

Method for

Determination of flow-rate characteristics of pneumatic fluid power components

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Machinery and Components Standards Policy Committee (MCE/-) to Technical Committee MCE/18 upon which the following bodies were represented:

- Advanced Manufacturing Technology Research Institute
- Association of British Mining Equipment Companies
- Bath University Library
- British Compressed Air Society
- British Fluid Power Association
- British Steel Industry
- Department of Trade and Industry (National Engineering Laboratory)
- Electricity Supply Industry in England and Wales
- Health and Safety Executive
- Institution of Mechanical Engineers
- Ministry of Defence

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- British Hydromechanics Research Association
- British Railways Board
- Society of Motor Manufacturers and Traders Limited

This British Standard, having been prepared under the direction of the Machinery and Components Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 29 June 1990

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National foreword

This British Standard has been prepared under the direction of the Machinery and Components Standards Policy Committee. It is identical with ISO 6358:1989 “*Pneumatic fluid power — Components using compressible fluids — Determination of flow-rate characteristics*”, published by the International Organization for Standardization (ISO).

Cross-references

International Standard	Corresponding British Standard
ISO 228-1:1982	BS 2779:1986 <i>Specification for pipe threads for tubes and fittings where pressure-tight joints are not made on the threads (metric dimensions)</i> (Technically equivalent)
ISO 261:1973	BS 3643 <i>ISO metric screw threads</i> Part 1:1981 <i>Principles and basic data</i> (Technically equivalent)

The Technical Committee has reviewed the provisions of ISO 5598:1985, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A British Standard related to ISO 1179:1981 is BS 4368 “*Compression couplings for tubes*” Part 3:1974 “*Specification for light series couplings (metric)*”.

Additional information. For the purposes of this British Standard the identification statement specified in clause 8 should read as follows: “Test for the determination of flow-rate characteristics complies with BS 7294:1990”.

Power is transmitted and controlled in pneumatic fluid power systems through a gas under pressure within a circuit. Components composing such a circuit are inherently resistive and affect the flow through it. It is therefore necessary to carry out tests to ascertain the characteristics of these components in order to determine their suitability for use within a circuit. Many components composing a pneumatic circuit operate under conditions of choked flow. This International Standard specifies tests at choked flow in recognition of these conditions.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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 Scope

This International Standard specifies a method for testing pneumatic fluid power components which use compressible fluids, i.e. gases, to enable their flow-rate characteristics under steady-state conditions to be compared.

It specifies requirements for the test installation, the test procedure and the presentation of results.

Accuracy of measurement is divided into two classes (A and B) which are explained in Annex A.

General background information is given in Annex B and the basic theoretical equations are given in Annex C. Guidance as to the use of practical units for the presentation of results is given in Annex D.

This International Standard generally applies to those fluid power components up to and including 20 mm nominal bore used with compressible fluids (gases), the internal flow passages of which remain constant during testing. Examples of such components are

- a) directional control valves, flow control valves, quick exhaust valves, etc.;
- b) moving part logic devices.

It may also apply to components larger than 20 mm nominal bore but this may require the provision of exceptionally large flow generating equipment.

Two test methods are described according to the type of component. There are also two sets of characteristic constants: C and b ; and A and s , respectively (as defined in 3.2 to 3.5). These may be calculated from the results.

The first set of characteristics (C and b) applies to cases where comparison of similar components is required, or when calculations of pressure and flow involve a single component only.

The second set of characteristics (A and s) is necessary when the flow behaviour of several components which are connected in series is to be estimated. This set may also be used as an optional alternative to the first set for simple flow calculations and for comparison of components.

This International Standard does not apply to components which exchange energy with the fluid (gas), for example cylinders, accumulators, etc.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid.

All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 228-1:1982, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Designation, dimensions and tolerances.*

ISO 261:1973, *ISO general purpose metric screw threads — General plan.*

ISO 1179:1981, *Pipe connections, threaded to ISO 228-1, for plain end steel and other metal tubes in industrial applications.*

ISO 5598:1985, *Fluid power systems and components — Vocabulary.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5598 and the following definitions apply. It should be borne in mind, however, that the following definitions may differ from those given in other specific International Standards.

3.1 choked flow

occurrence when upstream pressure, p_1 , is high in relation to the downstream pressure, p_2 , such that the velocity in some part of the component becomes sonic. The mass flow of the gas is proportional to the upstream pressure, p_1 , and independent of the downstream pressure, p_2

3.2 critical pressure ratio, b

pressure ratio (p_2/p_1) below which flow becomes choked

3.3 sonic conductance, C

mass flow rate through the component, q_m^* , divided by the product of the upstream pressure, p_1 , and the mass density at standard conditions ρ_0 (see Table 2) when the flow is choked, i.e.

$$C = \frac{q_m^*}{\rho_0 p_1} \text{ at } T = T_0$$

NOTE The numerical value of C depends upon the values chosen for the standard reference atmosphere.

3.4**coefficient of compressibility effect, s**

coefficient which takes into account the effects of the gas compressibility when flow is subsonic (see D.2.3)

3.5**effective area, A**

mass flow rate throughout the component, q_m , divided by the square root of twice the product of the pressure drop, Δp , and the mass density of the gas ρ_2 , i.e.

$$A = \frac{q_m}{\sqrt{2 \rho_2 \Delta p}}$$

this applies only when the pressure drop is small in relation to p_1 such that compressibility effects are insignificant, i.e. when $\Delta p/p_1 < 0,02$

4 Symbols and units

4.1 The symbols and units used throughout this International Standard are as shown in Table 1.

4.2 The numerals used as subscripts and the asterisk (*) used as a superscript to the symbols listed in Table 1 are as specified in Table 2.

4.3 The graphical symbols used in Figure 1 and Figure 2 are in accordance with ISO 1219.

5 Test installation**5.1 Test circuit for components with inlet and outlet ports**

A suitable test circuit as shown in Figure 1 shall be used.

5.2 Test circuit for components which exhaust directly to atmosphere

A suitable test circuit as shown in Figure 2 shall be used.

NOTE Figure 1 and Figure 2 illustrate basic circuits which do not incorporate all the safety devices necessary to protect against damage in the event of component failure. It is important that those responsible for carrying out the test give due consideration to safeguarding both personnel and equipment.

Table 1 — Symbols and units

Reference	Description	Symbol	Dimension ^a	SI units ^b
3.5	Effective area	A	L^2	m^2
3.2	Critical pressure ratio	b	pure number	
3.3	Sonic conductance	C	$L^4 T M^{-1}$	$s \, m^4/kg$
—	Absolute static pressure (equal to the relative static pressure plus the atmospheric pressure)	p	$M L^{-1} T^{-2}$	Pa^c
—	Mass flow rate	q_m	$M T^{-1}$	kg/s
—	Volume flow rate at standard conditions	q_v	$L^3 T^{-1}$	m^3/s
—	Gas constant (for a perfect gas)	R	$L^2 T^{-2} \Theta^{-1}$	$J/(kg \, K)$
3.4	Coefficient of compressibility effect	s	pure number	
—	Absolute temperature	T	Θ	K
—	Pressure drop ($p_1 - p_2$)	Δp	$M L^{-1} T^{-2}$	Pa^c
—	Mass density	ρ	$M L^{-3}$	kg/m^3

^a M = mass; L = length; T = time; Θ = temperature

^b The use of practical units for the presentation of results is described in Annex D.

^c 1 Pa = 1 N/m²