
**Diesel fuel and petrol filters for internal
combustion engines — Initial efficiency by
particle counting, retention capacity and
gravimetric efficiency**

*Filtres à carburant pour moteurs à combustion interne à essence ou
diesel — Efficacité initiale par comptage des particules, capacité de
rétention et efficacité gravimétrique*



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Contents

	Page
1 Scope	1
2 Normative references	1
3 Principle	1
4 Test equipment	1
5 Validation procedure	4
6 Test procedure	6
7 Sample analysis	8
8 Report of data	8

Annexes

A Damper on diaphragm-type dosing pump	9
B Flush-type static pressure tap	10
C Procedure for test dust and test fluid mixing	11
D Test report	12
E Logarithmic relationship between number of particles (<i>N</i>) and within-laboratory (<i>CV_a</i>) and between-laboratory (<i>CV_b</i>) coefficients of variation, expressed in %	18
F Particle size distribution of test dust	19
G Recapitulative list of symbols	20

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 13353, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

This document is being issued in the type 2 Technical Report series of publications (according to subclause G.4.2.2. of part 1 of the ISO/IEC Directives, 1992) as a "prospective standard for provisional application" in the field of filters for road vehicles because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this type 2 Technical Report will be carried out not later than two years after its publication with the options of: extension for another two years; conversion into an International Standard; or withdrawal.

Annexes A, B, C, D, E and F form an integral part of this Technical Report. Annex G is for information only.

Diesel fuel and petrol filters for internal combustion engines — Initial efficiency by particle counting, retention capacity and gravimetric efficiency

1 Scope

This Technical Report specifies a test procedure for evaluation of the initial efficiency, the efficiency evolution during clogging and the retention capacity of a fuel filter for internal combustion engines submitted to a constant flowrate of test liquid. It applies to filters having a rated flow from 50 l/h to 250 l/h. By agreement between filter manufacturer and customer, the procedure, with some modification, may be used for fuel filters with higher flowrates.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2942:1994, *Hydraulic fluid power — Filter elements — Verification of fabrication integrity and determination of the first bubble point*.

ISO 3722:1976, *Hydraulic fluid power — Fluid sample containers — Qualifying and controlling cleaning methods*.

ISO 3968:1981, *Hydraulic fluid power — Filters — Evaluation of pressure drop versus flow characteristics*.

ISO 4021:1992, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*.

ISO 4402:1991, *Hydraulic fluid power — Calibration of automatic-count instruments for particles suspended in liquids — Method using classified AC Fine Test Dust contaminant*.

ISO 4405:1991, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the gravimetric method*.

3 Principle

The first step of the procedure uses a test fluid with a low concentration of contaminant. The initial efficiency of the filter is evaluated by particle counting upstream and downstream of the filter, allowing on-line particle counting without any dilution. The second step consists of an injection of a high concentration of contaminant to clog the filter and to evaluate its efficiency by the gravimetric method.

4 Test equipment

4.1 Test fluid

4.1.1 Hydraulic fluid according to MIL H 5606¹⁾ or equivalent with a viscosity of 10 mm²/s minimum at 40 °C.

1) MIL H 5606, *Hydraulic fluid petroleum base, aircraft, missile and ordnance*.

4.1.2 Antistatic agent at 0,02 ml/l²⁾ added to each new batch of clean test fluid and to each batch of used fluid after cleaning. Antistatic agent is to be discarded one year after opening of the canister.

4.2 Test contaminant

Test contaminant is silica powder called ACFTD (Air Cleaner Fine Test Dust) whose particle size distribution in mass is given in table 1.

Table 1 — Contaminant particle size distribution

Size µm	Percentage of total mass %		
	min.	mean	max.
5,5	35	38	41
11	51	54	57
22	68	71	74
44	85	89	92
88	94	97	100
176	—	100	—

NOTE — Work is progressing towards an ISO standardized test dust.

4.3 Laboratory equipment

4.3.1 Automatic particle counter calibrated in accordance with ISO 4402 or equivalent.³⁾

4.3.2 Sampling bottles and glassware prepared in accordance with ISO 3722.

4.4 Test stand

A typical test stand is shown in figure 1, where some of the reference numbers are amplified in 4.4.1 and 4.4.2. It is composed of the test circuit and an injection system.

2) Dupont de Nemours Stadis 450 is an example of a suitable product available commercially. This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of this product.

3) A new calibration procedure using latex spheres in oil is being prepared by ISO TC 131/SC8/WG9.

4.4.1 Filter test circuit

4.4.1.1 The main reservoir **4** shall have a conical bottom with an included angle of not more than 90° and the fluid entering below the fluid surface. The total volume (V_F) of test fluid in the circuit is 6 l.

4.4.1.2 The main pump with a variable rotational frequency **10** is insensitive to contaminant and does not alter the particle size distribution of the contaminant. The pump shall not induce excessive flow pulsations. A diaphragm-type dosing pump with two pistons and a damper as described in annex A is suitable and guarantees pressure pulsations of less than 1 % of mean pressure.

4.4.1.3 Clean-up filters **5a** and **5b** shall be capable of providing an initial contamination level of less than 30 particles greater than 3 µm/ml. The clean-up filter **5b** is on-line during the initial efficiency test and off-line during the retention capacity test.

4.4.1.4 Upstream and downstream samplers (see **8a** and **8b**) shall be provided in accordance with ISO 4021. On-line particle counting is the recommended method. Bottle sampling may be used as an alternative but this shall be clearly indicated in the report.

4.4.1.5 The double-headed peristaltic pump **8** allows flow control of both upstream and downstream sampling.

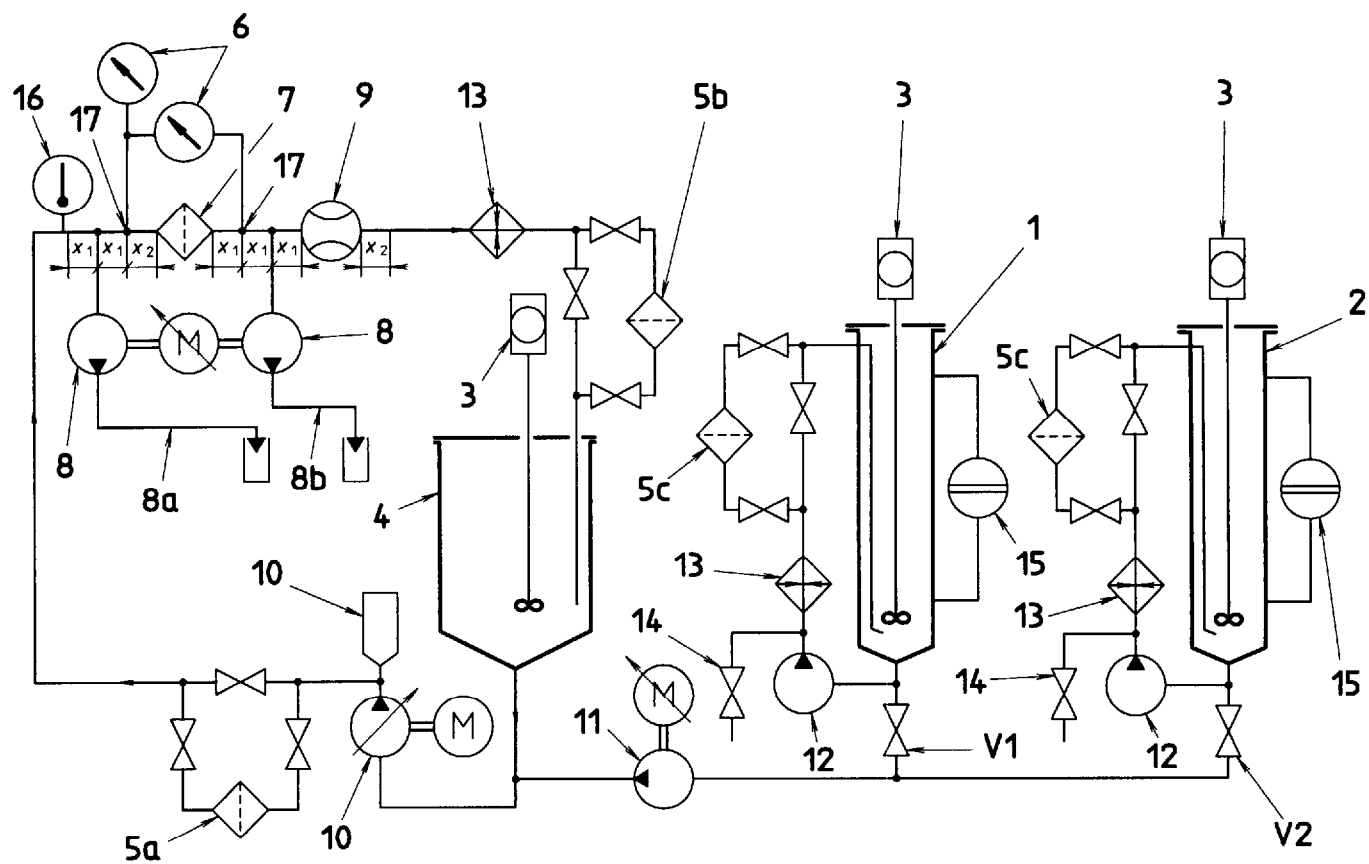
NOTE 1 Sampling flowrate is stated to be 50 ml/min. It is recommended that the sensor be calibrated at 50 ml/min. Where the calibrating flow is different, the sampling flowrate will be different and the injection flowrate will be twice this flow.

Continuous sampling is not shown in figure 1.

4.4.1.6 All pipes and the reservoir are chosen so as to avoid particle settling or segregation. For test flowrates specified in clause 1, pipes of 6 mm inside diameter are recommended. The reservoir height should be 1,5 to 3 times its diameter.

4.4.1.7 Pressure taps shall be in accordance with ISO 3968 and annex B.

4.4.1.8 Pressure gauges, temperature indicator, flowmeters and controllers shall ensure the accuracy stated in 4.5.



- x = straight length of pipe
 $x_1 = 10d$
 $x_2 = 5d$
(d = pipe i.d., in millimetres)
- 1 First injection tank (10 l to 15 l)
 - 2 Second injection tank (10 l to 30 l)
 - 3 Mechanical mixer (1 000 r/min to 1 500 r/min, 50 mm diameter stirrer)
 - 4 Main reservoir (8 l)
 - 5a Main clean-up filter with high capacity
 - 5b Return clean-up filter with high efficiency
 - 5c Injection clean-up filter
 - 6 Pressure indicator
 - 7 Test filter
 - 8 Double-headed peristaltic pumps (50 ml/min each)
 - 8a Upstream sampling line
 - 8b Downstream sampling line
 - 9 Flowmeter
 - 10 Diaphragm-type dosing pump with damper (volume 2 l) (see annex A)
 - 11 Contaminant injection pump (100 ml/min) (e.g. three-roller peristaltic type)
 - 12 Recirculation injection pump (centrifugal type)
 - 13 Heat control system
 - 14 Injection sampling taps (outlets)
 - 15 Level indicator
 - 16 Temperature indicator
 - 17 Flush-type static pressure tap (see annex B)
 - V1 Valve to isolate first injection pump
 - V2 Valve to isolate second injection pump

Figure 1 — Typical test stand

4.4.2 Injection system

4.4.2.1 The two injection tanks 1 and 2 shall have a conical bottom with an included angle of not more than 90° and the fluid entering below the fluid surface. The volume of the tank should be appropriate to the most probable test duration and calculated on the basis of an injection flowrate of 100 ml/min.

4.4.2.2 Each injection tank shall be equipped with a recirculation pump of centrifugal type 12 and with a stirrer 3. The recirculation flowrate in l/min should be at least twice the injection fluid volume in litres.

4.4.2.3 All pipes and the tanks should be chosen so as to avoid particle settling or segregation. Pipe lengths should be minimized.

4.4.2.4 The contaminant injection pump 11 is of the three-roller peristaltic type with a variable rotational frequency. The injection flowrate is kept at 100 ml/min ± 2 ml/min.

4.4.2.5 Temperature and level of injection fluids 15 are continuously indicated.

4.5 Test condition accuracy

Set up and maintain test condition accuracy within the limits given in table 2.

Table 2 — Test condition accuracy

Test condition	Allowable deviation from actual value
Flow	± 2 %
Pressure	± 2 %
Temperature	± 2 °C
Volume	± 2 %

5 Validation procedure

The validation test is conducted at the minimum flowrate to verify that the contaminant is not altered by the components of the circuit, to prove the ability of the main clean-up filter 5a to clean the system, and to verify that the contamination level is kept constant at the specified value.

5.1 Validation of test circuit

5.1.1 Fit a straight pipe in place of the test filter.

4) This contamination level is below the saturation limitations of most automatic particle counters.

5.1.2 Adjust the fluid volume, *V*, in litres, to the recommended value of 6 l and the flowrate to the minimum flow at which the test system will operate. Introduce into the main reservoir 4 a quantity of dried test dust, *m*, in milligrams, so the theoretical gravimetric level is 5 mg/l.⁴⁾ Use the mixing procedure in annex C.

EXAMPLE

$$m = V \times 5$$

If *V* = 6 l, then *m* = 30 mg.

5.1.3 Circulate the fluid in the test system for 1 h while counting particles every 5 min at the downstream sampling point 8b.

5.1.4 Record three differential counts for each period of 5 min and for a minimum sampling volume of 25 ml at the following particle size ranges, in micrometres:

3 to 5; 5 to 10; 10 to 15; 15 to 20; 20 to 30 and > 30

5.1.5 Accept the validation test only if

- a) the average of all particle counts obtained for a given size from each bottle or on-line count does not deviate by more than *x* % from the average particle counts for that size, *x* being determined by the curve in annex E;
- b) the average for all particle counts per millilitre for particle sizes larger than 5 µm is not less than 2 400 nor more than 2 800 (see annex F);
- c) the average for all particle counts per millilitre for particle sizes larger than 20 µm is not less than 110 nor more than 150 (see annex F).

5.2 Validation of main clean-up filter

5.2.1 At the end of the validation of the test circuit in 5.1, when the last sample has been taken, switch the valves so that the main clean-up filter 5a is in service.

5.2.2 Circulate the fluid in the test system for 1 h while counting particles every 5 min at the downstream sampling point 8b.