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Automotive Parts —
Fuel Filters for Diesel Engines —
Test Methods

ICS 43.060.40

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS D 1617 : 1995** is replaced with **JIS D 1617 : 1998**.

Giving consideration upon deliberations on the draft International Standards at **ISO TC/22**, Road vehicles, being in charge of **ISO 4020/1** which is the International Standard corresponding to this Standard, in this revision, this Standard prepared as that provided with the main text containing the technical content without modification but modifying the structure, using terms, etc. of **JIS D 1617 : 1995**, and with the Annexes (normative) based on **ISO 4020/1 : 1979**.

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Automotive parts—Fuel filters for diesel engines— Test methods

Introduction This Japanese Industrial Standard has been prepared as that provided with the main text containing the technical content of **JIS D 1617 : 1995** without any modification, and with Annexes based on the first edition of **ISO 4020/1** published in 1979 which is the International Standard corresponding to this Standard, without modifying the technical content and structure.

1 Scope This Japanese Industrial Standard specifies test methods for performance of fuel filters mainly used for automotive diesel engines (hereafter referred to as “filter”).

Remarks : The following International Standard corresponds to this Standard.

ISO 4020/1 : 1979 *Road vehicles—Fuel filters for automotive compression ignition engines—Part 1 : Test methods*

2 Normative reference The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions (including amendments) of the standards shall be applied.

JIS D 1601 *Vibration testing methods for automobile parts*

JIS D 1611 *Automotive parts—Test methods of lubricating oil filters*

JIS H 3300 *Copper and copper alloy seamless pipes and tubes*

JIS K 2204 *Diesel fuel*

JIS K 2503 *Testing method of lubricating oil for aircraft*

JIS Z 8703 *Standard atmospheric conditions for testing*

JIS Z 8901 *Test powers and test particles*

3 Definitions For the purpose of this Standard the following definitions apply.

- a) **rated flow** Oil flow rate defined upon agreement between the parties concerning with delivery, or that indicated by the manufacturer. Express in liter per min (l/min).
- b) **slurry** Mixture of test oil and test contaminant.
- c) **contaminant retention** Amount of contaminant retained by the filter until increase of pressure difference is reached an indicated value. Express in gram (g).
- d) **pressure difference** Difference of static pressures taken at the inlet and outlet of a filter. It is expressed in kilopascal (kPa).
- e) **filtering cleanliness** Amount of contaminant in 1 l of test oil which has been passed through the filter. It is expressed in milligram per liter (mg/l).
- f) **water separation efficiency** Water amount contained in 1 l of test oil which has been passed through the filter. It is expressed in milligram per liter (mg/l).

4 Test items Test items of the filter are listed as the following :

- a) **Pressure difference test**

- b) **Bubble test**
- c) **Test for contaminant retention and cleanliness**
- d) **Differential pressure strength test of filter element**
- e) **Pressure proof test**
- f) **Impulse test**
- g) **Vibration test**
- h) **Water separation test**

5 Test installation

5.1 Installation for pressure difference, contaminant retention and cleanliness test The test installation shall consist of oil reservoir, pump of less pulsation⁽¹⁾, main pipework system⁽²⁾, by-path piping with special nozzle, flow-meter, pressure gauge, sampling pipe, etc. (see **Attached Fig. 1**). An example is shown in **Attached Figs. 2 and 3**.

Notes ⁽¹⁾ The discharge pressure of the pump shall be at least 200 kPa and should effect a capacity of approximately 19 l/min in discharge amount.

⁽²⁾ Pipes in the main pipework system shall have smooth internal wall surface and round section, and for the piping these shall be so formed and constructed as preventing contaminant from adhering on the joinings or other parts during the test.

5.2 Bubble test installation The test installation shall be constructed as given in **Attached Fig. 12** of JIS D 1611.

5.3 Installation for differential pressure strength test of filter element The test installation shall be constructed as given in **Attached Fig. 1** or **Attached Fig. 2** of JIS D 1611.

5.4 Pressure proof test installation The test installation shall be constructed as given in **Attached Fig. 4**.

5.5 Impulse test installation The test installation shall be constructed as given in **Attached Fig. 8** of JIS D 1611.

5.6 Water separation test installation The test installation shall be constructed as given in **Attached Fig. 5**.

For the absolute filter use that having a capability of removing undissolved water passed through the filter under testing.

6 Test conditions

6.1 Temperature and humidity The temperature and humidity in the laboratory shall, unless otherwise specified, be at the ordinary temperature and humidity defined in **JIS Z 8703**.

6.2 Test oil The test oil shall, unless particularly indicated, be No. 2 gas oil of **JIS K 2204**. The solid content (petroleum ether insolubles) in the test oil should be at most 2 mg/l.

6.3 Test contaminant The test contaminant shall, unless particularly indicated, be Class 8 of **JIS Z 8901**.

6.4 Slurry The slurry shall be a mixture of 100 ml test oil and 4 g test contaminant.

7 Test method

7.1 Pressure difference test Using the test installation as given in **Attached Fig. 1**, allow test oil to flow through the filter at rates of 0 to 100% of the rated flow to determine each pressure difference at the steps of 20%, 40%, 60%, 80% and 100% of the rated flow.

The pressure difference shall be determined at the positions in a range between 5 times and 7 times the pipe inside diameter apart from the filter inlet and outlet respectively. The oil temperature at the filter inlet during the test shall be at $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$.

7.2 Bubble test For the bubble test clause 13, of **JIS D 1611** applies.

7.3 Test for contaminant retention and filtering cleanliness Using the test installation as given in **Attached Fig. 1**, carry out the test as the following :

- a) Pouring 19 l of test oil into the oil tank start the pump. Further, apply oil to the filter at the rated flow, stop the flow by closing the filter side stopcock when the oil temperature at the filter inlet is reached $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$, allow the test oil to circulate through the bypath pipe, and add an initial slurry into the oil tank.

Each adding amount of slurry shall be 100 ml of test oil mixed with 4 g of test contaminant.

At 4.5 min past adding the initial slurry, take 500 ml of sample from the sampling pipe. Further, at a lapse of 0.5 min thereafter open the filter side stopcock to take this moment to as zero duration.

- b) During the test add the slurry into the oil tank at 5 min intervals.
- c) Take each 500 ml of sample from the return pipe at 0.5 min, 1 min, 2 min, 4.5 min, 14.5 min, 29.5 min and 59.5 min after commencement of the test. Immediately after 500 ml sampling, supplement the same quantity of test oil.
- d) Determine the pressure differences at 0.5 min, 1 min, 2 min, 4.5 min, 14.5 min, 29.5 min and 59.5 min after commencement of the test and at 30 min intervals thereafter.
- e) Continue the test until pressure difference of the filter is reached the indicated value. When a pressure difference of the indicated value is reached, take each 500 ml of test samples from the sampling pipe and return pipe, and record the time.
- f) The contaminant retention shall be calculated, obtaining the sampling analysis results, from the following formula.

$$C = D_t - 19 D_f$$

where, C : contaminant retention (g)

D_t : total mass of added contaminant (g)

D_f : mass of contaminant contained in 1 l of oil in the oil tank at ending of the test (g)

- g) The filtering cleanliness shall be expressed by the average of the sampling values taken within the initial 1 h of 7.3 c).

7.4 Differential pressure strength test of filter element The differential pressure strength test of filter element shall be conducted according with the specifications of 7.1, 7.2, 7.3 (1) and 7.4 of **JIS D 1611** on the filter element has been subjected to the test of 7.3. The test pressure, however, shall be 500 kPa, unless indicated particularly.

7.5 Pressure proof test For the pressure proof test, using installation as given in **Attached Fig. 4**, apply gradually an oil pressure of 200% of the filter designed pressure, unless particularly indicated, and after holding for a period between 3 min and 5 min observe and record for oil leakage, permanent deformation and after defects on every part of the filter. The oil temperature during the test shall be at an ordinary temperature.

7.6 Impulse test For the impulse test, Clause 9 of **JIS D 1611** shall be applied. The test conditions, however, are left to the agreement between the parties concerned with delivery.

7.7 Vibration test The vibration test shall be carried out as the specifications of **JIS D 1601**, while the test conditions are left to the agreement between the parties concerned with delivery.

7.8 Water separation test The water separation test shall subject only to the filter having water separation property, with the following gist and by using the installation as given in **Attached Fig. 5**.

- a) With the water supply equipment closed the flow control value, fill the water tank with distilled water to be added to the test oil.
- b) Pour necessary test oil for the test into the oil tank, open the stopcock, at the filter inlet and lack pressure control value at the filter outlet, and start the pump. Adjust the test flow by changing the pump rotation and regulate the test temperature to be at $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- c) Open the stopcock 2 for testing the filter to be used in the suction side of pump, or stopcock 3 for that to be used in the discharge side.
- d) Open and so adjust the flow control value of water supply equipment as that the distilled water flows at 1% of the test flow-rate. Take the moment of completion adjusting as the zero duration.
- e) After starting the test, take each 100 ml of the test oil through the sampling value into a graduated test tube defined in 4.3 of **JIS K 2503** at 10 min intervals.
- f) Determine and record the pressure differences of the filter at the commencement of test and at 20 min intervals thereafter.
- g) The separated water by the filter during the test shall be drained before reaching 50% volume of the filter water bowl.
- h) For the water separation test, taking 1 h for the testing time, supply distilled water into the test oil continuously for the duration.
- i) The water separation efficiency shall be expressed by the maximum of the sampling values.

8 Analysis of samples

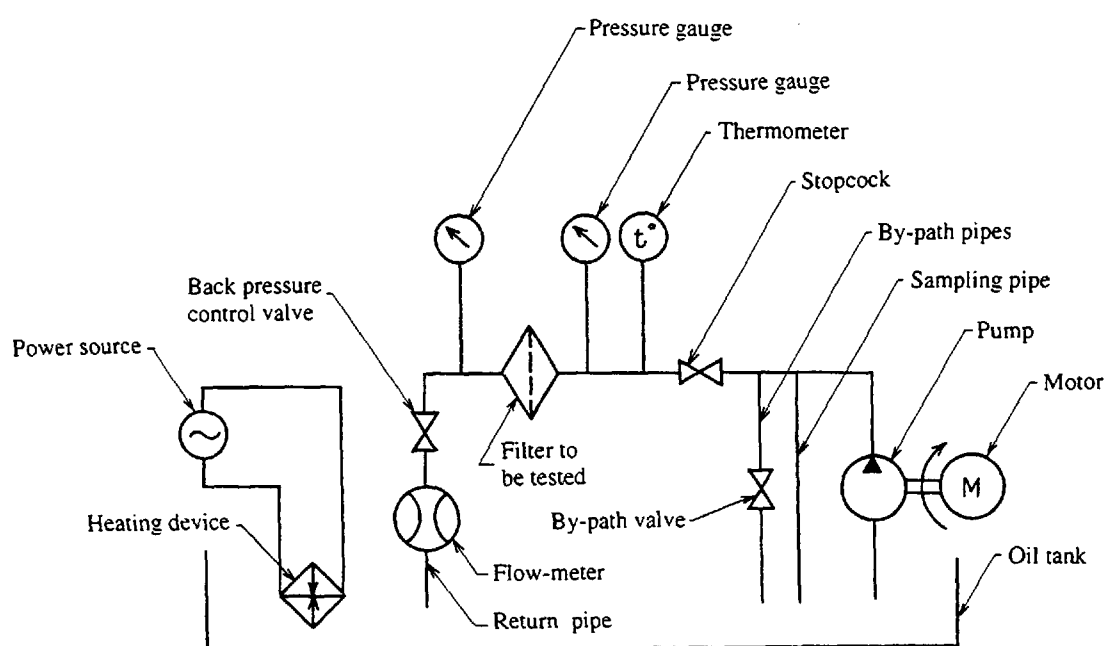
8.1 Contaminant retention and filtering cleanliness The contaminant retention efficiency and filtering cleanliness shall be obtained from analyzing the samples taken by the methods of 7.3 in the following gist.

- a) Dry an analytical filter in an oven at a temperature of 75°C for at least 20 min, and after cooling in a desiccator to an ordinary temperature, weigh it to the nearest 0.1 mg. The analytical filter shall have a capability of sufficiently seizing the contaminant passed through the filter under test.
- b) Mount the weighed analytical filter onto a container.
- c) Filter the sample with the analytical filter under a vacuum. Flush repeatedly the sampling bottle with petroleum ether not to allow contaminant to remain, and filter the liquid.
- d) Wash away the contaminant adhering on the funnel part of analytical filter, and filter. Using the petroleum ether as fine jet, apply it until the test oil adhering on the analytical filter has disappeared completely.

- e) Furthermore, wash away the test oil on the analytical filter surface with approximately 200 ml of petroleum ether while filtering it.
- f) After washing take out the analytical filter and, after drying in an oven at a temperature of 75 °C for 20 min or more, allow to cool in a desiccator down to an ordinary temperature, and weigh to the nearest 0.1 mg.

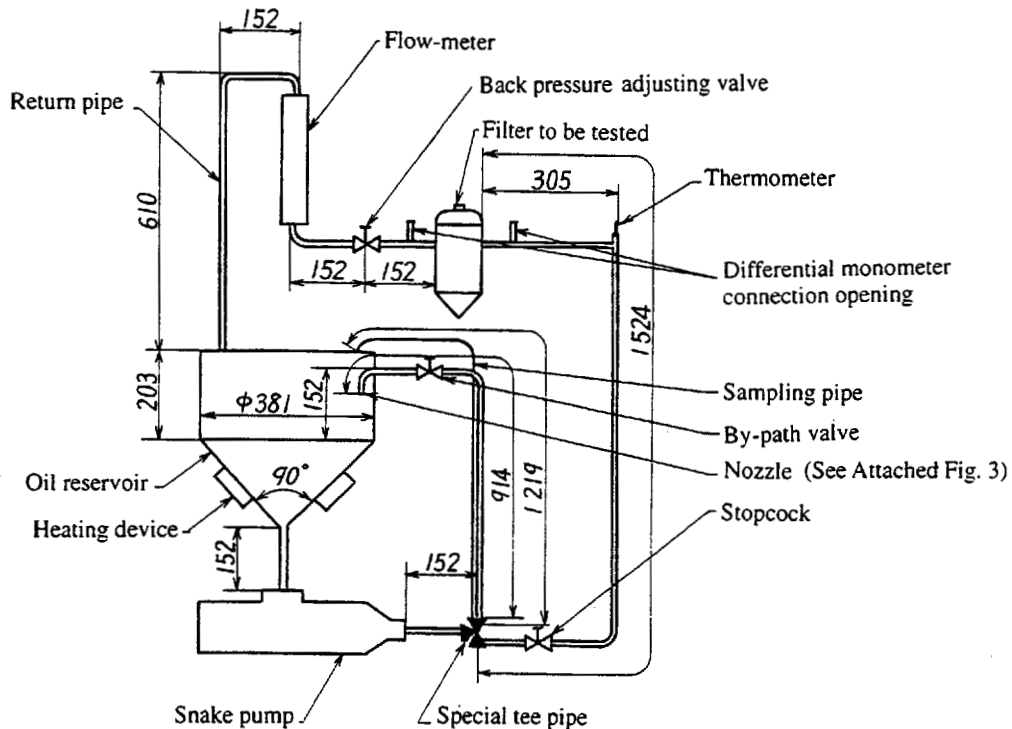
8.2 Analysis of water separation The water separation efficiency shall be obtained through analyzing the sample obtained in 7.8 by means of centrifuge separation.

For the test apparatus use a precipitation-number tester as specified in **JIS K 2503**, installing two pieces or two pairs of test tubes, rotate it for 10 min at a rate by which a relative centrifuge force between 600 and 700 is obtained, and measure the water amount to record.



Attached Fig. 1 Test installation for pressure difference, contaminant retention and filtering cleanliness

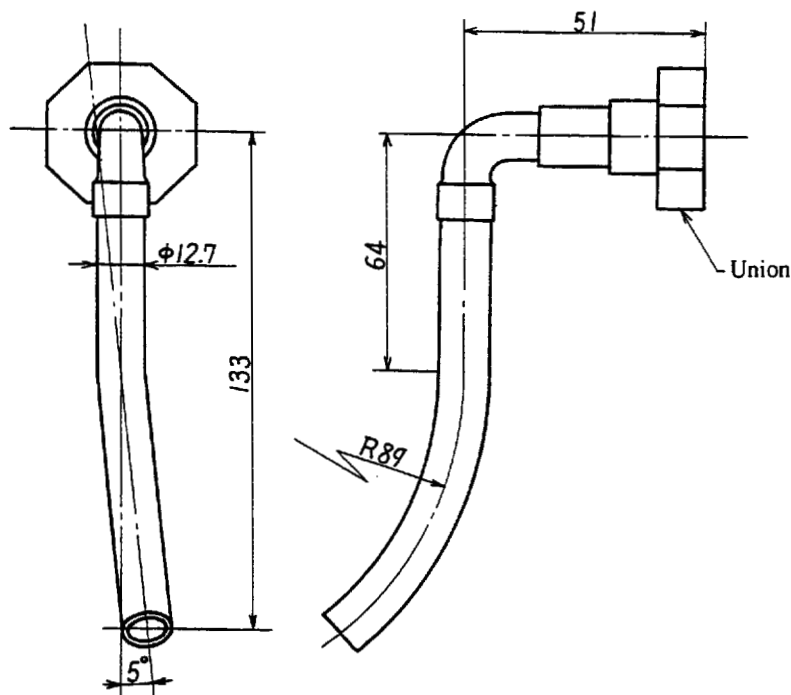
Unit : mm



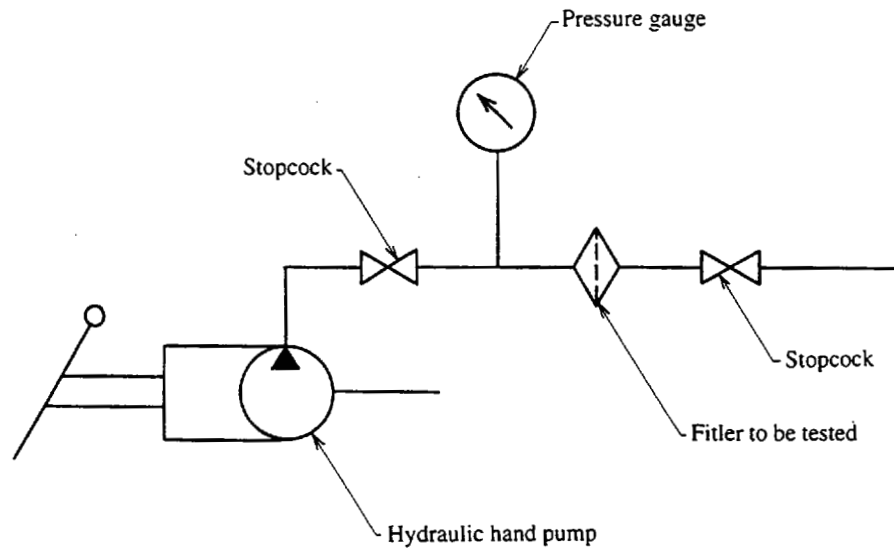
- Remarks 1 For the sampling pipe, use a copper tube of C1100 T-H of JIS H 3300, with ϕ 5 mm outer diameter and 0.8 mm thickness.
- 2 For the piping, use copper tubes of C1100T-H of JIS H 3300, with ϕ 15.88 mm diameter and 1.6 mm thickness.

Attached Fig. 2 Test installation for contaminant retention and filtering cleanliness
(An example for rated flow of 1.5 l/min to 10 l/m)

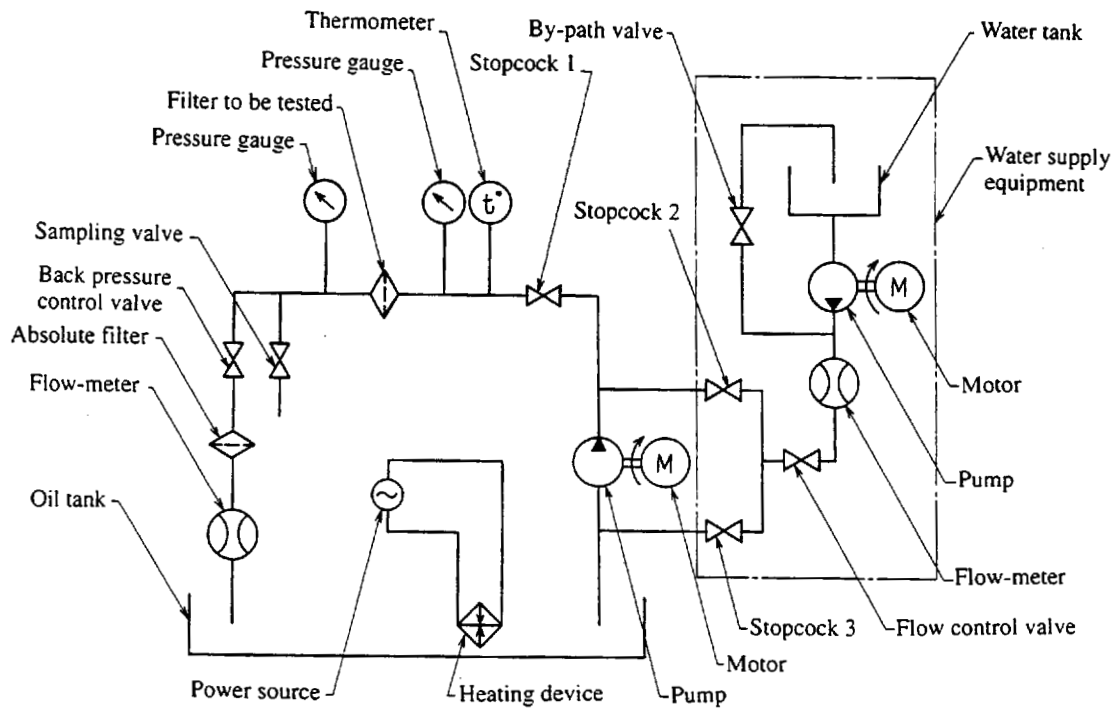
Unit : mm



Attached Fig. 3 Nozzle part



Attached Fig. 4 Pressure proof test installation



Attached Fig. 5 Water separation test installation

Annex 1 (normative) Automobile parts—Fuel filters for diesel engines— ISO test methods

Introduction These Annexes 1 and Annex 1.A to 1.F has been prepared based on the first edition of ISO 4020/1, *Road vehicles—Fuel filters for automotive compression ignition engines—Part 1 : Test methods* published in 1979, without any modification in the technical content.

Annexes 1.A to 1.F correspond to Annexes A to F of ISO 4020/1 : 1979 respectively. However, the parts underlined with dots are the matters not specified in the corresponding International Standard.

1 Scope This Annex specifies test methods for fuel filters.

Filter classification is specified in ISO 4020/2.

Remarks : ISO 4020/2 has been withdrawn in 1993.

2 Field of application This Annex applies to fuel filters provided for automotive diesel engines and for test installations for injection equipment.

This may also be applied to diesel engine fuel filters not for automobile but using less residuals fuel.

This Annex is intended for filters having a rated flow of up to 200 l/h, while, by agreement between the parties concerned with delivery, the test, with some modifications, may be used for filters with higher rates (over 200 l/h) of flow.

Remarks : The following International Standard corresponds to this Annex.

ISO 4020/1 : 1979, *Road vehicles—Fuel filters for automotive compression ignition engines—
Part 1 : Test methods*

3 Normative reference

JIS K 0068 : 1992 *Test methods for water content of chemical products*

Remarks : The particulars referred from ISO 760, *Determination of water by the Karl Fischer method* are equivalent to the corresponding parts of said standard.

JIS Z 8801 *Test sieves*

ISO 4020/2 : 1979 *Road vehicles—Fuel filters for automotive compression ignition engines—Part 2:
Test values and classification*

4 Terms and definitions

No.	Term	Symbol	Unit	Definition
1	Fine filter	—	—	Filter used for final protection of the fuel injection equipment
2	Prefilter	—	—	Filter defined by its position in the fuel system, i.e. a filter before the final filter
3	Strainer	—	—	Filter with element, made of fibre or metal wire, through which impurities are removed
4	Sedimentor	—	—	Separator in which contaminant is removed by density difference
5	Particle retention	—	%	A measure of the ability of a filter to remove a specified test dust offered under specified conditions of test. It is expressed quantitatively by relating the test dust retained by the filter to that offered
6	Test liquid	—	—	The liquid to be used may be different for the various tests
7	Life	$\frac{T}{V}$	min l	Expression in terms of time and volume of contaminated test liquid to choke a filter element to a pressure difference of 70 kPa when the test liquid is passed through the filter at a specified flow rate
8	Pressure difference	Δp	kPa	A measure of the difference in pressure taken at the inlet and outlet of a filter when test liquid is flowing through the filter at a specified flow rate
9	Rated flow	Q	l/min l/h	Normal operating flow at which liquid is passed through a filter. It can be that specified by the manufacturer or as agreed between manufacturer and user
10	Contaminant, organic	—	—	Suspension of carbon black in test liquid, formulated to provide similar filter choking characteristics to those of normal diesel fuel
11	Contaminant, inorganic	—	—	Fused aluminium oxide dust of closely controlled particle size. It is the incombustible constituent which is added to the organic contaminant for the purpose of revealing the particle retention property of a filter
12	Collapse/burst pressure of filter element	Δp	kPa	The pressure difference at which a choked filter element suffers structural failure
13	Burst pressure of complete filter	p	kPa	The internal pressure at which the filter housing suffers structural failure
14	Bubble test	V_B	ml/min	Indicates quality standard of filter element by measurement of volume of air escaping through filter medium or joints in unit time, when immersed in liquid at specified depth and internal pressure
15	Test of cleanliness	W	mg	This test enables the degree of cleanliness of new filters to be determined. It reveals the amount of impurities flushed from the clean side of the filter under specified test conditions
16	Test flow rate	Q	l/min l/h	The rate at which test liquid flows through the filter during a specific test. It may be different from the rated flow
17	Undissolved water	—	—	Water dispersed in test liquid, i.e. diesel fuel containing water which can be separated by physical means, for example by centrifuging

Remarks : 1 bar=10⁵ Pa=100 kPa

5 Test materials

5.1 Test liquid The test liquid used for all tests except the water separation test (6.5) and collapse/burst test of the filter element (6.6) shall be a straight mineral oil⁽²⁾ with properties as shown in **Annex 1.D**. Except for tests 6.1 and 6.2, this liquid shall be used at such a temperature that its kinematic viscosity lies between 4 mm²/s and 6 mm²/s. Alternatively, it shall be blended with refined spindle oil or premium grade kerosene to give a viscosity between these limits at the test temperature. All test liquids shall be free from additives apart from colouring dyes. Provision shall be made to ensure that the test liquid is free from undissolved water. The liquid for each test shall be drawn from its storage container at a point above the zone of sedimentation.

Before use, all liquids shall be passed through a highly efficient filter medium, the latter being adequately supported and suitably clamped at the edges; see the following items from A.4 of **Annex 1.A** (vacuum pump, filtration apparatus and filter paper disc under "other equipment"), for example;

- vacuum pump : negative pressure 85 kPa;
- filtration apparatus : filter paper disc holder;
- filter paper disc or membrane: diameter 140 mm, mean pore size between 0.4 µm and 1.1 µm.

The pressure differential across the filter paper shall not exceed 85 kPa.

5.2 Test contaminants for tests for particle retention and life

5.2.1 Organic contaminant concentrate for choking fuel filters ⁽¹⁾⁽²⁾ The concentrate shall consist of a dispersion in a ratio of 1 g of carbon black to a mixture of 90 ml of test liquid and 10 ml of detergent additive. For the method of preparation, see **Annex 1.E**.

5.2.2 Inorganic contaminant The contaminant shall be fused aluminium oxide dust ⁽²⁾. The particle size distribution shall conform to the diagram in **E.8** of **Annex 1.E**.

5.3 Test installation, general There shall be no sudden changes in tube or hose bore throughout the test rigs.

Notes ⁽¹⁾ This concentrate is difficult to prepare and when prepared requires to be tested for suitability as described in **Annex 1.E**.

⁽²⁾ Suitable products are available commercially. Details may be obtained from the Secretariat of Technical Committee **ISO/TC 22** or from the ISO Central Secretariat.

6 Tests

6.1 Test of cleanliness of new filters This test shall be carried out first to ascertain whether the clean side of the filter to be tested is free from dirt and of other loose particles which may result from production, storage and transport.

6.1.1 Test installation See A.1 of **Annex 1.A**.

The test liquid temperature shall be (23±10) °C.

6.1.2 Other equipment See A.1 of **Annex 1.A**.

6.1.3 Procedure

- a) Clean and dry the test sieve for 30 min in a drying cabinet at approximately 20 °C (approximately 80 °C) above the final boiling point of the petroleum ether employed according to d) and allow to cool for 30 min to ambient temperature.
- b) Weigh the test sieve to the nearest 0.1 mg on a laboratory balance and insert the test sieve in a horizontal position in the measuring device (⑦ of drawing in A.1 of Annex 1.A.)
- c) Pump the test liquid through the circuit for 1 h at twice the rated flow of the filter under test.
- d) Spray approximately 10 ml of petroleum ether through the cleaning hole (clearing plug part in the drawing) on to the inner walls of the measuring device in order to wash down particles from the wall and to gather them on the sieve.
- e) Remove the test sieve with tweezers, place it on filter paper and allow to dry.
- f) Then place the test sieve in a clean, dry Petri dish, cover it with a lid, dry and allow to cool as before the first weighing.
- g) Weigh the test sieve to the nearest 0.1 mg. The mass of dirt released by the filter is equal to the difference between the results of the two weighings of the sieve.

6.1.4 Test report

6.1.4.1 The test report shall indicate at least the following :

- a) the filter make and model;
- b) a description of the filter tested and internal diameter of connections;
- c) the rated flow (l/min or l/h);
- d) the type or blend of test liquid.

6.1.4.2 Indicate the mass, in milligrams (mg), of dirt released.

6.2 Bubble test This test may show whether the filter element is “tight”, i.e. whether it does not contain pores larger than the unused filter medium. If this test is made, it should be carried out prior to the other tests specified, but it may be carried out after the cleanliness test in 6.1..

6.2.1 Test installation See A.2 of Annex 1.A.

The test liquid temperature shall be 23 °C±5 °C.

6.2.2 Other equipment See A.2 of Annex 1.A.

6.2.3 Procedure

- a) Before mounting the filter element to be tested ⑨ on the rotating axle, immerse it in the test liquid sufficiently long to completely wet the filter medium, and drain off the surplus test liquid.
- b) Mount the filter element on the rotating axle ⑩ and immerse it in the tank ⑧.
- c) Open the stopcock ③ and adjust the constant-pressure device ⑤ to indicate a pressure of 1.3 kPa^{+0.1}₀ kPa on the liquid manometer ⑥.
- d) Turn the filter element at approximately 10 cycles per min on the rotating axle. The volume of air escaping in 1 min shall be measured.

6.2.4 Test report

6.2.4.1 The test report shall indicate at least the following information :

- a) the filter make and model;
- b) a description of the filter; whether it is new or used; in the latter case, the approximate period of service;
- c) the type or blend of test liquid;
- d) its viscosity at the test temperature (mm^2/s);
- e) the test temperature ($^{\circ}\text{C}$).

6.2.4.2 Indicate the volume, in millilitres (ml), of escaped air.

6.3 Test for pressure difference of new filters The purpose of this test is to measure the pressure differential across the filter at the filter manufacturer's rated flow. This test shall be carried out prior to the tests for particle retention and life and for water separation efficiency, but may be carried out after the cleanliness and bubble tests.

Remarks : This method is equally applicable for the measurement of the pressure drop in a filter which has been in use for a determined period, or at a flow rate different from the nominal rate.

6.3.1 Test installation See A.3 of Annex 1.A.

The test liquid temperature shall be $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

6.3.2 Other equipment See A.3 of Annex 1.A.

6.3.3 Procedure

- a) Connect the filter to be tested into the test rig, start up the system and prime and vent the filter to ensure removal of air from the filter and pressure gauges, inverting the filter if necessary.
- b) Close the control valve ⑩ and adjust the pressure by means of the by-pass valve ⑫ to that used in practice. Adjust the zero of the differential pressure gauge ⑭.
- c) Open the control valve ⑩ to re-establish the pressure reading on the upstream pressure gauge ⑧ to that used in practice, and partially close the by-pass valve ⑫.

Thus adjust the flow rate, indicated by the flow-meter ⑥, to the desired value.

- d) Record the value shown on the differential pressure gauge ⑭.

6.3.4 Test report

6.3.4.1 The test report shall indicate at least the following :

- a) the filter make and model;
- b) a description of the filter; whether it is new or used; in the latter case, the approximate period of service;
- c) the rated flow and the test flow rate (l/min or l/h);
- d) the type of blend of test liquid;
- e) its viscosity at the test temperature (mm^2/s);