

Valves for hydraulic fluid power systems —

Part 1: Methods for determining pressure differential/flow characteristics

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Foreword

This revised British Standard, prepared under the direction of the Mechanical Engineering Standards Committee, deals with the testing of valves used in hydraulic fluid power systems. This Part of this standard, together with BS 4062-2, supersede BS 4062:1966, which is withdrawn.

This Part 1 of this standard describes methods for determining the pressure differential flow characteristics of valves under steady-state conditions. It corresponds to the methods described in the latest proposals (ISO/DIS 4411¹⁾) under consideration by Technical Committee ISO/TC 131 of the International Organization for Standardization (ISO). For this reason, the standard is published in two Parts; Part 2 describes methods for determining the performance of valves under steady state and dynamic conditions.

Three classes of accuracy A, B and C, are associated with the determination and are related as detailed in Appendix A. The class of accuracy should be agreed between manufacturer and user. It is expected that the methods of measurement used for testing the majority of valves will be those included in class C. The methods of measurement in class B may be employed where a higher degree of accuracy is required. Class A methods of measurement will necessitate laboratory conditions, and may be employed exceptionally on tests where the attainment of high accuracy is held to justify the greatly increased time and cost expended.

Methods for presenting the test results are described. In order to facilitate performance comparisons and eliminate known variables, such as the viscosity and temperature of the operating medium, a non-dimensional basis has been selected for appropriate types of test.

It is hoped that the standard will unify testing methods and enable the performance of different types of valve to be more readily compared.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

¹⁾ In course of preparation.

1 Scope

This Part of this British Standard describes methods for determining under steady-state conditions, the pressure differential/flow characteristics caused by the flow through any given path in a hydraulic fluid power valve.

Requirements for test installations and methods for presenting results are included. The standard does not establish how closely production unit performance complies with specification requirements, nor specifies which performance characteristics should be checked during a production test.

Accuracy of measurement is divided into three classes, A, B and C, which are explained in Appendix A, and methods of calculating pipe loss are described in Appendix B.

Guidance in the use of practical units for the presentation of results is given in Appendix C. Appendix D provides a pretest checklist of those items where agreement is necessary between the parties concerned.

NOTE The titles of the publications referred to in this standard are given on the inside back cover.

2 Definitions

For the purposes of this standard, the following definitions, together with those given in BS 5775 for quantities and units, apply.

2.1

flow (Q)

the volume rate of flow at the point of measurement

NOTE See 4.1.11.

2.2

fluid velocity, pipe related (v)

the mean velocity of the fluid based upon the flow Q and pipe internal diameter d

2.3

fluid velocity, valve related (u)

the mean velocity of the fluid based upon the flow Q and nominal diameter of the valve D

2.4

friction factor (λ)

a coefficient used in non-dimensional presentation of pipe loss

NOTE See Appendix B.

2.5

loss coefficient (K)

a coefficient used in non-dimensional presentation of valve loss, and defined by the expression

$$K = \frac{2\Delta p}{\rho u^2}$$

2.6

pipe length (l)

the sum of the pipe lengths between the upstream and downstream pressure-tapping points

2.7

pressure differential (Δp)

the pressure loss attributed to the valve

NOTE See 5.5.

2.8

nominal diameter of valve (D)

the manufacturer's value of the nominal diameter of the valve

2.9

Reynolds number (Re)

a dimensionless quantity defined by the expressions

$$Re = \frac{uD}{\nu} \text{ (valve related)}$$

$$Re = \frac{vd}{\nu} \text{ (pipe related)}$$

3 Symbols and units

The units and symbols used in this standard are as given in Table 1.

4 Test installations

4.1 Test circuits

4.1.1 Use a circuit for testing valves similar to that shown in Figure 1.

NOTE 1 Figure 1 is a basic circuit that does not incorporate all the safety devices necessary to protect against damage in the event of any component failure. It is important that those responsible for conducting the test give consideration to safeguarding personnel and equipment.

NOTE 2 The graphical symbols used in Figure 1 to Figure 5 are in accordance with BS 2917.

4.1.2 Use a fluid supply with a controllable flow.

4.1.3 Install a relief valve in the supply line to protect the circuit from excessive pressures.

4.1.4 To establish a steady flow pattern at the upstream pressure tapping, ensure that the length of pipe upstream of that tapping is in accordance with the following.

- a) For class A accuracy of measurement, use a visibly straight, uniform bore pipe length of 50 times its inside diameter.

- b) For class B or C accuracy of measurement, use a visibly straight, uniform bore pipe length at least 10 times its inside diameter.

4.1.5 For all classes of accuracy of measurement, use a visibly straight, uniform bore pipe length of five times its inside diameter between the upstream pressure tapping and the valve.

4.1.6 To ensure adequate pressure recovery, use a visibly straight, uniform bore pipe length of 10 times its inside diameter between the valve and the downstream pressure tapping.

4.1.7 Use a visibly straight, uniform bore pipe length of five times its inside diameter between the downstream pressure tapping and the temperature-measuring point.

4.1.8 Use a visibly straight, uniform bore pipe length of five times its inside diameter downstream of the temperature-measuring point.

4.1.9 Use pipes and fittings consistent with the nominal diameter of the valve.

4.1.10 Mount all pipes in the horizontal plane; if this is not possible, apply a correction factor to the measured pressures.

4.1.11 Install a flow meter to measure the rate of flow at a point downstream of the pipe length described in 4.1.8.

4.2 Pressure-tapping points

4.2.1 For class A accuracy of measurement, use static pressure-measuring connections that consist of a piezometer ring having:

- a) two equally spaced tappings, if the pipe inside diameter is equal to or less than 6 mm;
- b) three or more equally spaced tappings, if the pipe inside diameter is greater than 6 mm.

Interconnect the tappings and the measuring device with one lead.

4.2.2 For classes B and C, use single pressure tappings or those described in 4.2.1.

4.2.3 Ensure that the centreline of the tappings intersect the pipe centreline and are normal to it.

4.2.4 Ensure that no tappings are installed on the lowest point of the pipe.

4.2.5 Use pressure tappings having identical diameters equal to or less than $0.1d$, but not less than 1 mm nor greater than 6 mm.

4.2.6 Ensure that the length of a pressure-tapping hole is not less than twice its diameter.

4.2.7 Ensure that the connecting lead to the pressure-measuring device has a cross-sectional area of not less than half the total area of the tapping holes.

4.3 Filtration

4.3.1 Install a filter that provides a standard of filtration approved by the valve manufacturer.

4.3.2 State in the test report the position and specific description of each filter used in the test circuit.

5 Test procedure

5.1 Test fluid

5.1.1 Use and state in the test report the test fluid approved by the manufacturer of the valve when conducting the test.

5.1.2 For classes A and B accuracy of measurement, measure the kinematic viscosity ν and the mass density ρ from fluid samples taken from the test installation immediately before the test.

5.1.3 For class C accuracy of measurement, either measure the kinematic viscosity and mass density (see 5.1.2) or use the viscosity and density data obtained from the fluid supplier.

5.1.4 State in the test report the kinematic viscosity ν and the mass density of the fluid ρ for the range of temperatures used in the test.

5.2 Temperatures

5.2.1 When a non-dimensional presentation is required [see 6.2 a)], there is no requirement for the complete test to be conducted at one controlled temperature, but for each test condition the temperature shall be controlled within the limits given in Table 2.

5.2.2 When a dimensional presentation is required [see 6.2 b)] and the test is to be conducted with one stated fluid at one temperature, control the temperature during the test within the limits given in Table 2.

5.2.3 Perform the tests within the range of fluid temperatures recommended by the valve manufacturer for the intended application of the valve.

5.3 Steady-state conditions

5.3.1 Record all readings only after steady-state conditions are reached.

5.3.2 When steady-state test conditions are reached, take only one set of readings of individual quantities over concurrent equal time periods. Record each reading as the mean value of each quantity being measured.