TECHNICAL SPECIFICATION

ISO/TS 13353

First edition
2002-08-15

Diesel fuel and petrol filters for internal combustion engines — Initial efficiency by particle counting

Filtres à carburant pour moteurs à combustion interne à essence ou diesel — Efficacité initiale par comptage des particules

Reference number
ISO/TS 13353:2002(E)

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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.

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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;

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An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

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

ISO/TS 13353 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

This first edition cancels and replaces ISO/TR 13353:1994, which has been technically revised.

Annexes A to E form a normative part of this Technical Specification.

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Diesel fuel and petrol filters for internal combustion engines — Initial efficiency by particle counting

1 Scope

This Technical Specification specifies a test procedure for evaluating the initial efficiency of an internal combustion engine fuel filter by submitting the filter to a constant flow rate of test liquid. It is applicable to diesel and petrol filters having a rated flow of from 50 l/h to 250 l/h. By agreement between filter manufacturer and customer, the procedure, with some modification, can be used for fuel filters with higher flow rates.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

ISO 3968, *Hydraulic fluid power — Filters — Evaluation of differential pressure versus flow characteristics*

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

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

ISO 4548-12:2000, *Methods of test for full-flow lubricating oil filters for internal combustion engines — Part 12: Filtration efficiency using particle counting, and contaminant retention capacity*

ISO 11171, *Hydraulic fluid power — Calibration of automatic particle counters for liquids*

ISO 11943, *Hydraulic fluid power — On-line automatic particle-counting systems for liquids — Methods of calibration and validation*

ISO 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

3 Symbols

For the purposes of this Technical Specification, the symbols given in Table 1 apply.

Table 1 — Symbols

Symbol	Unit	Definition	Recommended value
C_e	mg/l	Gravimetric upstream level	—
C_{e1}	mg/l	Upstream gravimetric level for initial efficiency	5
$C_{i,i}$	mg/l	Gravimetric injection sump level (initial value)	—
$C_{i,e}$	mg/l	Gravimetric injection sump level (end value)	—
$C_{i,m}$	mg/l	Gravimetric injection sump level (mean value)	—
E	%	Efficiency by number	—
F_s	—	Safety factor	1,2
m	mg	Quantity of dust	—
$m_{i,e}$	g	Total dust addition in 60 min (efficiency test)	—
N_0	µm(c)/ml [a]	Number of particles upstream (differential counts)	—
N_1	µm(c)/ml [a]	Number of particles downstream (differential counts)	—
N_i	µm(c)/ml [a]	Initial test system cleanness [number of particles > 4 µm(c)/ml]	—
q_{Ve}	l/min	Minimum flow rate	—
q_{Ve1}	l/min	Test flow rate	—
q_{Vi}	ml/min	Injection flow rate	—
q_{Vi1}			100
$q_{Vi,i}$	ml/min	Injection flow rate (initial value)	—
$q_{Vi,e}$	ml/min	Injection flow rate (end value)	—
$q_{Vi,m}$	ml/min	Injection flow rate (mean value)	—
t	min	Test duration	—
V	l	Volume of test circuit	6
V_i	l	Volume of fluid for validation of injection system	12
V_F	l	Final sump volume (see D.1)	—
		Total volume [see 5.4.2, a)]	—

[a] Throughout this Technical Specification, micrometres (c) [µm(c)] means that a particle size measurement is carried out using an automatic particle counter calibrated in accordance with ISO 11171.

4 Principle

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 dilution.

5 Test equipment

5.1 Test fluid

This shall be hydraulic fluid as specified in annex E, or equivalent, with a viscosity of 10 mm^2/s min. at 40 °C.

5.2 Test contaminant

The test contaminant shall be ISO 12103-A3 (ISO medium test dust) in accordance with ISO 12103-1.

5.3 Laboratory equipment

5.3.1 Automatic particle counter

The counter or counters shall be calibrated and validated in accordance with ISO 11171 and ISO 11943.

5.3.2 Sampling bottles and glassware

Bottles and glassware shall be cleaned and qualified in accordance with ISO 3722.

5.4 Test stand

5.4.1 General

An example of a test stand, comprising filter test circuit and injection system, is shown in Figure 1. The test stand is specified in 5.4.2 and 5.4.3. The alphanumeric references in brackets in the following subclauses and throughout this Technical Specification correspond to the test stand components as numbered in Figure 1.

5.4.2 Filter test circuit (see Figure 1)

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

The main pump (10), with a variable rotational frequency, is insensitive to the contaminant and does not alter the contaminant's particle size distribution. The pump shall not induce excessive flow pulsations (less than 1 % of mean pressure). A suitable solution (damper) is given in annex A.

NOTE 1 For the main pump, a diaphragm-type dosing pump with two pistons is suitable.

Clean-up filters (5a and 5b) shall be capable of providing an initial contamination level of less than 30 particles per millilitre of a size greater than 4 µm(c). The clean-up filter (5b) shall be on-line during the initial efficiency test.

Upstream and downstream samplers (8a and 8b) in accordance with ISO 4021 shall be provided. 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.

The sampling pumps (8) allow flow control of both upstream and downstream sample flow. The sensor shall be calibrated at the used sampling flow rate. The injection flow rate shall be twice this flow.

NOTE 2 For the sampling pumps, double-headed peristaltic pumps are suitable.

NOTE 3 Sampling flow rate is stated to be 50 ml/min (maximum).

All pipes and the reservoir (4) shall be chosen so as to avoid particle settling or segregation. For the test flow rates applicable to this Technical Specification, pipes of a 6 mm inside diameter are recommended. The reservoir height should be 1,5 to three times its diameter.

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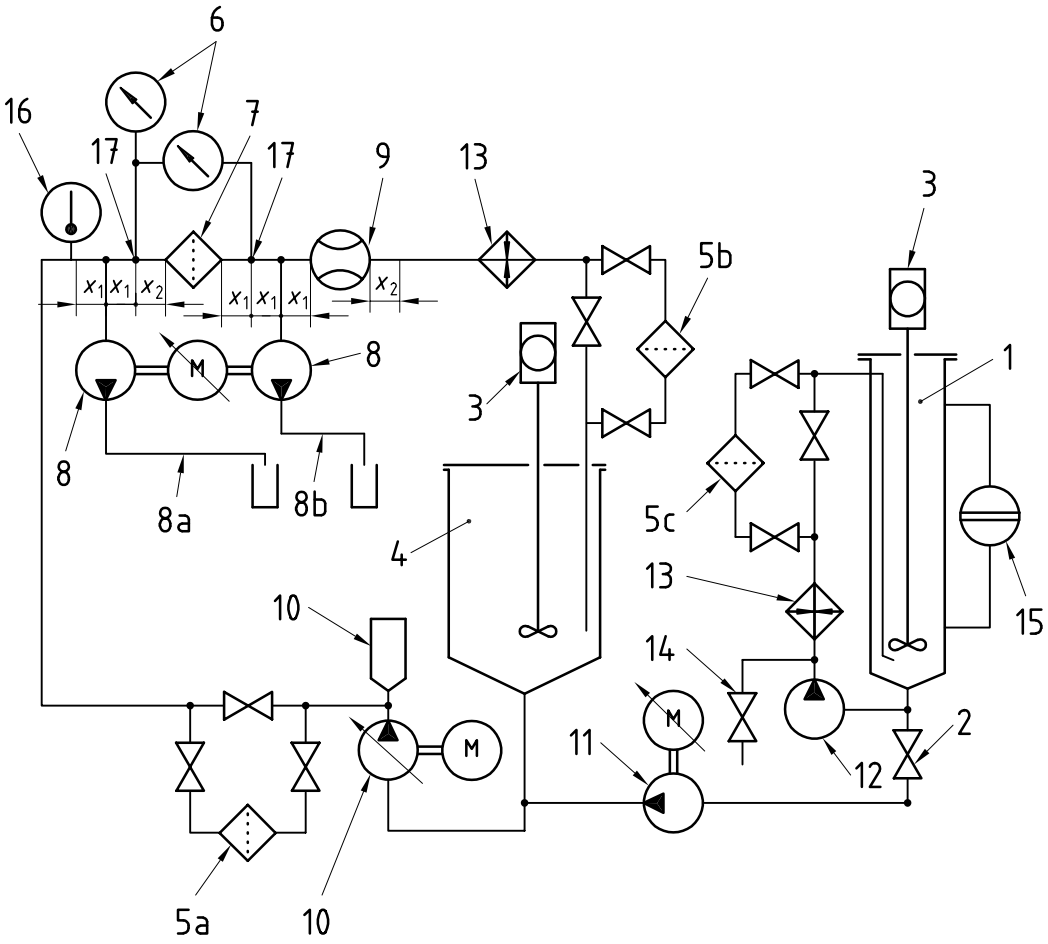
Pressure taps shall be in accordance with ISO 3968 and annex B and shall be placed as shown in Figure 1.

Pressure gauges, temperature indicators, flowmeters and controllers shall be able to ensure the test condition accuracy given in 5.5.



Key

1	Injection tank	10	Dosing pump (two pistons) with damper (see annex A)
2	Valve for isolating injection pump	11	Contaminant injection pump
3	Mechanical mixer	12	Recirculation injection pump
4	Main reservoir	13	Heat control system
5a	Main clean-up filter with high capacity	14	Injection sampling taps (outlets)
5b	Return clean-up filter with high efficiency	15	Level indicator
5c	Injection clean-up filter	16	Temperature indicator
6	Pressure indicator	17	Flush-type static pressure tap (see annex B)
7	Test filter	x	straight length of pipe
8	Sampling pumps	D	pipe inside diameter, in millimetres
8a	Upstream sampling line	x_1	= 10D
8b	Downstream sampling line	x_2	= 5D
9	Flowmeter		

NOTE For fluid power system component graphic symbols, see ISO 1219-1.

Figure 1 — Test stand circuit diagram — Example

5.4.3 Injection system

The injection tank (1) shall have a conical bottom with an included angle of not more than 90° and with 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 flow rate of 100 ml/min max.

The injection tank (1) shall be equipped with a recirculation pump (12) and stirrer (3). The recirculation flow rate in litres per minute should be at least twice the injection fluid volume in litres.

NOTE 1 For the recirculation pump, a centrifugal type pump is suitable.

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

The contaminant injection pump (11) shall have a variable rotational frequency. The injection flow rate shall be maintained at 100 ml/min max. (accuracy in accordance with Table 2).

NOTE 2 For the contaminant injection pump, a three-roller peristaltic type pump is suitable.

The temperature and level of injection fluids (15) are continuously indicated.

5.5 Test condition accuracy

Set up and maintain the test condition accuracy in accordance with Table 2.

Table 2 — Test condition accuracy

Test condition	Allowable deviation from actual value
Flow, flow rate	± 2 %
Pressure	± 2 %
Temperature	± 2 °C
Volume	± 2 %
Test dust	± 0,5 mg

6 Validation procedures

6.1 General

The validation test is conducted at the minimum flow rate in order 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.

6.2 Validation of test circuit

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

b) Adjust the fluid volume, V, in litres, to the recommended value of 6 l, and the flow rate 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 that the theoretical gravimetric level is 5 mg/l[1)]. Use the mixing procedure given in annex C.

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

EXAMPLE $m = V \times 5$

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

c) Ensure that the conductivity of the test fluid is at least 1 000 pS/m by measuring fluid conductivity prior to each test. A level of 1 500 pS/m ± 500 pS/m is recommended. An initial level of 100 µg/g of an antistatic agent such as Dupont de Nemours Stradis® 450[2)] has been shown to produce conductivity within this range.

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

e) Record three cumulative counts for each period of 5 min, for a minimum sampling volume of 25 ml at the particle size ranges $>$ 5 and $>$ 20, in micrometres.

f) Accept the validation test only if

1) each particle count obtained at 5 µm(c) and 20 µm(c) does not deviate by more than 10 % from the average particle count for these sizes,

2) the average for all particle counts per millilitre for particle sizes larger than 5 µm(c) is not less than 6 000 nor more than 7 300, and

3) the average for all particle counts per millilitre for particle sizes larger than 20 µm(c) is not less than 77 nor more than 106.

6.3 Validation of main clean-up filter

a) At the end of the validation of the test circuit as specified in 6.2, when the last sample has been taken, switch the valves so that the main clean-up filter (5a) is in service.

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

c) Record three cumulative counts for each period of 5 min and for a minimum sampling volume of 25 ml at the particle size ranges specified in 6.2 e).

d) Fit the curve of the number of particles for each particle size as a function of time, and determine the time to reach the acceptable cleanliness level specified in 5.4.2. This time period should then be used as a minimum period for cleaning the test circuit on each occasion necessary. If excessive time is needed (more than 1 h), change to a finer clean-up filter (5a).

6.4 Validation of complete system

The validation of the complete system should be conducted by particle counting in order to confirm the ability of the contaminant injection system to deliver a constant number of particles to the test circuit during 60 min, and the ability of the return clean-up filter (5b) to retain particles not retained by the test filter (7).

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

b) Introduce into the injection tank (1) a quantity of suspension to simulate a test duration of 60 min, providing a base upstream gravimetric level (C_{e1}) of 5 mg/l at the minimum flow rate, q_{V_e}, of the test stand. (For test dust and fluid mixing, see annex C.)

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 Specification and does not constitute an endorsement by ISO of this product.

Calculate the volume of fluid, V_i, in litres, by

$$V_i = 60 \times q_{V_i}$$

where q_{V_i} is the injection flow rate, in litres per minute.

Calculate the mass of test dust, m, in milligrams, to be introduced into the injection fluid to prepare the sump:

$$m = V_i \left(\frac{q_{V_e} \times C_{e1}}{q_{V_i}} \right)$$

where

V_i is the volume of injection fluid, in litres;

q_{Ve} is the minimum flow rate, in litres per minute;

C_{e1} is the upstream gravimetric level, in milligrams per litre;

q_{V_i} is the injection flow rate, in litres per minute.

c) Switch on the main pump (10) at q_{V_e} and the injection pump (11) at q_{V_i} and count the particles every 5 min for 1 h.

d) Record three cumulative counts for each 5 min period, for a minimum sampling volume of 25 ml at the particle size ranges specified in 6.2 e) and validated in accordance with 6.2 f).

7 Test procedure

7.1 Preparation for initial efficiency

a) Calculate the volume, V_{i1}, in litres, of fluid to be introduced in the injection tank (1) in order to enable a test duration, t, of 60 min at the injection flow rate, q_{Vi1} (e.g. 100 ml/min), with a safety factor, F_s, of 1,2.

$$V_{i1} = F_s \times q_{V_{i1}} \times t \times 10^{-3}$$

In this case,

$$V_{i1} = 1{,}2 \times 100 \times 60 \times 10^{-3}$$
$$= 7{,}2$$

b) Calculate the mass, m_{i1}, in milligrams, of dried contaminant to be added to the injection tank (1) to allow a gravimetric level of the injection fluid, C_{e1}, of 5 mg/l upstream of the test filter (7):

$$m_{i1} = \left(\frac{q_{V_{e1}}}{q_{V_{i1}}} \right) C_{e1} \times V_{i1}$$

where

$q_{V_{e1}}$ is the test flow rate, in litres per minute;

$q_{V_{i1}}$ is the initial injection flow rate (e.g. 100 ml/min);

V_{i1} is as defined in 7.1 a).

In this case,

$$m_{i1} = \left(\frac{q_{V_{e1}}}{0,1} \right) 5 \times 7,2$$
$$= 360 \times q_{V_{e1}}$$

Use the mixing procedure given in annex C.

Bypass the injection clean-up filter (5c) and circulate the fluid for at least 10 min.

7.2 Initial efficiency measurement

a) If possible, check that the test filter integrity is in accordance with ISO 2942. If the element is not readily accessible, as in a spin-on configuration, check after testing the filter and disqualify the element if it fails to meet the designated fabrication integrity value.

b) Fit a straight pipe in place of the test filter (7), circulate 6 l of fluid in the test system at the rated flow, and maintain a temperature which corresponds to a viscosity of 13,2 $mm^2/s \pm 1$ mm^2/s[3)], with the return clean-up filter (5b) in service. Control conductivity in accordance with 6.2 c) and add the antistatic agent, if necessary.

It is recommended that the fluid be circulated throughout the system for 10 min before bringing in the clean-up filter.

c) Adjust the sample flow rate with the sampling pump (8) in each sampling line (8a and 8b). Flows from the sampling lines should not be interrupted at any time during the entire test. At this stage of the test (before the real beginning of the efficiency test), return the sampling lines to the main reservoir (4).

d) Check the cleanliness through the upstream sampling point (8a) and continue to filter the system until the cleanliness is in accordance with 5.4.2.

e) Fit the test filter (7) on the test rig in the specified orientation (horizontally or vertically). If the element can be removed, first fit only the empty housing for the determination of the pressure drop of the housing, then fit the element into the housing for the determination of the total pressure drop. The pressure drop of the element is then equal to the total pressure drop minus the pressure drop of the housing.

f) Record the pressure drop for 25 %, 50 %, 75 %, 100 % and 125 % of the rated flow of the filter.

g) Adjust the flow to the test flow rate. The deviation due to the sampling flow rate shall be taken into account. Check the cleanliness through the upstream sampling point (8a) and continue to filter the system until the cleanliness is as specified in 5.4.2.

h) Change over the sampling lines (8a and 8b) from the main reservoir (4) to an additional reservoir (for disposal), and initiate the test by starting the contaminant injection pump (11).

i) 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 (c):

— 4 to 5;

— 5 to 10;

— 10 to 15;

— 15 to 20;

3) 1 mm^2/s = 1 cSt

— 20 to 30;

— > 30.

j) At 10 min and 50 min, take a sample from the injection tank (1) and measure the initial and end gravimetric level in accordance with ISO 4405.

k) Record the injection flow rate within the first 10 min and within the last 10 min, ensuring that the test condition accuracy is in accordance with Table 2. If the required accuracy is not obtained, disqualify the measurements.

8 Report of data

8.1 Calculations of initial efficiency

Complete the test report presented in annex D and calculate the filter efficiency numerically.

8.2 Graphs

a) Plot on an arithmetical scale the evolution of initial efficiency versus test time (see Figure D.1).

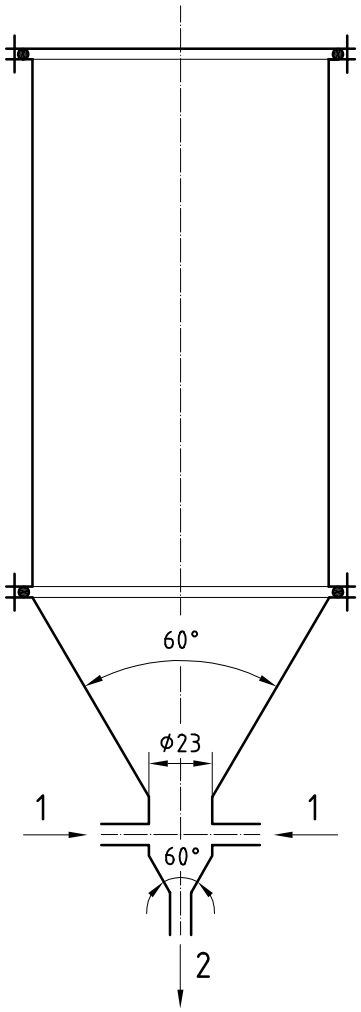
b) Plot on an arithmetical scale the evolution of average initial efficiency (for the calculation, see D.1) versus particle size (see Figure D.2).

Annex A
(normative)

Damper

See Figure A.1.

Dimensions in millimetres



Key

1 Inlet
2 Outlet

Figure A.1 — Damper (on dosing pump with two pistons)

Annex B
(normative)

Flush-type static pressure tap

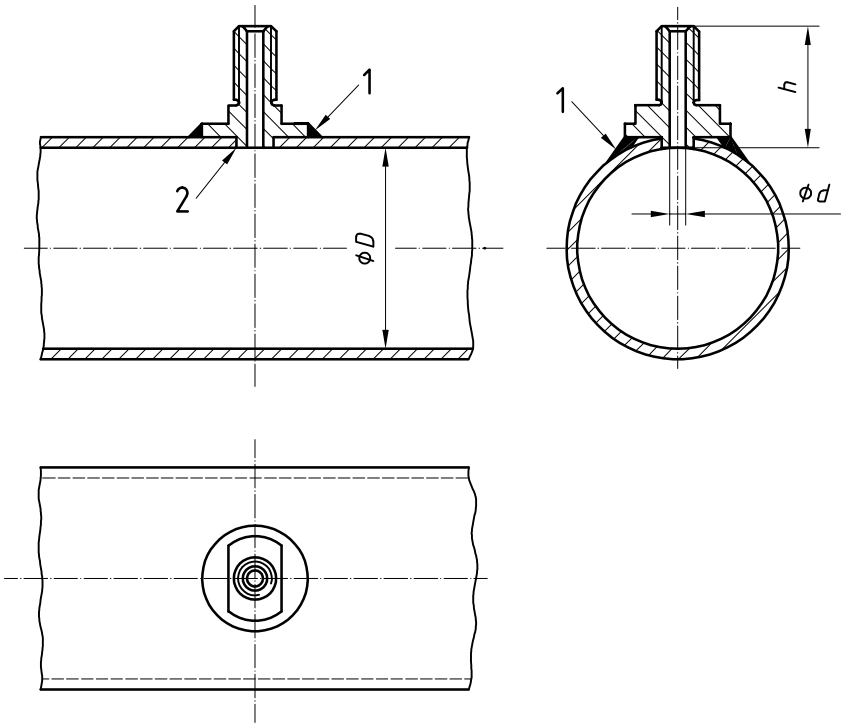
The flush-type static pressure tap diameter, d, is calculated using

$$d = \frac{D}{10}$$

where D is the inside diameter of the pipe, in millimetres.

The value of d shall be between 2 mm and 9 mm, and h shall be greater than $2d$.

See Figure B.1.



Key
1 Weld
2 No burr

Figure B.1 — Flush type static pressure tap

Annex C
(normative)

Procedure for test dust and test fluid mixing

C.1 Drying of dust

a) Prepare a sufficient mass of test dust for the series of tests to be performed, in a clean metal or ceramic dish.

b) Dry in an oven at 105 °C for at least 24 h.

c) Just before use, extract from the dish, with a clean spatula, a quantity of dust 1,5 times greater than the exact mass required and put it in another clean dish. Store it in a desiccator.

d) After 1 h, weigh the exact mass of dust, dried and cooled to room temperature, to an accuracy in accordance with Table 2.

C.2 Mixing dust and fluid

a) Fill a clean 250 ml sampling bottle with test dust.

b) Add to the bottle about 50 ml of clean oil.

c) Mix carefully with a spatula until the mixture is completely homogeneous.

d) Add 150 ml of new, clean oil. Close the bottle and shake it vigorously.

e) Leave the bottle in an ultrasonic bath for 2 min to 3 min.

f) Shake it in a shaker for 5 min.

C.3 Transfer to test rig

a) Empty the bottle into the injection tank, previously filled with a volume of clean oil equal to (V_i – 500 ml), where V_i is calculated in accordance with 7.1.

b) Rinse the bottle by filling with 100 ml of clean oil and shaking vigorously. Pour the liquid back into the injection tank.

c) Repeat the rinsing according to b), twice.

Annex D
(normative)

Test report

D.1 Initial particle filtration efficiency (on-line counting or bottle counting)

Date of test: ..... Test number: .....

Filter element: .... Test fluid: ISO 13353, annex E Batch No.: .....

Housing type: .... Test dust: ISO 12103-A3 No.: .....

Test flow rate: ..... l/min Test temperature: 40 °C ± 2 °C

Initial pressure loss (test filter): ..... kPa Final sump volume, V_F: l

Gravimetric upstream level, C_e: ..... mg/l

Initial test system cleanliness [number of particles > 4 µm(c)/ml], N_i: ..... µm(c)/ml

Gravimetric injection tank level initial value, $C_{i,i}$: ..... mg/l

Gravimetric injection tank level end value, $C_{i,e}$: ..... mg/l

Gravimetric injection tank level mean value, $C_{i,m} = \frac{C_{i,i} + C_{i,e}}{2}$ ..... mg/l

Injection flow rate initial value, $q_{V_{i,i}}$: .....ml/min

Injection flow rate end value, $q_{V_{i,e}}$: .....ml/min

Injection flow rate mean value, $q_{V_{i,m}} = \frac{q_{V_{i,i}} + q_{V_{i,e}}}{2}$: .....ml/min

Mean level times mean injection flow rate result in the dust addition, $q_{V_{i,m}} \times C_{i,m} \times 10^{-3}$: ..... mg/min

Total dust addition within 60 min test time, $m_{i,e} = q_{V_{i,m}} \times C_{i,m} \times 6 \times 10^{-2}$: ..... g

Calculation of the average initial efficiency, E:

$$E = \frac{\sum N_0 - \sum N_1}{\sum N_0}$$

Sample No.	Time min		Range µm(c)					
			4 to 5	5 to 10	10 to 15	15 to 20	20 to 25	> 30
1	5	N_0						
		N_1						
		E %						
2	10	N_0						
		N_1						
		E %						
3	15	N_0						
		N_1						
		E %						
4	20	N_0						
		N_1						
		E %						
5	25	N_0						
		N_1						
		E %						
6	30	N_0						
		N_1						
		E %						
7	35	N_0						
		N_1						
		E %						
8	40	N_0						
		N_1						
		E %						
9	45	N_0						
		N_1						
		E %						
10	50	N_0						
		N_1						
		E %						
11	55	N_0						
		N_1						
		E %						
12	60	N_0						
		N_1						
		E %						

N_0 upstream number of particles per millilitre (differential count of the two adjacent channels)

N_1 downstream number of particles per millilitre (differential count of the two adjacent channels)

E efficiency by number: $\frac{N_0 - N_1}{N_0} \times 100$

D.2 Graphs

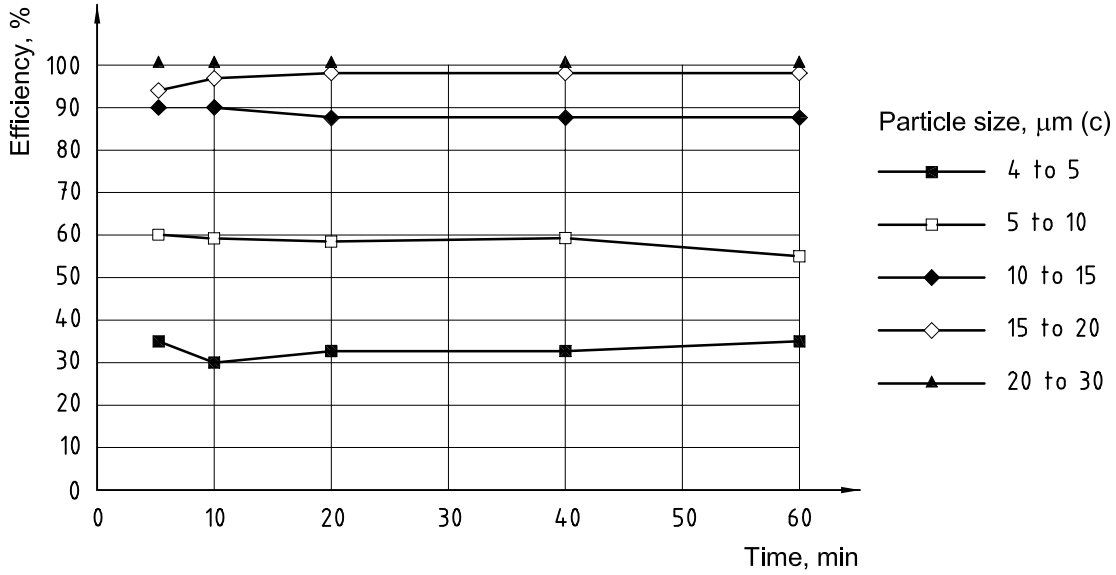


Figure D.1 — Evolution of initial efficiency vs test time

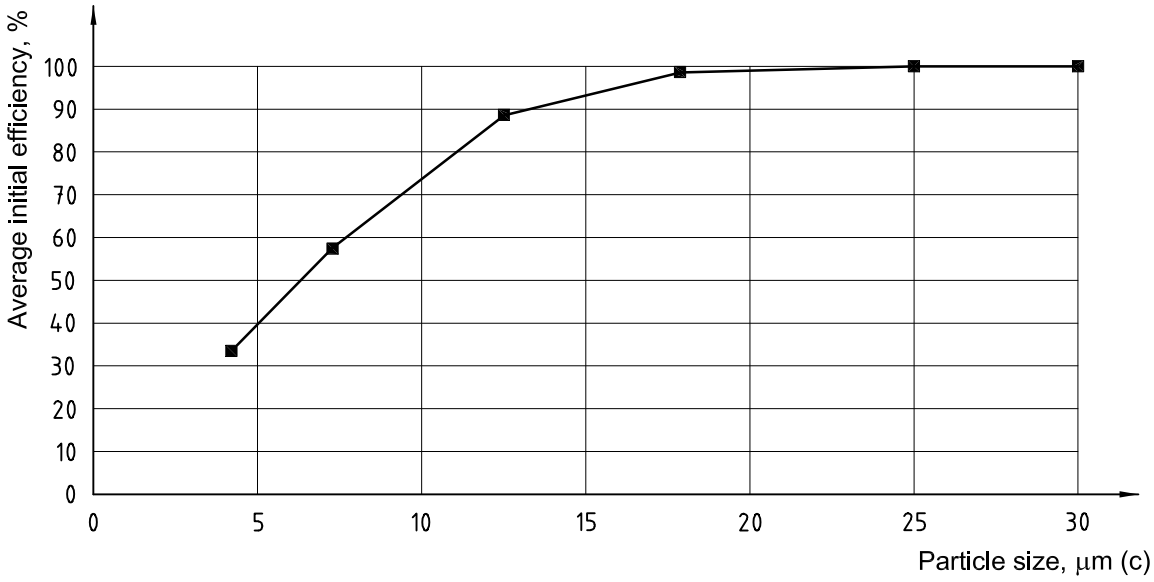


Figure D.2 — Evolution of average initial efficiency vs particle size

Annex E
(normative)

Specification of test fluid for filter test

E.1 General

This annex is reproduced from Annex A of ISO 4548-12:2000.

Suitable test fluids are aircraft hydraulic oils MIL-H-5606 and AIR 3520.

E.2 Petroleum base stock

The petroleum base stock shall have the following properties.

— Pour point: – 59,4 °C “min.”
— Flash point: 93,3 °C “min.”
— Acid or base number: 0,1 mg KOH/g “max.”
— Precipitation number: 0.

E.3 Additives

The test fluid shall contain the following added materials.

— Viscosity-temperature coefficient improver: 10 % “max.”
— Oxidation inhibitors: 2 % “max.”
— Tricresyl phophate anti-wear agent: 0,5 % ± 0,1 %.

The free phenol content of the tricresyl phosphate anti-wear agent should not exceed 0,05 %.

E.4 Properties

The test fluid shall have the following properties.

— Viscosity at 40 °C: 13,2 mm^2/s “min.”
— Viscosity at – 40 °C: 500 mm^2/s “min.”
— Pour point: – 59,4 °C “min.”
— Flash point: 93,3 °C “min.”
— Precipitation number: 0.
— Acid or base number: 0,2 mg KOH/g “max.”

E.5 Colour

The test fluid shall be clear and transparent. For identification it shall contain a red dye in a proportion not greater than one part of dye per 10 000 parts of oil.

Bibliography

[1] ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols*

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