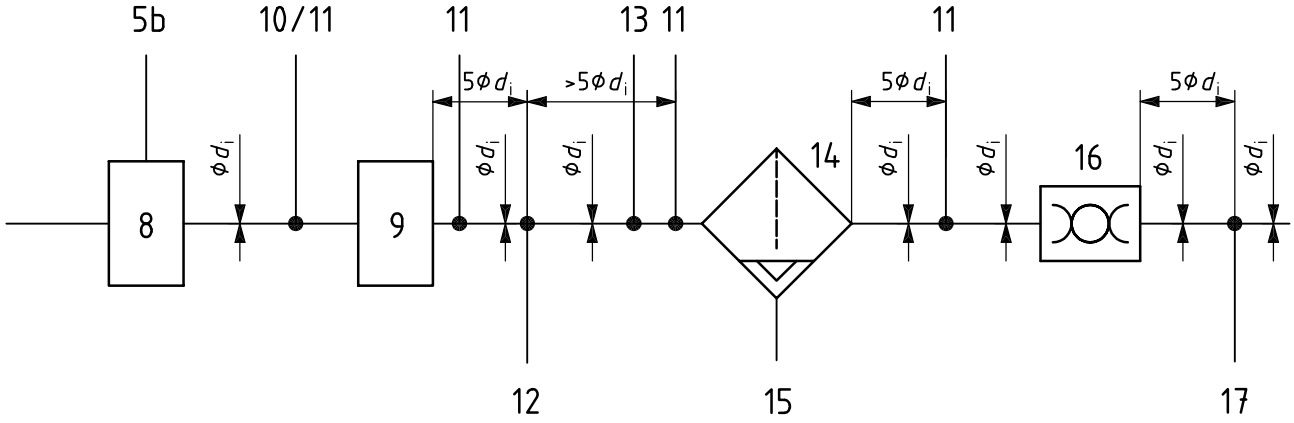


Key

1	fuel sump	7	adjustable water injection pump	14	test filter (water separator)
2	test pump	8	injection device	15	water drainage system
3	heat exchanger	9	water emulsifying device (orifice plate holder)	16	inline static mixer
4	sampling point (sampling valve)	10	pressure gauge	17	downstream sampling point (downstream sampling device: see Figure 3)
5a	fuel flow meter	11	differential pressure gauges (2)	18	three-way ball valve (optional)
5b	water flow meter	12	upstream sampling point (upstream sampling device: see Figure 3)	19	collecting sump (optional)
6	water sump	13	temperature indicator	20	final water separator assembly
				21	back pressure regulating valve

[a] See Figure 2.

Figure 1 — Filter test stand (diagrammatically)

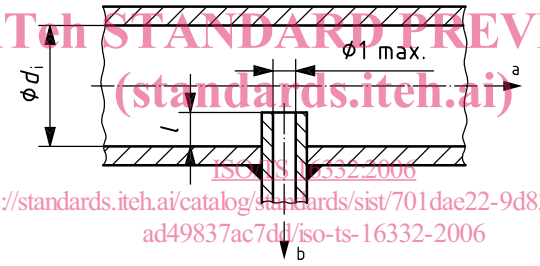


Key

Ød_i inner pipe diameter

Figure 2 — Length and inner diameter d_i of test stand pipes (detail X of Figure 1)

Dimension in millimetres



Key

l $d_i/4 < l < d_i/3$

Ød_i inner pipe diameter

a Flow of test fluid.

b Sampling flow.

Figure 3 — Upstream and downstream sampling device

6 Test conditions

6.1 Volume of fuel

The volume of the fuel [fuel sump (1)] shall be 15 times the test flow rate Q_T per minute.

6.2 Test temperature T

The test shall be conducted at a test temperature T of 23 °C ± 2 °C, measured at the test filter inlet.

Alternatively, the test may be performed at a test temperature T as agreed between customer and filter manufacturer. This shall be recorded in the test report.