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Methods of test for full-flow lubricating oil filters for internal combustion engines

Part 5: Test for cold start simulation and hydraulic pulse durability

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Methods of test for full-flow lubricating oil filters for internal combustion engines —

Part 5: Test for hydraulic pulse durability

Méthodes d'essai des filtres à huile de lubrification à passage intégral pour moteurs à combustion interne —

Partie 5: Méthode d'essai de résistance aux impulsions hydrauliques

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*, Subcommittee SC 7, *Tests for lubricating oil filters*.

This third edition cancels and replaces the second edition (ISO 4548-5:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— The test system schematic has been revised to include updated instrumentation.

— The cold start simulation test and hydraulic pulse durability procedures have been combined into Clause 8.

— The names of the tests have been revised to the “extreme” and “normal” pressure surge tests.

— The test system setup has been defined in more detail.

— A round robin test has been added to be performed to validate the changes. The results have been summarized in a new informative annex (see Annex B).

A list of all parts in the ISO 4548 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 4548 (all parts) establishes standard test procedures for measuring the performance of full-flow lubricating oil filters for internal combustion engines. The series has been prepared in separate parts, each part relating to a particular performance characteristic.

Together the tests provide the information necessary to assess the characteristics of a filter, but if agreed between the purchaser and the manufacturer, the tests can be conducted separately.

INTERNATIONAL STANDARD ISO 4548-5:2020(E)

Methods of test for full-flow lubricating oil filters for internal combustion engines —

Part 5:
Test for hydraulic pulse durability

1 Scope

This document specifies a method of testing the ability of full-flow lubricating oil filters manufactured with metal pressure vessel materials for internal combustion engines to withstand an internal pressure surge. Normally surges occur when an engine is started from cold, and cyclic internal pressure variations experienced during operation.

These tests are intended for application to spin-on type filters and detachable filters with disposable elements.

The tests can be applied to other filters, if thought applicable, by agreement between the filter manufacturer and the purchaser.

NOTE This test is not intended to replace simulated environmental testing (e.g. at very low temperatures). If such testing is required, it will be the subject of negotiation between the supplier and customer.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1219-1, *Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications*

ISO 4548-1, *Methods of test for full-flow lubricating oil filters for internal combustion engines — Part 1: Differential pressure/flow characteristics*

3 Terms, definitions and graphical symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4548-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.2 Graphical symbols

For the purposes of this document, the graphical symbols given in ISO 1219-1 apply.

4 Operational characteristics to be tested

Filters are subjected in service to pressure fluctuations caused by either engine cold starting conditions or hydraulic pulse events during normal operation. The test specified in Clause 8 can be performed at a range of pressures on separate filters to simulate in-service conditions and verify the capability of the filter canister and seal to withstand these pressures.

5 Test rig

See Figure 1 as an example of a typical test circuit. An alternative test rig, which produces the pressure pulse waveforms shown in Figure 2, may be used.

6 Test fluid

The test fluid shall be oil with a viscosity class ISO VG 22. The temperature shall be 60 °C ± 10 °C, unless otherwise specified.

NOTE The kinematic viscosity of ISO VG22 is 10 mm^2/s ± 5 mm^2/s at 63 °C.

7 Accuracy

7.1 The measuring instruments shall be capable of measuring to the levels of accuracy given in Table 1. The last column in the table gives the limits within which the test conditions shall be maintained.

Table 1 — Instrument accuracy and test condition variation

Test condition	Unit	Measurement accuracy	Permissible test condition variation
Pressure	kPa	±5 %	—
Time	s	±0,002 s	—
Temperature	°C	±1 °C	±2 °C

7.2 Use pressure transducers, amplifiers and recording devices with a combined system frequency response such that in the frequency range 0 kHz to 2 kHz, the amplitude ratio is within 0 dB to −3 dB.

7.3 Pressure transducer(s) shall be mounted directly into the test component, or as nearly as possible, so as to record the internal conditions applied to the component. Any restrictions between the transducers and the pressure-containing envelope being tested should be avoided.

7.4 Instruments and procedures should conform to ISO 9110-1 and ISO 9110-2.

8 Hydraulic pulse durability test (see Figure 1)

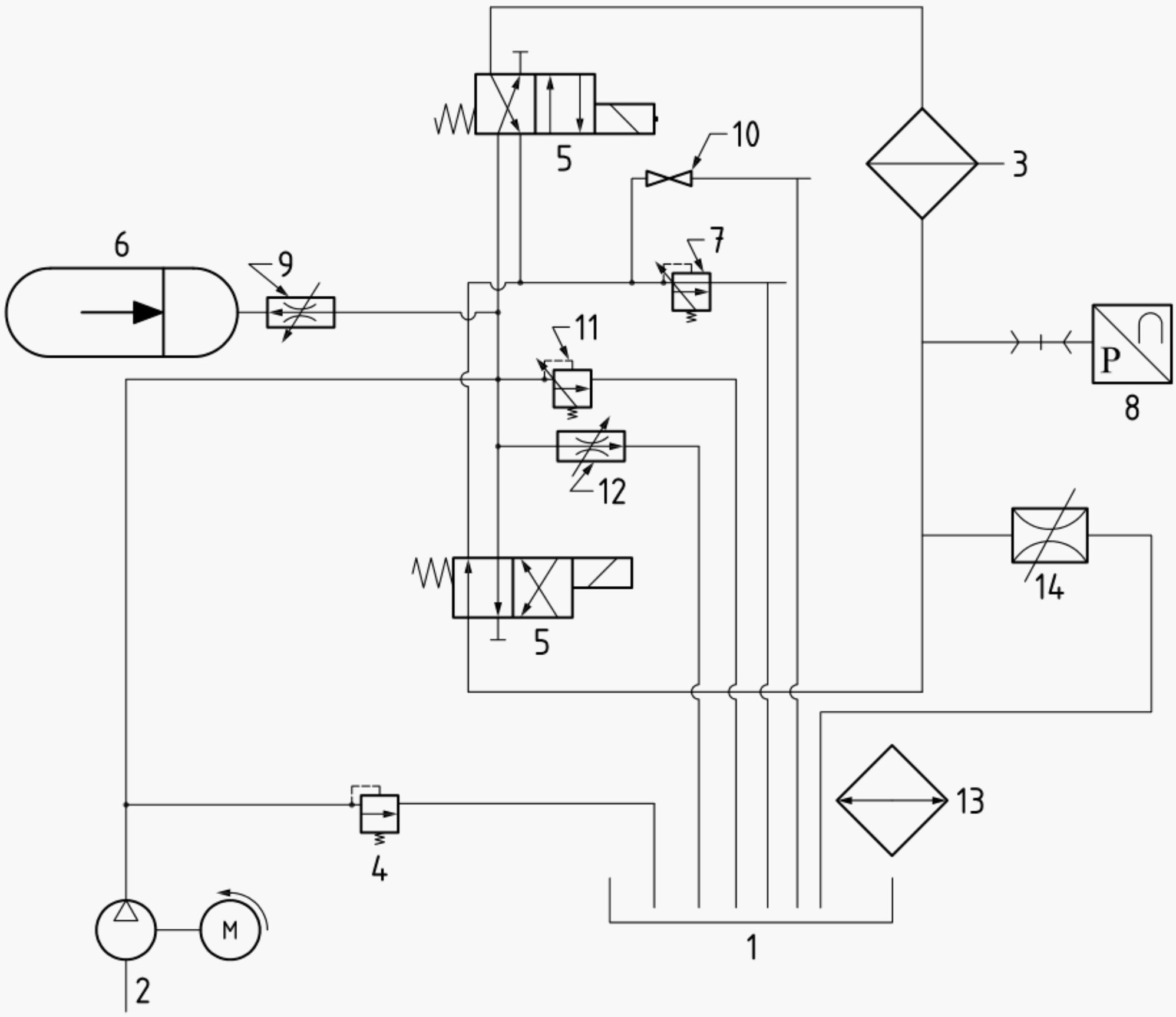
8.1 Fit a filter on an appropriate adaptor and install the test filter to the filter manufacturer's recommended tightening torque or angle of rotation for the filter to be tested. When multiple samples are to be tested for getting the statistically meaningful data, the mean and standard deviation should be calculated and reported. Additionally, the B10 value by Weibull analysis can be calculated and reported when tested with more than seven samples.

NOTE Weibull analysis (see Annex B) and the B10 value are described in ISO 19973-1.

8.2 Connect the test adaptor to the pipework system of the test rig.

NOTE Figure 1 has been shown to produce an acceptable waveform. Other hydraulic configurations will work as well.

8.3 Adjust the charge in the accumulator (item 6) to approximately 50 % of the maximum test pressure agreed with the customer. In the absence of such an agreement, one of the values given in Annex A may be used. Set the system pressure relief valve (item 4) to at least 110 % of the test pressure. Open the inlet pressure valve (item 11) to reduce test pressure to minimum. Start the pump (item 2). Allow the rig to run until all air has been purged from the system. Bleed the filter to be tested (item 3) by opening the bleed valve (item 14). The directional control valves (item 5) shall be open to pass oil through the filter and bleed air out of the system. The adjust valve (item 12) should be open 10 % to 20 % to allow pressure adjustment during the test. Open the flow restrict valve (item 9) approximately 50 %. Close the bleed valve (item 14). Adjust the inlet pressure valve (item 11) to the specified pressure. Precision modulation of pressure can be attained by using the adjust valve (item 12). Start the test.

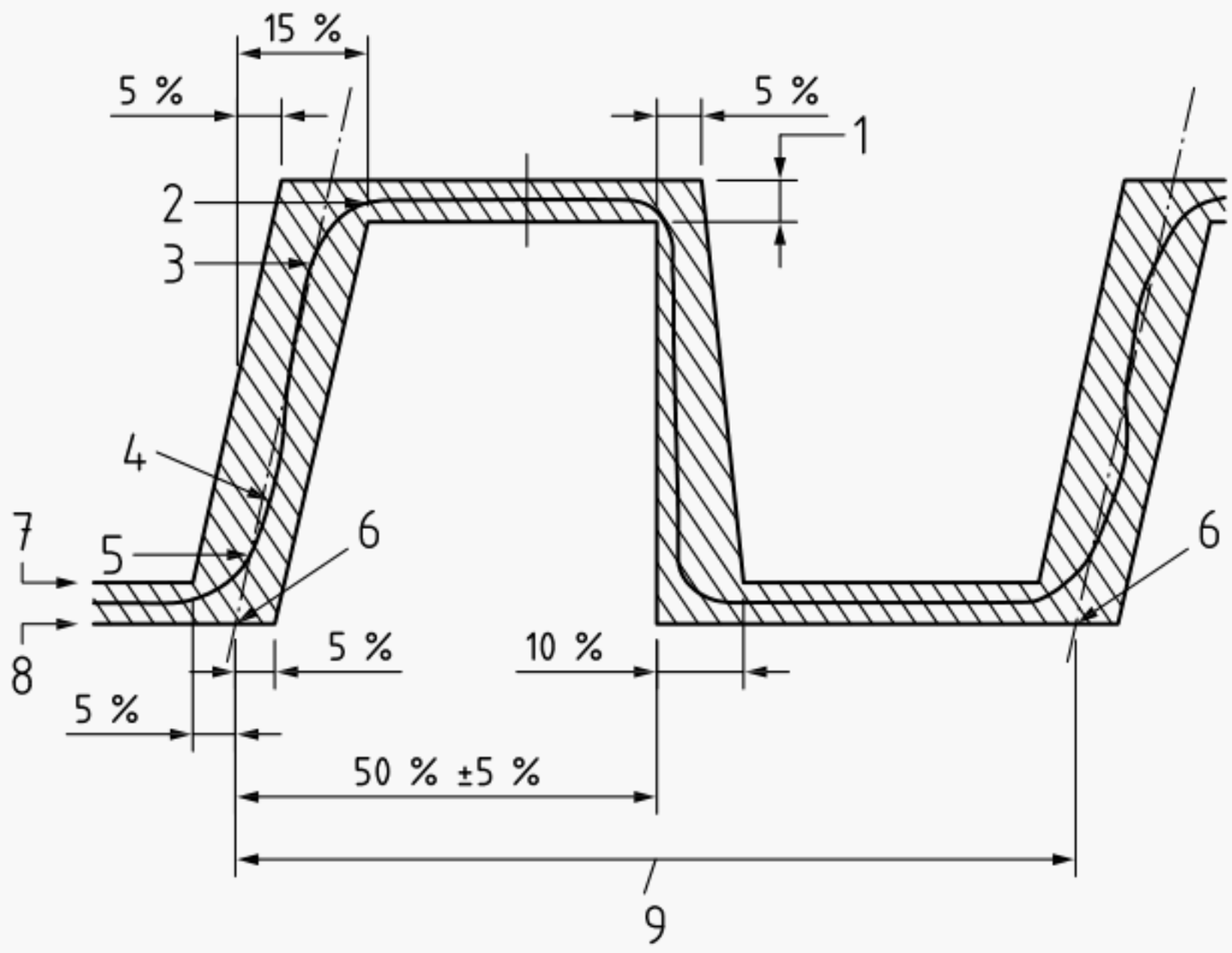


Key

1	oil reservoir	8	pressure sensor
2	pump assembly	9	flow restrict valve
3	filter to be tested	10	shunt valve
4	system pressure valve	11	inlet pressure valve
5	directional valve	12	adjust valve
6	accumulator	13	heat exchanger in reservoir
7	outlet pressure valve	14	bleed valve

Figure 1 — Test rig for the hydraulic pulse durability test

Initiate the cyclic test at system pressure meeting the waveform specified in Figure 2. Valves 14, 9 and 10 can be adjusted to remove pressure spikes. Without a specific pulse frequency requirement transmitted by the customer, the cycle rate shall be in the range of 0,5 cycles to 2 cycles per second.



Key

1 test pressure ±5 %
2 cyclic test pressure
3 85 % cyclic test pressure
4 secant pressure rise
5 15 % cyclic test pressure
6 point "0" — the intersection of the secant pressure rise with zero pressure (0 kPa)
7 5 % cyclic test pressure
8 0 kPa (0 psi)
9 time for one impulse cycle

NOTE 1 The above waveform is shown as an example.

NOTE 2 The hatched area shows the tolerances of the test pressure.

Figure 2 — Diagrammatic pressure pulse waveform for the hydraulic pulse durability test

An oscilloscope or an alternative device shall be provided to monitor the pressure waveform and cycle times.

8.4 Set the counter to zero.

8.5 Regulate the reservoir oil temperature to maintain the required viscosity (see Clause 6).

8.6 Allow the test to continue, monitoring until failure occurs or until the number of cycles agreed with the engine manufacturer has been applied. In the absence of such an agreement, the value given in Annex A for the test pressure chosen may be used.

8.7 Upon test completion, check the angle of rotation and/or tightening torque (i.e. turn in the tightening direction).

8.8 Remove the filter, allow it to drain and visually examine the unit to determine the failure point and type of failure, if any.

9 Test report

The test report shall include at least the following:

a) the name of the test establishment;

b) the filter type (manufacturer, model number and batch number);

c) the date of the test;

d) a description of the filter and whether it is new or used; if it is used, the approximate period of service;

e) the rated flow, in litres per minute;

f) the test pressure, in kilopascals;

g) the test cycle rate, in hertz;

h) the test fluid;

i) the test temperature;

j) the mode of failure and its location;

k) the installation and removal angle or torque (in newton metres);

l) the number of cycles to failure or the number of cycles completed.

Annex A
(informative)

Values to be used for tests if no agreement is reached with the manufacturer

In the absence of manufacturer test specifications, Table A.1 gives the pressure and number of cycles that may be used in the extreme surge condition test and the normal surge condition test for the chosen category of filter. Either one or both of the pressure ranges may be used for the chosen category of filter.

Table A.1 — Pressure and number of cycles to be used for tests

Filter type	Category	Extreme surge condition test		Normal surge condition test	
		Pressure kPa	Number of cycles	Pressure kPa	Number of cycles
Spin-on (light duty)	A	1 000	1 000	500	25 000
Spin-on (heavy duty)	B	1 300	3 000	700	50 000
Detachable with disposable element	C	1 600	5 000	900	75 000

Annex B
(informative)

Results of the round robin test program conducted to verify the procedure specified in this document

B.1 Hydraulic pulse durability test results

Table B.1 shows the results of round robin tests conducted to evaluate the procedure specified in this document. Five test facilities participated in the evaluations using the test pressure of 862 kPa at a rate of 2 Hz. The test specimens consisting of eleven or twelve filters were spin-on lube filters with an outside diameter of 94 mm from a single manufacturing batch.

For statistical analysis the mean and the standard deviation were calculated. In addition, the B10 life was calculated by using Weibull analysis, as specified in ISO 19973-1 at the 95 % confidence level.

Table B.1 — Results of hydraulic pulse durability tests on spin-on lube filters tested at 0 kPa to 862 kPa at a dynamic frequency of 2 Hz

Filter number	Test facility				
	1	2	3	4	5
1	107 953	113 569	96 225	114 701	50 035
2	122 056	53 211	101 659	78 129	74 731
3	73 135	124 388	118 890	87 971	70 292
4	114 213	109 006	67 266	75 294	65 964
5	63 699	73 183	104 183	105 340	67 377
6	74 839	90 501	62 919	65 873	60 721
7	103 819	69 416	96 594	58 728	64 595
8	49 942	53 014	83 732	74 273	70 041
9	53 320	84 842	80 354	83 018	60 343
10	109 564	93 941	81 953	100 002	72 421
11	111 093	90 684	81 878	124 367	63 510
12	47 600	84 208	48 860	73 513	—
Mean	85 936	86 664	85 376	86 767	65 457
Standard Deviation	28 140	22 300	19 548	20 205	6 883
B10 life[a]	52 000	57 500	60 500	58 000	57 000

NOTE All the filters failed due to the same failure mode of fatigue crack in the can flute.

[a] The B10 life values rounded to three significant figures are determined according to ISO 19973-1:2015, Figure 1 from each facility's Weibull curve.

B.2 Conclusions and supplemental information

B.2.1 Facilities 1 to 4 showed correlation in terms of the mean and standard deviation. Facility 5 had a tighter distribution with a smaller mean within the standard deviation range of Facilities 1 to 4.

B.2.2 All the five test facilities showed good correlation in terms of the B10 life by the Weibull calculation.

B.2.3 Due to the inherent variability in fatigue failures; making an appropriate pass or fail decision using the test procedure, multiple test specimens should be used.

B.2.4 Supplemental information concerning metal fatigue testing and rated fatigue life may be located in ISO 10771-1 and ISO 12829 methods.

Bibliography

[1] ISO 9110-1, *Hydraulic fluid power — Measurement techniques — Part 1: General measurement principles*

[2] ISO 9110-2, *Hydraulic fluid power — Measurement techniques — Part 2: Measurement of average steady-state pressure in a closed conduit*

[3] ISO 10771-1, *Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes — Part 1: Test method*

[4] ISO 12829, *Hydraulic spin-on filters with finite lives — Method for verifying the rated fatigue life and the rated static burst pressure of the pressure-containing envelope*

[5] ISO 19973-1:2015, *Pneumatic fluid power — Assessment of component reliability by testing — Part 1: General procedures*

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