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Hydraulic fluid power — Filters — Test method for differential pressure devices

Transmissions hydrauliques — Filtres — Méthode d'essai pour les indicateurs de colmatage

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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.

ISO 16860 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

Introduction

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

The filter element is the porous device that performs the actual process of filtration. The differential pressure device is an accessory that signals when a predetermined value of differential pressure across the filter element has been reached. It is normally used to signal when a restricted filter element should be replaced and, in cases where the device is linked to the bypass valve, signals the status of bypass valve condition.

Hydraulic fluid power — Filters — Test method for differential pressure devices

1 Scope

This International Standard provides a standard method for determining the operating characteristics of a differential pressure or bypass valve condition-signalling device used as an accessory to a hydraulic fluid power filter.

2 Normative references

The following referenced documents are indispensable for the application 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 3448, *Industrial liquid lubricants — ISO viscosity classification*

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

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.

3.1
actuation pressure
differential pressure at which a pressure-operated visual indicator or electrical switch signals a change of condition

3.2
low temperature lockout
device that prevents a differential pressure device or switch from actuating below a designated temperature but allows normal actuation above a higher designated temperature

NOTE Low temperature lockouts prevent false signalling of a filter element during cold start conditions.

3.3
bypass valve condition signalling indicator
device that provides an external signal, by visual or electrical means, of the status of the bypass valve.

4 Test equipment

The following test equipment is required.

4.1 Test stand, capable of exceeding requirements of 7.4.

4.2 Test medium, with a viscosity of ISO VG 32 in accordance with ISO 3448, unless otherwise specified, or with a specified viscosity in accordance with the recommendation of the differential pressure device manufacturer, or a supply of compressed air, suitably filtered and regulated.

4.3 Low temperature box or **environmental chamber**, with a suitable enclosure that can be controlled to the desired temperatures for testing differential pressure devices that incorporate a low temperature lockout and that can confirm the lockout release temperature.

4.4 Temperature measuring device, with an accuracy of ± 0,5 °C.

4.5 Test block, able to contain a differential pressure device(s) so that the required tests can be performed (see 7.2, 7.3, 7.4 and 7.5).

The fixture shall have a proof pressure at least 50 % higher than that of the item under test. It is recommended that the fixture be pressure tested to the proof pressure at least once per year, if it is used frequently.

5 Test conditions

Unless specific test requirements dictate otherwise, all tests shall be conducted at room temperature.

6 Types of differential pressure devices

The differential pressure device types described in Annex A are those generally considered to be in use and it is the intent of this International Standard to provide a means of determining their operating characteristics.

For differential pressure device types or characteristics not covered by this International Standard, the manufacturer shall be consulted in order to determine details of the methods to be used to determine their operating characteristics.

WARNING — Differential pressure devices used as additions to a filter assembly may be rated for pressures in excess of the filter assembly. Test pressures should not exceed the maximum rated pressure of the filter assembly used for test.

7 Procedure for testing differential pressure devices and bypass valve condition signalling indicators

7.1 Actuation pressure test — Filter housing method

7.1.1 Perform one of the following procedures which best simulates the device application.

a) Remove the filter element from its housing and plug the filter element port (this allows the pressure to build up in the test housing and on the upstream side of the differential pressure device).

b) Remove the filter element and install a flow-restricting orifice in the filter element port in the housing. The orifice should be sized to produce a differential pressure of approximately 75 % of the specified differential pressure device actuation pressure at 50 % of the rated filter flow rate. This will produce a differential pressure build-up in the test housing between the upstream and downstream sides of the device.

7.1.2 Connect the inlet port of the filter housing to the controlled pressure and flow source of the test stand.

If the filter element port is plugged in accordance with 7.1.1 a), vent the outlet port to atmosphere. Venting to atmosphere will automatically give a back pressure of 0 (zero) gauge pressure and the inlet gauge pressure may be read directly.

If the filter element port is plugged with an orifice in accordance with 7.1.1 b), connect the outlet port to the return line of the test stand with a pressure relief valve located downstream of the outlet pressure gauge and piloted by the pressure in the upstream line. Adjust the pressure-relief valve to maintain the upstream pressure equal to the maximum working pressure of the filter housing, unless otherwise specified. The differential pressure device actuation pressure is the difference between the inlet and outlet pressure gauge readings.

If the test is performed at pressure, it is recommended that a differential pressure transducer be used in place of pressure gauges for improved measurement accuracy.

7.1.3 Install the differential pressure device into the filter housing in accordance with the manufacturer's instructions.

7.1.4 If the differential pressure device is of the electrical or electronic type, make the appropriate electrical connections to a means of displaying either the actuation indication or the differential pressure.

7.1.5 Increase the inlet pressure to actuate the differential pressure device and record the pressure level at which the device actuates, then reduce the pressure to zero and, if necessary, manually reset the device. Repeat three times and calculate the average of the four values.

7.1.6 Increase the inlet pressure to about 85 % of the actuation pressure determined in 7.1.5. Increase the inlet pressure in increments of 5 kPa to 10 kPa (0,05 bar to 0,1 bar) and hold for 30 s ± 3 s at each increment. Continue to increase the pressure until the device actuates and record the actuation pressure.

For auto-reset type bypass indicators, increase the pressure to 50 kPa (0,5 bar) above the actuation pressure measured.

7.1.7 Decrease the pressure in increments of 5 kPa to 10 kPa (0,05 bar to 0,1 bar) and hold for 30 s ± 3 s at each increment until the device resets or the device can be manually reset and record the pressure value on the report sheet.

7.1.8 Repeat 7.1.6 and 7.1.7 twice more and record the average of the three readings as the actuation pressure.

7.1.9 Verify that the device resets itself or can be reset manually. Failure to reset shall be cause for rejection.

7.2 Actuation pressure test — Test block method

7.2.1 If air is used as the test medium, lubricate the internal surfaces of the device with a suitable lubricant that is clean and dry. Install the differential pressure device into the test block in accordance with the manufacturer's instructions.

7.2.2 Connect the upstream port of the test block to a pressure source (either hydraulic or pneumatic) and pressure gauge and set the pressure relief valve or pressure regulator to a value 25 % higher than the expected setting of the device under test. Ensure that the downstream port is vented to atmosphere and is free of any obstructions.

7.2.3 If the device is of the electrical or electronic type, make the appropriate electrical connections to a means of displaying either the actuation indication or the differential pressure.

7.2.4 Increase the inlet pressure to actuate the differential pressure device and record the pressure level at which the device actuates, then reduce the pressure to zero and, if necessary, manually reset the device. Repeat three times, then calculate the average of the four readings.

7.2.5 Increase the inlet pressure to about 85 % of the average actuation pressure determined in 7.2.5. Increase the pressure in increments of 5 kPa (0,05 bar) to 10 kPa (0,1 bar) and hold for 30 s ± 3 s at each increment. Continue increasing pressure until the device actuates and record the actuation pressure value on the report sheet.

For auto-reset type bypass indicators, increase the pressure to 50 kPa (0,5 bar) above the actuation pressure measured.

7.2.6 Decrease the pressure in increments of 5 kPa (0,05 bar) to 10 kPa (0,1 bar) and hold for 30 s ± 3 s at each increment until the device resets or the device can be manually reset, as required, and record the pressure value on the report sheet.

7.2.7 Repeat 7.2.5 and 7.2.6 twice more and record the average of the three readings as the actuation and reset pressure.

7.2.8 Verify that the device resets itself or can be manually reset. Failure to reset shall be cause for rejection.

7.3 Bypass valve condition signalling indicator test

7.3.1 Determine the bypass valve opening and closing pressures in accordance with ISO 3968.

7.3.2 Increase the bypass valve opening pressure determined in 7.3.1 and observe if the indicator correctly shows that the bypass valve opens. Record the indicator position on the report sheet.

7.3.3 Decrease the bypass valve opening pressure and observe if the indicator correctly shows that the bypass valve closes. Record the indicator position on the report sheet.

7.3.4 Verify that the indicator resets itself or can be manually reset. Failure to reset shall be cause for rejection.

7.4 Proof pressure test

7.4.1 Use the same device(s) tested in 7.1, 7.2 or 7.3.

7.4.2 Install the device into the filter housing or test block in accordance with the manufacturer's instructions.

7.4.3 Plug the test housing outlet and connect the pressure supply to the inlet. Slowly fill the housing, and bleed off all air.

7.4.4 Increase the inlet pressure to the device proof pressure value specified by the manufacturer and hold for 2 min. Record any leakage.

7.4.5 Reduce the inlet pressure to zero ($^{+5}_{0}$ %) and inspect the device for any deformation and record the result on the report sheet.

7.4.6 If the device being tested is a differential pressure device, repeat the differential pressure device actuation test described in either 7.1 or 7.2 and the device should actuate within the limits set by the manufacturer. If the device is a bypass valve condition signalling indicator, repeat the test described in 7.3.

7.4.7 If the device fails the actuation tests carried out in 7.4.6, it fails the proof pressure test.

7.5 Actuation cycle test

7.5.1 Use the same device(s) tested in 7.4.

7.5.2 Install the device and plug the filter port in accordance with 7.1, 7.2 or 7.3.

7.5.3 Cycle the device actuation pressure from 0 % ($^{+5}_{0}$ %) to 150 % (± 5 %) and back to 0 %. The rate of pressure rise shall be between 100 kPa/s and 500 kPa/s (1 bar/s and 5 bar/s). For manual reset type devices, the device shall be reset after each cycle. Subject the device to a minimum of 1 000 pressure cycles, or as specified. Record the test pressure and number of cycles on the report sheet.

7.5.4 If the device being tested is a differential pressure device, repeat the differential pressure device actuation test in either 7.1 or 7.2 and the device should actuate within the limits set by the manufacturer. If the device is a bypass valve condition signalling indicator, repeat the test in 7.3.

7.5.5 If the device fails the actuation test described in 7.5.4 it fails the actuation cycle test.

7.6 Thermal lockout test

7.6.1 Install the device in accordance with either 7.1, 7.2 or 7.3 and place the assembly in either a cold box or an environmental chamber. Provide a temperature measuring device at or near the device under test.

7.6.2 Stabilize the device at the manufacturer's stated temperature below which it should not actuate.

7.6.3 Apply a system pressure of 110 % to 120 % of the maximum differential pressure device actuation pressure determined in 7.1 or 7.2 or the bypass valve opening pressure determined in 7.3. Verify that the device did not actuate.

7.6.4 Gradually increase the temperature and stabilize at the temperature at which the device should actuate. Verify that the device actuates and record on the report sheet the temperature at which it actuates.

7.7 Optional additional electrical and electronic tests

It is recognized that many filter differential pressure devices contain electrical and electronic components that might need to be tested. Such tests measure or verify dielectric strength, insulation resistance and other electrical and electronic characteristics but these tests are beyond the scope of this International Standard. See the Bibliography for a list of standards that cover relevant test methods.

8 Test requirements

Each type of differential pressure device shall undergo testing in accordance with the requirements of Table 1

Table 1 — Typical test requirements for differential pressure devices

Test type [a]	Mechanical automatic, manual or gauge type	Electrical automatic, manual or gauge type	Mechanical bypass valve indicator	Electrical bypass valve indicator
Actuation pressure (7.1 or 7.2)	X	X	—	—
Bypass valve condition signalling (7.3)	—	—	X	X
Proof pressure (7.4)	X	X	X	X
Actuation cycle (7.5)	X	X	X	X
Thermal lockout (7.6)	X (if so equipped)	X (if so equipped)	X (if so equipped)	X (if so equipped)
Other electrical and electronic tests (7.7)	—–	X	—–	X

[a] The relevant subclause number is given in parentheses.

9 Marking

Differential pressure devices shall be marked with their actuation pressure. Electrical differential pressure switches shall be marked with their voltage and current ratings and, if appropriate, a wiring diagram.

10 Data presentation

Data from tests conducted in accordance with this International Standard shall be recorded on the report sheet in Table 2.

11 Identification statement (reference to this International Standard)

Use the following statement in test reports, catalogues and sales literature when electing to comply with the requirements of this International Standard:

"Differential pressure device characteristics determined in accordance with ISO 16860:2005, *Hydraulic fluid power — Filters — Test method for differential pressure devices.*"

Table 2 — Differential pressure device test data report sheet

Test laboratory: _____ Test date: _____ Operator: _____

Filter differential pressure device identification

Device type: _____ Part no.: _____ Serial No.: _____

Test conditions

Ambient temperature: _____ °C Test housing: _____ Filter port restriction: ☐ Plug ☐ Orifice

Installation torque: _____ N·m

Test medium: _____ Test medium temperature: _____ °C Test medium viscosity: _____ mm^2/s

Test results

Actuation pressure test

	Initial		After proof pressure test		After actuation cycle test	
	Increase	**Decrease**	**Increase**	**Decrease**	**Increase**	**Decrease**
Test 1	kPa	kPa	kPa	kPa	kPa	kPa
Test 2	kPa	kPa	kPa	kPa	kPa	kPa
Test 3	kPa	kPa	kPa	kPa	kPa	kPa
Average	kPa	kPa	kPa	kPa	kPa	kPa

Proof pressure test

Test pressure: _____ kPa Deformation? ☐ Yes ☐ No Leakage: _____ ml

Actuation cycle test

Test pressure: _____ kPa Number of cycles: _____

Thermal lockout test

Actuation temperature: _____ °C

Optional electrical tests

Annex A
(informative)

Typical types of differential pressure device used as filter accessories

Table A.1 — Types of differential pressure device

Signal type	Indicator	Actuation [a]	Reading type	Reset type
Visual (gauge)	Pointer	Progresses green to red or differential pressure	Continuous	Automatic
Visual (single stage)	Rod	Rod pops up	Signal only when differential pressure has been exceeded	Manual: push to reset, invert to reset or internal reset
Visual (multistage)	Rod	Rod pops up in progressive stages	Progressive colours from green or yellow to red	Manual
Electrical or visual electrical	Pointer or rod	Closes or opens circuit	Panel light or audible signal or equipment shutdown	Automatic or manual

[a] Available in some designs with a low temperature lockout.

Table A.2 — Types of bypass valve condition indicator

Signal type	Indicator	Actuation	Reading type	Reset type
Visual (gauge)	Pointer or coloured band	Progresses green to red	Continuous	Automatic or manual
Electrical or visual electrical	Pointer or rod	Closes or opens circuit	Panel light or audible signal or equipment shutdown	Automatic or manual