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

Transmissions hydrauliques — Éléments filtrants — Vérification de la conformité de fabrication et détermination du point de première bulle

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Contents

Page

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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

This fifth edition cancels and replaces the fourth edition (ISO 2942:2004) which has been technically revised.

This revision permits the use of test fluids other than 2-propanol for determination of fabrication integrity. Specifically:

a) in 4.2, acceptable test fluids for determination of fabrication integrity are defined;

b) in 5.2.1, a formula to calculate the minimum allowed fabrication integrity pressure for an element in the test liquid is provided;

c) in 5.3.1, a formula is provided to calculate the pressure normalized to the surface tension of 2-propanol;

d) in Annex A, the manufacturer's minimum specified fabrication integrity is now listed, as well as the first bubble point in the test liquid and the normalized first bubble point; and

e) in Annex B, the theoretical underpinning for relating bubble point data obtained in one fluid to the bubble point that would be obtained using a different fluid is presented.

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

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. Filters maintain fluid cleanliness by removing insoluble contaminants.

The ability of a filter to achieve and maintain the required level of performance depends, among other parameters, upon its filtration rating and structural integrity. Any imperfections in the structure, either through poor manufacturing techniques or lack of strength, allow by-passing of unfiltered fluid.

The integrity of the element after manufacture can be evaluated using a non-destructive filter integrity test. This test determines whether flaws are present which would allow the fluid to bypass the filtering process and provides for quality control. The test is also used to evaluate whether damage has been sustained by the element during both service and laboratory tests.

The first bubble point test is used for investigative product development or production process evaluation. The acceptability of filtration performance cannot be determined by the first bubble point test.

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

1 Scope

This document specifies a bubble-point test method applicable to filter elements used in hydraulic fluid power systems. It can be used both to verify the fabrication integrity of a filter element (by checking the absence of bubbles) and to permit the localization of the largest pore of the filter element by determining the first bubble point.

NOTE Verification of fabrication integrity is used to define the acceptability of the filter elements for further use or testing.

The first bubble point is established through continuation of the fabrication integrity test. It is under no circumstances a functional characteristic of a filter element; in particular, it cannot be used to estimate filtration rating, efficiency or retention capacity and is intended to be used for information only.

This document specifies a method to normalise fabrication integrity and bubble point data to a standard value of surface tension when test fluids other than 2-propanol are used.

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 304, *Surface active agents — Determination of surface tension by drawing up liquid films*

ISO 5598, *Fluid power systems and components — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

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

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

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

3.1
filter element
porous device that performs the actual process of filtration

Note 1 to entry: This definition differs from that given in ISO 5598, which reads: “The porous part of a filter which performs the actual process of filtration.”

3.2
fabrication integrity
physical acceptability of a filter element to meet the specification designated by the filter manufacturer

3.3
first bubble point
pressure at which the first bubble stream appears when a filter element is tested using the method specified in this document

Note 1 to entry: In the absence of manufacturing defects, this value is indicative of the largest pore of the filtering medium.

3.4
surface tension
tension acting in the surface of a phase, directed towards the interior of the phase, caused by intermolecular attractions between the molecules at the surface and those located below the surface

4 Apparatus and materials

4.1 Bubble-point testing apparatus, as shown in Figure 1, is comprised of the elements 4.1.1 to 4.1.5.

4.1.1 Compressed-air supply, with filter(s) and pressure regulator(s), adjustable up to 10 kPa.

4.1.2 Pressure-measuring device, with an accuracy of ±5 % of the reading.

4.1.3 Temperature-measuring device, with an accuracy of ±1,0 °C.

4.1.4 Test container, for containing the test liquid (see 4.2) in which to submerge the filter element under test.

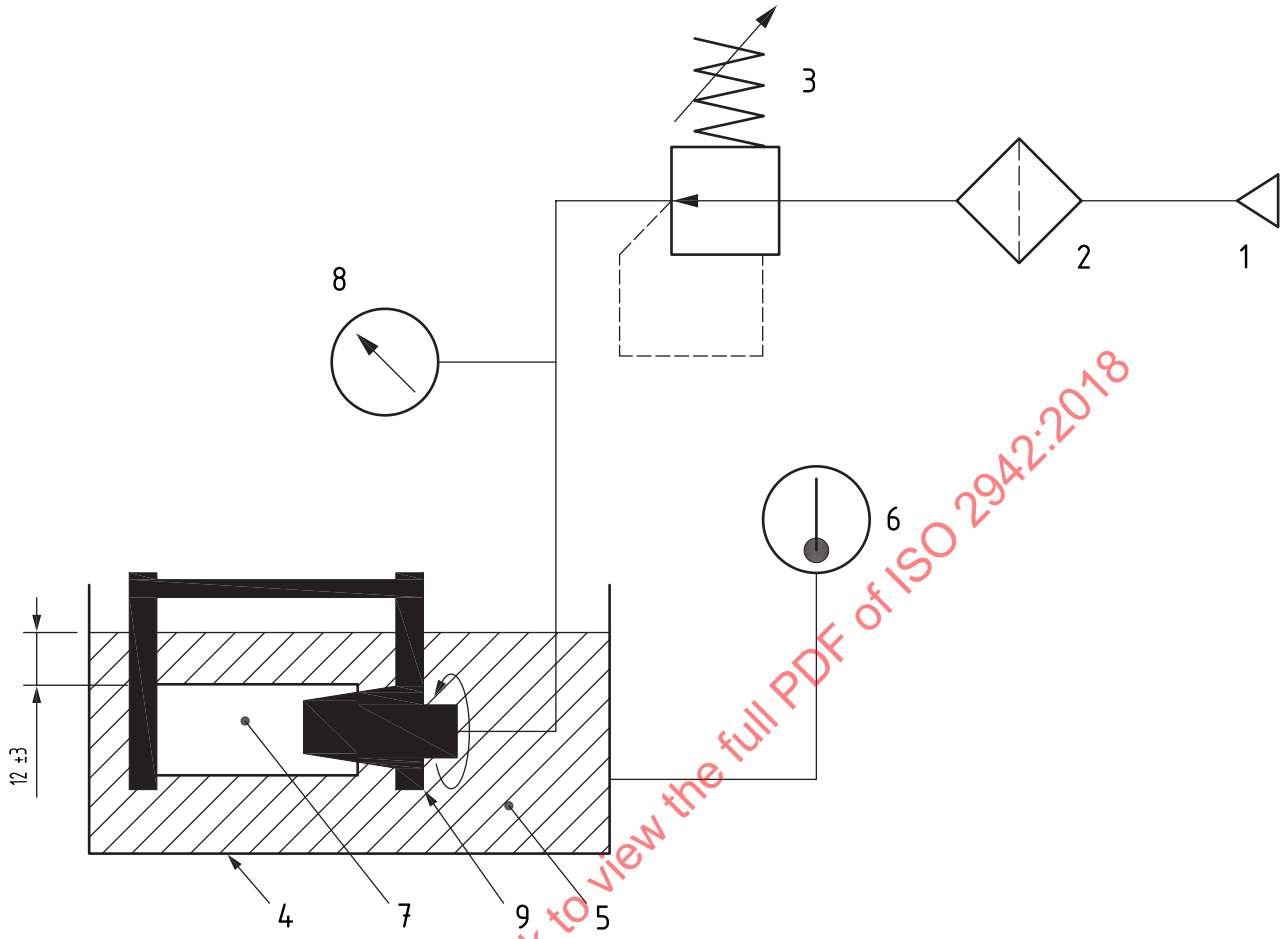
4.1.5 Element retention and rotation fixture, for restraining the filter element during immersion to the required depth and allowing rotation about the element's major axis either manually or with an automatic mechanism. The fixture shall include sealing bungs, of a material compatible with the test liquid (see 4.2) for sealing the compressed air supply line to the open end cap(s) of the filter element. One bung shall have an orifice which allows the transmission of the air pressure through an open end cap and if required a second sealing bung without an orifice to seal the opposite end cap of the filter element.

4.2 Test liquid

The test liquid shall be clean 2-propanol (isopropyl alcohol) or an alternative liquid designated by the filter element manufacturer with a surface tension between 14 mN/m and 33 mN/m. Its cleanliness shall be consistent with subsequent test requirements. Its surface tension shall be regularly checked in accordance with the requirements of ISO 304. The liquid shall be replaced when its surface tension has changed by more than 15 % of its original value.

If the test filter element has been exposed to other hydraulic fluids prior to being subjected to the fabrication integrity test, then it is permissible to use the same type of hydraulic fluid as the fabrication integrity test liquid, provided that the surface tension requirements of this subclause are met. If this is not possible, all residual previous liquid shall be removed by appropriate means before testing. This is to ensure correct and consistent wetting of the element's media.

Dimensions in millimetres



Key

1 compressed air supply
2 compressed air filter
3 pressure regulator
4 test container
5 test liquid
6 temperature-measuring device
7 filter element under test
8 pressure-measuring device
9 element retention and rotation fixture

Figure 1 — Typical bubble-point testing apparatus

5 Test methods

WARNING — Exercise care when using solvents with low flash points, as there could be a risk of fire or explosion. Appropriate precautions shall be taken to avoid inhalation of fumes from these solvents. Always use suitable protective equipment.

5.1 General procedure

5.1.1 Check that the manufacturer's identification number or part number of the filter element to be tested complies with the manufacturer's specification. Determine the minimum fabrication integrity of

the filter element and the corresponding value for surface tension on which it is based from the filter manufacturer.

5.1.2 Remove any packaging or protective covering from the filter element. Visually examine the element for defects that might affect the validity of the test results. Install the clean filter element in the bubble-point testing apparatus (see 4.1) with the major axis of the filter element parallel to the surface of the test liquid (see 4.2).

5.1.3 Submerge the filter element in the test liquid, which shall be at a temperature of (22 ± 5 °C).

5.1.4 Allow the filter element to remain submerged in the test liquid for at least 5 min before proceeding, to ensure that the filter element media fibres are wetted. The filter element may be soaked in the test container (4.1.4) prior to its being secured in the element retention and rotation fixture (4.1.5). If soaking is carried out while the filter element is secured in the element retention and rotation fixture, ensure that no pressure is applied to the filter during the soaking period.

5.1.5 Ensure that the lines connecting the pressure-measuring device (4.1.2) to the rest of the apparatus are void of liquid.

5.2 Verification of fabrication integrity (absence of air bubbles)

5.2.1 Calculate the minimum allowed fabrication integrity pressure for the element in the test liquid, P_T in kPa using Formula (1).

$$P_T = \frac{P_M \gamma}{21{,}15} + 0{,}000\,1\rho \tag{1}$$

where

P_M is the fabrication integrity of the element in 2-propanol as designated by the filter manufacturer, kPa;

γ is the surface tension of the test liquid, mN/m;

ρ is the density of the test liquid, kg/m^3.

Record P_M and P_T as the pressure specified by the manufacturer in accordance with the requirements of Annex A.

The preceding formula assumes that the designated P_M uses 2-propanol with a surface tension of 21,15 mN/m as the reference fluid. If a different surface tension is used as the reference, then the value of P_M should be corrected to correspond to the reference surface tension of 21,15 mN/m.

NOTE In the formula, the constant 0,000 1 has units of measurement of mm (m/s^2) and the constant 21,15 has units of mN/m.

5.2.2 Apply an air pressure equal to about 10 % of P_T to the inside of the filter element to clear any lines of test liquid and to pressurize the element. If necessary, readjust the depth of the test liquid covering the element to (12 ± 3 mm) above the top of the filter media.

5.2.3 After the pressure stabilizes, completely rotate the element around its major axis to ensure that no streams of bubbles are evident, and then gradually increase the pressure to P_T in a minimum of

four suitable increments [for example, 100 Pa]. Allow the element at least one rotation of 360° at each increment while checking for evidence of bubbles. Continue increasing the pressure until P_T is reached.

Air bubbles might be trapped on or within the outer structure of the filter element, resulting in a few spurious bubbles. These bubbles shall be ignored. A steady stream of bubbles from the filter element at or below the manufacturer's designated pressure is the only consideration.

Adequate lighting is required for reliable observation.

Increase air pressure slowly to allow equilibrium to be established and to prevent overshooting of pressure. Avoid mechanical vibration or jarring of the test element to prevent upsetting bubble equilibrium, which will give an erroneous and an unrepresentative first bubble-point value. The speed at which the filter element is rotated should be controlled so as not to disturb or release air from the element.

Adjust the depth of the test liquid covering the filter element to (12 ± 3) mm above the top of the filter media throughout the test.

5.2.4 Record the temperature of the test liquid.

5.2.5 The acceptance criterion is that there shall be no evidence of a continuous stream of bubbles at or below P_T, the pressure specified by the manufacturer corrected for the test liquid actually used. Record the acceptance or failure of the filter element in accordance with the requirements of Annex A.

5.3 Determination of the first bubble point

5.3.1 Gradually apply air pressure progressively to the inside of the filter element, while rotating it about its axis. Increase the pressure in suitable increments in accordance with 5.2.3, beginning at zero pressure or, if this test is a continuation of the fabrication integrity test, at the pressure reached in 5.2.3.

Stop the pressure rise as soon as a single continuous stream of bubbles appears and record the location from which the stream of bubbles is originating in accordance with the requirements of Annex A. This pressure, P, in kPa corresponds to the first bubble point for the test liquid. Calculate the corresponding pressure in kPa normalized to the surface tension of 2-propanol, P_R, using Formula (2).

$$P_R = \frac{21{,}15}{\gamma}\left(P - 0{,}000\,1\rho\right) \tag{2}$$

Record P and P_R (this is the normalized first bubble point), the test liquid temperature and the location of the bubbles in accordance with the requirements of Annex A.

Air bubbles might be trapped on or within the outer structure of the filter element, resulting in a few spurious bubbles. These bubbles shall be ignored.

Avoid mechanical vibration or jarring of the test element to prevent upsetting the bubble equilibrium, which causes erroneously low pressure readings.

5.3.2 Completely release the air pressure in the filter element to allow the filter-element medium to be thoroughly wetted with liquid, repeat the procedures given in 5.3.1 twice (resulting in a total of three measurements), and record the corresponding pressures and locations. When applying the pressure the second and third times, it is permitted to increase the starting pressure from 0 % to 50 % of the pressure measured in 5.3.1 rapidly and without respecting the suitable increments.

6 Data presentation

Record the result of the verification of fabrication integrity and the data for the determination of the normalized first bubble point in accordance with the typical test report shown in Annex A.

7 Identification statement (Reference to this document)

Use the following statement in test reports, catalogues and sales literature when electing to comply with this document:

Filter element fabrication integrity verified and/or first bubble point determined in accordance with ISO 2942:2018, *Hydraulic fluid power — Filter elements — Verification of fabrication integrity and determination of the first bubble point.*

Annex A
(informative)

Test report for verification of filter element fabrication integrity and determination of the first bubble point

Date of test: Operator:

Test liquid

Type: _____ Surface tension: _____mN/m Temperature °C : _____

Filter element

Manufacturer: _____

Manufacturer's identification

Number or part number: _____

Batch number/date code: _____

Used/Unused: _____

Comment: _____

Fabrication integrity

Manufacturer's minimum specified fabrication integrity pressure = _____kPa at a surface tension of _____ mN/m

Calculated manufacturer's minimum specified fabrication integrity pressure at the test surface tension P_T = ____kPa

Appearance of a continuous stream of bubbles: ☐ YES ☐ No

If yes, location of continuous stream of bubbles: ☐ Filter media ☐ Side seams ☐ End cap

at the pressure of ___kPa in 2-propanol which corresponds to the Manufacturer's minimum fabrication integrity pressure.

First bubble point

Pressure measured when the first single continuous stream of bubbles appears:

Reading	Pressure in test liquid kPa	Normalized pressure kPa	Location of bubbles	Comments
first reading			☐ filter media ☐ end cap ☐ side seam	
second reading			☐ filter media ☐ end cap ☐ side seam	
third reading			☐ filter media ☐ end cap ☐ side seam	