INTERNATIONAL STANDARD

ISO 4548-15

First edition
2014-07-15

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

Part 15: Vibration fatigue test for composite filter housings

Essai de fatigue aux vibrations pour matériaux composites — Partie 15: Essai de fatigue aux vibrations pour les corps de filtre pressurisés à base de matériaux composites

Reference number
ISO 4548-15:2014(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 ..... **iv**
1 Scope **1**
2 Normative references **1**
3 Terms, definitions, and graphical symbols **1**
3.1 Terms and definitions 1
3.2 Graphical symbols 1
4 Operational characteristics to be tested **1**
5 Test rig **2**
6 Test liquid **2**
7 Preconditioning **3**
8 Vibration fatigue test **3**
9 Test report **5**
Bibliography **7**

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 70, *Internal combustion engines*, Subcommittee SC 7, *Tests for lubricating oil filters*.

ISO 4548 consists of the following parts, under the general title *Methods of test for full-flow lubricating oil filters for internal combustion engines*:

— *Part 1: Differential pressure/flow characteristics*

— *Part 2: Element by-pass valve characteristics*

— *Part 3: Resistance to high pressure and to elevated temperature*

— *Part 4: Initial particle retention efficiency, life and cumulative efficiency (gravimetric method)*

— *Part 5: Cold start simulation and hydraulic pulse durability test*

— *Part 6: Static burst pressure test*

— *Part 7: Vibration fatigue test*

— *Part 9: Inlet and outlet anti-drain valve test*

— *Part 10: Life and cumulative efficiency in the presence of water in oil*

— *Part 11: Self-cleaning filters.*

— *Part 12: Particle retention ability and contaminant holding capacity using particle counting*

— *Part 13: Static burst test for composite filters*

— *Part 14: Cold start simulation and hydraulic pulse durability for composite pressure vessel materials*

— *Part 15: Vibration fatigue test for composite filter housings*

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

Part 15:
Vibration fatigue test for composite filter housings

1 Scope

This part of ISO 4548 specifies a method of testing the structural integrity of full-flow lubricating oil filters to withstand engine vibrations. This test is intended for application to spin-on type filters and detachable filters with disposable elements with a maximum flow rate of 100 L/min. Upon agreement between manufacturer and purchaser, this test method can be applied to filters with higher flow rates.

This test method is intended for test parts made from composite materials that experience mechanical property changes within the temperature range experienced in service. The test can be applied to filters with other temperature sensitive materials if thought applicable by agreement between the filter manufacturer and the purchaser.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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.

3.2 Graphical symbols

The graphical symbols used in this part of ISO 4548 are in accordance with ISO 1219-1.

4 Operational characteristics to be tested

Integrally mounted oil filter assemblies, including filter heads, adaptors, mounting brackets, etc., are subjected to forcing frequencies due to engine or installation vibrations. The test specified in this document verifies the ability of the filter assembly to withstand vibration for a predetermined number of cycles while under pressure.

5 Test rig

The test rig shall comprise the following components, together with the necessary tubing, connectors and supports (see Figure 1):

a) electro-mechanical vibrator, together with the necessary hardware and electronics to control and monitor displacement, velocity and acceleration;

b) oil pressure source, which can be manually or mechanically operated;

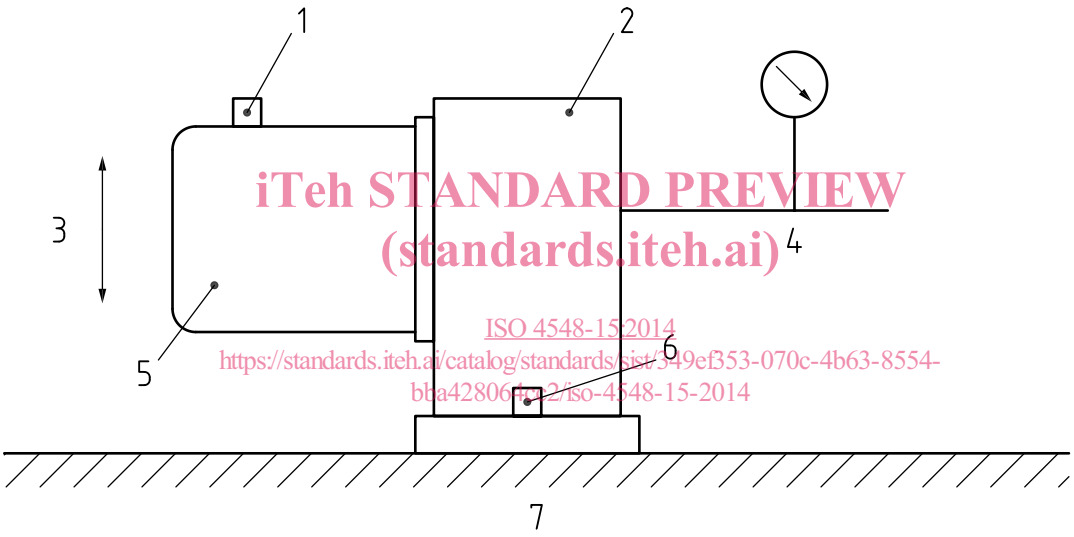
c) device to measure oil pressure, with sufficient range to cover the rated pressure of the test filter;

d) two accelerometers, featuring linear calibration and ranges appropriate for the part being tested;

e) filter to be tested, together with filter head or adaptor;

f) device to heat the test part to the specified temperature.

NOTE This device could be a thermal chamber that fits over the vibrator platform or a system to flow hot oil through the test part.



Key

1 output accelerometer
2 adaptor
3 axis of excitation
4 pressure source
5 oil filter under test
6 input accelerometer
7 vibrator table

Figure 1 — Test rig: First arrangement

6 Test liquid

The test liquid shall be oil with a kinematic viscosity of less than 10 $mm^2/s \pm 5$ mm2/s (10 cSt ± 5 cSt) at ambient temperature [ISO viscosity class ISO VG22 at 63 °C or SAE 5W at 68 °C (see References [1] and[3])] or as agreed upon by the filter manufacturer and the purchaser.

7 Preconditioning

Lube filtration products are exposed to engine oils and high temperatures as part of their function. The physical properties of composites can be affected by the fluid and temperature interactions. The following optional steps lay out a method to precondition the parts to simulate any reduction in material strength due to exposure to lube system conditions. This preconditioning method can be modified as agreed upon by the filter manufacturer and the purchaser.

7.1 Fill the test part with the fluid used in application.

7.2 Place the test part in a laboratory oven or thermal chamber and heat to a test temperature and duration agreed upon by the filter manufacturer and purchaser. If no temperature or duration is specified, then heat to 121°C for 250 hours. The default conditions are representative of real world conditions and deemed sufficient to promote material property degradation in sensitive materials. At the end of soaking period and after cooling down to ambient temperature, the oil can be drained to facilitate installation on the vibration stand.

NOTE Lube oil will expand when heated. Precautions will be needed to ensure that the test filter does not fail hydrostatically. This can be achieved by leaving one port open to atmosphere.

8 Vibration fatigue test

8.1 Install the filter on the filter head or adaptor as per Figure 1, applying the recommended torque or angle of rotation for the filter to be tested.

8.2 Mount the filter and head assembly on a rigid bracket or adaptor plate with high deformation resistance, using suitable jointing or sealant to ensure leak-proof mating surfaces.

8.3 Rigidly mount the bracket or adaptor plate/filter assembly on the vibrator table, ensuring that the filter polar axis is at a right angle to the axis of excitation.

8.4 Connect the filter to a pressure gauge and to a source of oil pressure at normal ambient temperature, using flexible tubing in such a way as to ensure that it does not interfere with the vibration of the filter unit.

8.5 Attach the input accelerometer to the filter head/adaptor and the output accelerometer to the filter, positioned approximately 100 mm from the top face of the sealing ring, or at a distance equivalent to 85 % of the filter length if the filter is shorter than 120 mm. The polar axis of both accelerometers shall be parallel to the axis of excitation (see Figure 1). Make the appropriate electrical connections between the accelerometer, vibration control and monitoring equipment.

8.6 Ensure that the test filter is filled with the test liquid and that all entrapped air has been expelled from the assembly. Pressurize the assembly to the rated pressure of the filter, or as agreed upon by the manufacturer and customer. If no test pressure is given, then pressurize the test filter 500 kPa. This pressure shall be maintained throughout the duration of the test.

8.7 Start the application of temperature and bring the test part to 121°C or as agreed upon by the filter manufacturer and purchaser before proceeding to step 8.8. Maintain this temperature throughout the vibration test.

8.8 Start the vibrator and conduct a resonant search up to a frequency of 400 Hz, maintaining peak input acceleration at a constant value of 60 m/s^2 ± 0,3 m/s^2, unless otherwise agreed upon by the filter manufacturer and customer.

If resonance occurs at a single frequency, then carry out the following test at that frequency. If resonance occurs at more than one frequency, carry out the following test at the frequency which exhibits the maximum amplitude (peak-to-peak displacement). If resonance does not occur, carry out the following test at a frequency of 150 Hz.

Adjust the power of the vibrator to give peak input acceleration as agreed between the filter manufacturer and engine manufacturer or, in the absence of such an agreement, an acceleration of 60 m/s2, and determine the total amplitude of vibration.

NOTE 1 The total amplitude (peak-to-peak) of vibration, *S*, in metres, can be calculated as follows:

$$S = \frac{a}{2\pi^2 f^2}$$

where

a is the peak acceleration, in metres per second squared;

f is the frequency of vibration, in hertz.

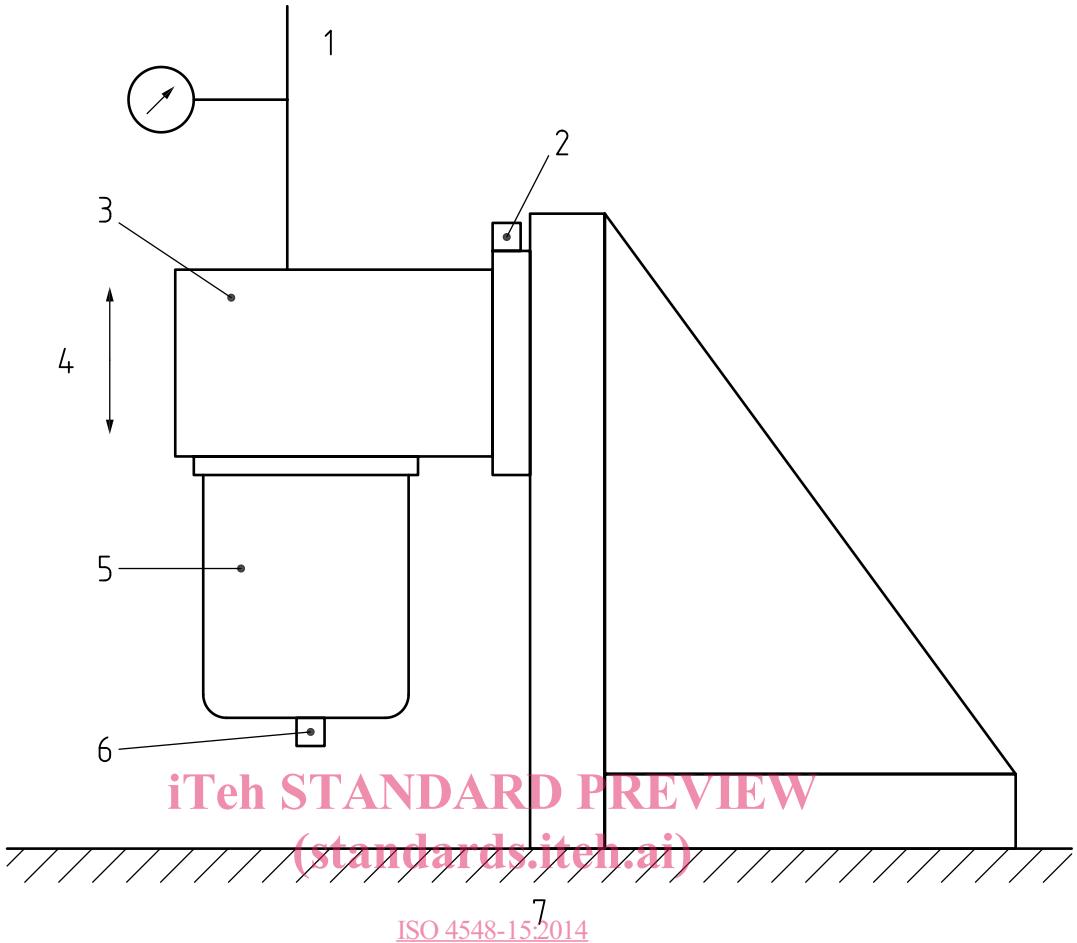
Composite materials can exhibit a non-linear response to an applied force at much lower levels than a metallic material. It is recommended that the response linearity be verified. If the response is non-linear, then the applicability of this method for the application should be verified.

8.9 Test the assembly to a total of 10^7 cycles unless prior failure occurs. Commence testing at the frequency determined in 8.8. Since the resonant frequency of the assembly under test could vary throughout the test, verify the test filter resonance periodically. This can be done automatically by shaker controllers with resonance tracking. Otherwise, repeat the procedure described in 8.8 and correct the frequency values after each 5×10^5 cycles and continue with the test.

8.10 If 10^7 cycles can be completed without apparent failure, then repeat the procedures given in 8.1 to 8.9 but with the test filter oriented such that the polar axis is normal to the axis of excitation. This position and accelerometer locations are shown in Figure 2.

8.11 If 10^7 cycles in the second direction can be completed without apparent failure, determine the removal torque or angle of rotation of the test filter for comparison with the initial setting.

8.12 Drain the test of fluid and carefully dismantle it to reveal any visual signs of internal damage.



Key

1 pressure source
2 input accelerometer
3 adapter
4 axis of excitation
5 oil filter under test
6 output accelerometer
7 vibrator table

Figure 2 — Test rig: Second arrangement

9 Test report

The test report shall include at least the following:

a) the name of the test establishment;

b) the filter designation (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 L/min;

f) the test pressure, in kPa;