
International Standard



3968

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Hydraulic fluid power — Filters — Evaluation of pressure drop versus flow characteristics

Transmissions hydrauliques — Filtres — Évaluation de la perte de charge en fonction du débit

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Descriptors : fluid power, hydraulic fluid power, filters, oil filters, test, flow measurement, differential pressure, head losses.

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3968 was developed by Technical Committee ISO/TC 131, *Fluid power systems and components*, and was circulated to the member bodies in January 1981.

It has been approved by the member bodies of the following countries :

Austria	Germany, F. R.	Poland
Belgium	Hungary	Romania
Canada	India	Spain
China	Italy	Sweden
Czechoslovakia	Japan	United Kingdom
Finland	Netherlands	USA
France	Norway	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
South Africa, Rep. of

Hydraulic fluid power — Filters — Evaluation of pressure drop versus flow characteristics¹⁾

0 Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure in a closed circuit. One component of a hydraulic fluid power system is the filter which prevents certain contaminants from circulating in the system.

Hydraulic filters normally include a housing which serves as the pressure-containing vessel to direct the flow of fluid through a filter element which separates contaminants from the fluid.

In operation, fluid flowing through a filter meets resistance due to kinetic and viscous effects. The pressure required to overcome this resistance and to maintain flow is known as the pressure drop. Pressure drop is the total reduction in pressure from the housing inlet port to the outlet port and represents the sum of housing and filter element losses.

Factors which affect clean filter pressure drop are fluid viscosity, fluid specific gravity, flow rate, filter element medium and flow passages.

1 Scope and field of application

1.1 This International Standard specifies a procedure for evaluating the pressure drop versus flow characteristics of industrial oil hydraulic filters and provides a basis of agreement between the filter manufacturer and user.

1.2 Two standards of measurement are specified :

- a) Class A — For accurate evaluation for referee purposes — requiring laboratory conditions.
- b) Class B — For evaluation for general purposes — requiring test facilities less stringent than laboratory conditions.

1.3 This International Standard specifies the method of measuring the pressure drop across a hydraulic fluid filter under various conditions of flow.

2 References

ISO 1219, *Fluid power systems and components — Graphic symbols.*

ISO 2944, *Fluid power systems and components — Nominal pressures.*

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification.*

ISO 4411, *Hydraulic fluid power — Values — Method of determining pressure differential/flow characteristics.*²⁾

ISO 5598, *Fluid power systems — Vocabulary.*²⁾

3 Definitions

For the purposes of this International Standard, the following definitions apply. For definitions of other terms used, see ISO 5598.

3.1 filter rated flow : For a filter under test, the flow rate recommended by its manufacturer at a specified kinematic viscosity.

3.2 viscosity index : An empirical measure of the viscosity temperature characteristics of a fluid. When the variation is small, the index is high.

4 Symbols

The following symbols are used in this International Standard :

- a) q_V is the volume flow rate;
- b) p_1 is the pressure measured at the inlet side of the filter;
- c) p_2 is the pressure measured at the outlet side of the filter;
- d) Δp is the pressure drop across the filter ($\Delta p = p_1 - p_2$).

1) As ISO 4411 concerns the subject of pressure measurement, this International Standard will be updated by means of a revision on publication of the former.

2) At present at the stage of draft.

5 Graphical symbols

Graphical symbols used are in accordance with ISO 1219.

6 Test equipment

When conducting pressure drop versus flow rate measurements on a filter, it is not necessary to have a test rig with a high system pressure. It is sufficient to maintain p_2 at a positive gauge pressure. A suitable test rig is one consisting of a pump, a reservoir, a clean-up filter, the filter under test and, if necessary, a heat exchanger, together with the necessary devices for measuring pressure, flow and temperature (see clause 7). Figure 1 shows a typical test rig in schematic form.

6.1 Pump

Use a pump with a flow rate equal to or greater than the maximum flow rate required to be passed through the filter under test. Use pump delivery pressure which is adequate to pump this flow through the test filter as well as through the clean-up filter and the remainder of the rig. Provide a means of continuously varying the flow rate from zero to its maximum, either embodied within the pump or by an external bypass control. Provide for the suppression of pressure ripples, if necessary, to ensure that pressure readings may be made with the required accuracy.

6.2 Reservoir

Use a reservoir of a size suited to the pump and designed to minimize air entrainment and the ingress of airborne contamination.

6.3 Temperature control

Provide suitable means for measurement and control of temperature.

6.4 Clean-up filter (see figure 1)

Use a clean-up filter with an efficiency of particle removal equal to or higher than that of the filter under test so that there can be no measurable increase in pressure drop across the latter due to partial blocking. Use a clean-up filter capable of passing the maximum flow rate of the filter under test.

6.5 Mounting of filter (see figure 1)

Mount the filter in the test rig in the attitude in which it is normally to be used. Use the correct size(s) of standard union(s) to connect the filter. Use pipes between the filter and the pressure measuring points which have substantially the same internal diameters as the unions.

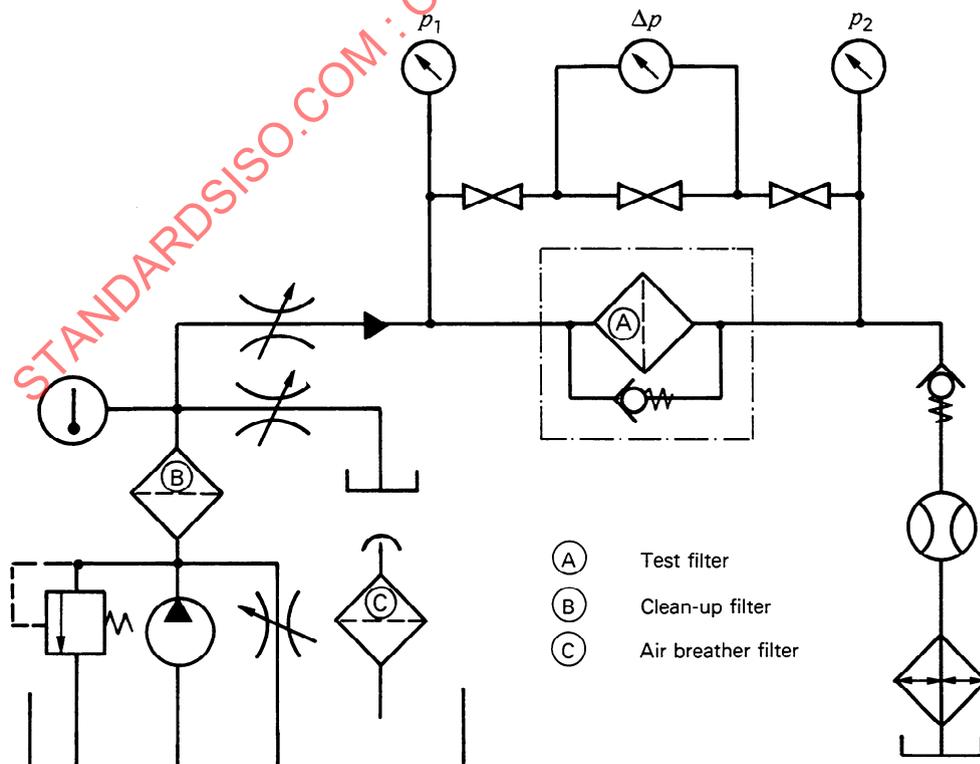


Figure 1 — Example of a test circuit suitable for the measurement of pressure drop and flow rate

6.6 Fluid

Use the filter rated flow recommended by the manufacturer at a specified kinematic viscosity for a filter fitted with a clean element to produce a specified pressure drop across the filter using a fluid at a specified kinematic viscosity. Carry out the test procedure given in this International Standard using a petroleum base fluid with the following characteristics :

- a) a viscosity grade of VG 32 (see ISO 3448);
- b) a viscosity index of 95 or higher;
- c) a mass density of 850 to 900 kg/m³;^{*}
- d) designated system fluid where required.

7 Measurement

7.1 Pressure measurement

Measure pressure by means of a pressure gauge, manometer or any other device that will satisfy the accuracies given below. Use Bourdon tube pressure gauges which conform to International Standards. Fit straight lengths of pipe as specified in 6.5 immediately upstream and immediately downstream of the filter. Place pressure tapings at five times the internal pipe diameter upstream and ten times the internal pipe diameter downstream of the filter ports. Take the mean reading of any fluctuating pressure. Fill the pipes connecting the pressure measuring device to the tapping points with rig fluid. Use the following tolerances for accuracy of measurement :

Class A : $\pm 1\%$

Class B : $\pm 3\%$

7.2 Temperature measurement

Measure the temperature of the fluid upstream of the filter by a thermometer immersed either directly in the fluid stream or in a pocket immersed in the fluid stream. Record the temperature. Control the temperature upstream of the filter so that the viscosity is maintained within the following limits :

Class A : $\pm 5\%$

Class B : $\pm 10\%$

7.3 Kinematic viscosity and density measurement

Measure the viscosity and the density in accordance with the relevant national standard for Class A and report the measuring technique used. For class B, the date and viscosity and density provided by the fluid supplier are adequate.

7.4 Flow measurement

Use a flow meter, or flow meters, capable of measuring the full flow rate range of the filter under test with the following tolerances for accuracy of measurement :

Class A : $\pm 2\%$

Class B : $\pm 5\%$

8 Test procedure

8.1 Pressure drop versus flow rate

Set the flow rate q_V at the filter rated flow and allow to run for several minutes. Bleed the system as necessary to minimize the air entrained in the entire circuit. After initial running and bleeding, increase the flow and take readings of p_1 and p_2 for increasing values of q_V in at least ten equal increments from zero to a minimum of 1,2 times the filter rated flow. Repeat the procedure for decreasing values of q_V . Take the average of the ascending and descending sets of results. Calculate and record Δp .

8.2 Integral bypass valve

Obtain the following three sets of data for pressure drop versus flow rate when the filter under test has an integral bypass valve :

- a) with the bypass valve free to operate;
- b) with the bypass valve fixed in its closed position;
- c) with the element blocked and the bypass valve free to operate.

The test with blocked element and valve free to operate (c) gives the leakage rate of the valve up to the Δp at which the valve opens. Beyond this point, the value measured is the flow rate versus Δp for the valve.

The downstream connection to the filter may be disconnected to allow precise measurement of valve leakage rate by means of a calibrated measuring cylinder. Record the leakage rate on the final results graph at 25 %, 50 % and 75 % of the pressure differential at which the valve opens (see figure 2).

8.3 Filter housing

When it is required to know the pressure drop versus flow rate characteristics of the filter housing, repeat the test by the method given in 8.1 with the filter element removed from the filter housing.

* Specific gravity = 85 to 90 %

If the complete removal of the filter element from the filter housing may give rise to cyclonic or other unusual flow conditions, use a substitute element giving an insignificant pressure drop. Use a substitute element such that the flow path is maintained identical, as nearly as is practicable, to that of the actual element but with a large open area as compared to the actual filter element to minimize viscous pressure drop. Provide details of the substitute element with the results.

8.4 Rig correction

Subtract a correction from the values of Δp obtained from the tests specified in 8.1, 8.2 and 8.3 to allow for the pressure differential of the portions of the test rig between the pressure measuring points. Remove the filter, or filter housing, from the test rig. Join the two unions used to connect it in such a way that they are in concentric contact.

NOTE — A convenient way of joining externally threaded unions of equal size is to use a short length of internally threaded pipe. A

specially prepared connector is necessary for unions of unequal size or of a special pattern.

Obtain a further set of pressure drop versus flow rate data for this assembly and record.

For any given flow rate, the true pressure drop is obtained by subtracting the value of Δp measured in 8.4 from the values of Δp measured in 8.1, 8.2 and 8.3.

9 Presentation of results

Present the results as shown in the table. Plot the results as true values of Δp against q_V as shown in figure 2.

State clearly any deviation from the specified method.

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Table – Typical reporting method

Testing establishment Date Test Test No.

Filter description

Manufacturer's recommended rated flow l/min

Integral by-pass valve None Free to operate Locked closed Free to operate (element blocked)

Substitute element (description) Not used

Class of standard of measurement A B

Test fluid : Make and type Test temperature °C

Density at test temperature kg/m³ Kinematic viscosity at test temperature mm²/s *

Flow**	Filter complete				Filter housing only				Rig correction				Additional data
	Temperature °C	p ₁ bar*** or kPa	p ₂ bar or kPa	Δp bar or kPa	Temperature °C	p ₁ bar or kPa	p ₂ bar or kPa	Δp bar or kPa	Temperature °C	p ₁ bar or kPa	p ₂ bar or kPa	Δp bar or kPa	
0,2 q _V													
0,4 q _V													
0,6 q _V													
0,8 q _V													
1,0 q _V													
1,2 q _V													
1,0 q _V													
0,8 q _V													
0,6 q _V													
0,4 q _V													
0,2 q _V													

* 1 mm²/s = 10⁻⁶ m²/s = 1 cSt

** The flow values are suggestions – the values of the flow may be modified in accordance with the requirements of test procedure (see clause 8).

*** 1 bar = 100 kPa = 10⁵ N/m²

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Testing establishment Date Test Test No.

Filter description

Manufacturer's recommended rated flow l/min

Integral by-pass valve None Free to operate Locked closed Free to operate (element blocked)

Substitute element (description) Not used

Class of standard of measurement A B

Test fluid : Make and type Test temperature °C

Density at test temperature kg/m³ Kinematic viscosity at test temperature mm²/s

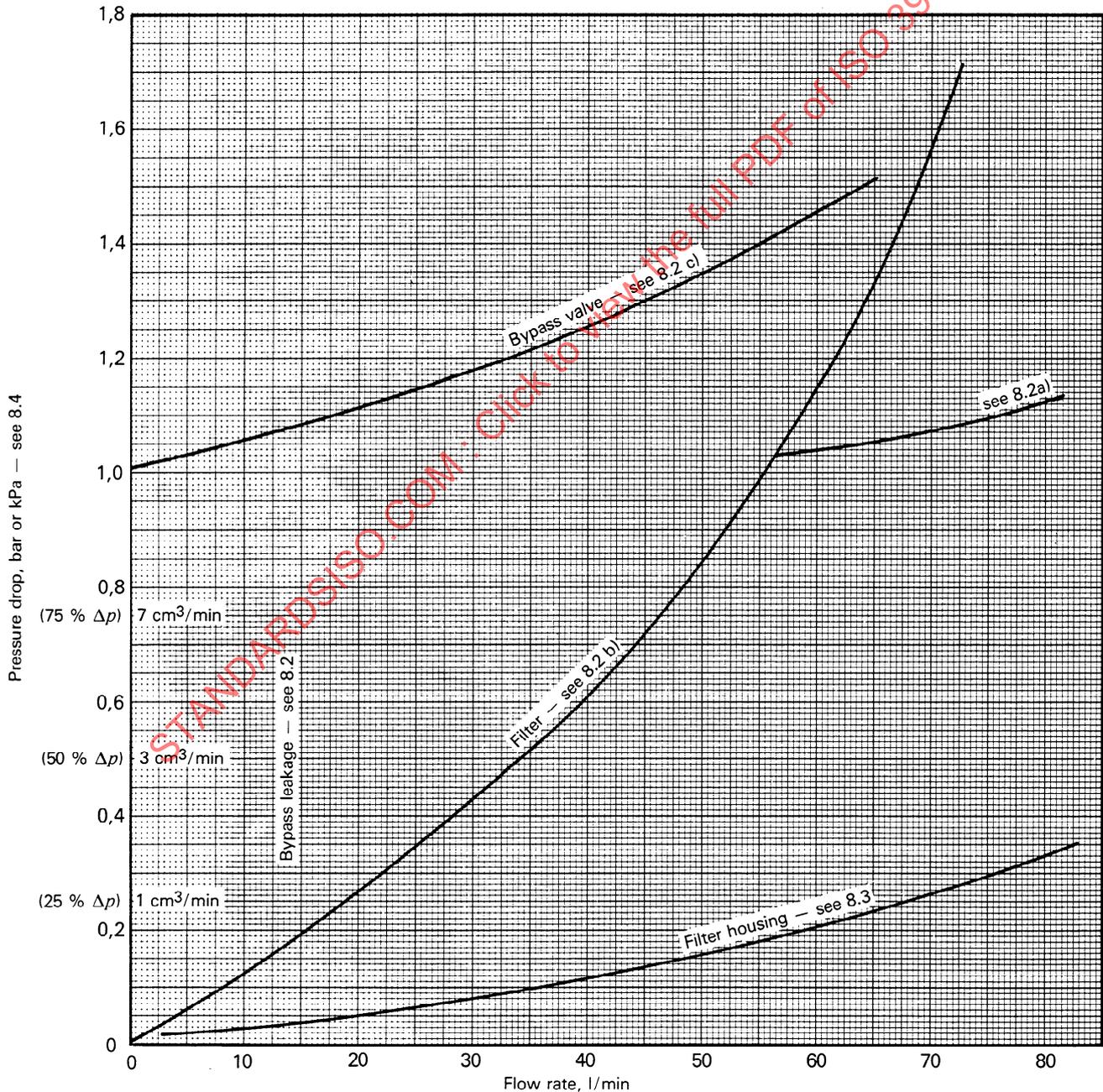


Figure 2 – Typical presentation of pressure drop versus flow rate curves and bypass leakage rates for a filter with an integral bypass valve

10 Identification statement (Reference to this International Standard)

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

"Evaluation of pressure drop versus flow characteristics conforms to ISO 3968, *Hydraulic fluid power — Filters — Evaluation of pressure drop versus flow characteristics.*"

Bibliography

The following document served as a reference in the preparation of this International Standard and will be helpful in its utilization :

ISO 2944, *Fluid power systems and components — Nominal pressures.*

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