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Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids —

Part 2: General rules

Transmissions pneumatiques — Détermination des caractéristiques de débit des éléments traversés par un fluide compressible —

Partie 2: Règles générales

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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.

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ISO 6358-2 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

This second edition cancels and replaces the first edition (ISO 6358:1989), which has been technically revised.

ISO 6358 consists of the following parts, under the general title *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluid*:

— *Part 1: General rules for components with internal flow passages that are fixed*

— *Part 2: General rules*

— *Part 3: Alternative test methods — Discharge test*

— *Part 4: Alternative test methods — Charge test*

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Introduction

In pneumatic fluid power systems, power is transmitted and controlled through a gas under pressure within a circuit.

Components that make up such a circuit are inherently resistive and affect the flow rate through it. It is therefore necessary to carry out tests to ascertain the characteristics of these components in order to determine their suitability.

Many components that make up a pneumatic circuit operate under conditions of choked flow. This part of ISO 6358 specifies tests at choked flow in recognition of these conditions and is intended to test and present flow-rate characteristics of a wider range of pneumatic fluid power components by more accurate and standardized methods.

Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids —

Part 2:
General rules

1 Scope

This part of ISO 6358 specifies a method for testing pneumatic fluid power components that use compressible fluids, i.e. gases, and that have internal flow passages that can be either fixed or variable. This part of ISO 6358 does not apply to components that exchange energy with the fluid during flow rate measurement, e.g., cylinders, accumulators, etc. It specifies requirements for the test installation, the test procedure and the presentation of results. It also specifies a method for analysing the test results to enable the comparison of their flow-rate characteristics under steady-state conditions.

Accuracy of measurement is divided into two classes (A and B), which are explained in Annex A. Guidance as to the use of practical units for the presentation of results is given in Annex C. Characteristic presentation equations and background information of the pneumatic fluid power components are given in Annexes B, D and F. Guidance as to the calculation of flow rate characteristics is given in Annex E.

The contents of normative references, terms and definitions, symbols and units, test installation, errors and classes of measurement accuracy and use of practical units are common to those for part 1 of ISO 6358.

This part of ISO 6358 applies to the following components:

a) directional control valves, such as solenoid valves and non-return (check) valves;

b) flow control valves, such as speed control valves;

c) quick-exhaust valves;

d) air filters and pneumatic exhaust silencers;

e) piping components, such as connectors and flexible tubes;

f) combined components, such as valve manifolds and cylinder end heads; and

g) other devices and combined systems that have inlet and exhaust ports.

This part of ISO 6358 does not apply to components whose flow coefficient is unstable during use (i.e., those that exhibit hysteretic behaviour or have an internal feedback phenomenon).

This part of ISO 6358 describes four sets of characteristic parameters: C, b, m, and Δp_c; these may be calculated from the test results. The sonic conductance, C, represents the choked flow rate. The critical pressure ratio, b, represents the range of choked flow. The subsonic index, m, is the characteristic index, which represents the conditions of flow rate in a component such as variable orifice. The parameter Δp_c, is the cracking pressure of a non-return (check) valve or similar component.

For testing an installation with a large nominal bore or to shorten testing time or to reduce energy consumption, it is desirable to apply the methods specified in part 3 of ISO 6358, which covers alternative discharge test methods, or part 4 of ISO 6358, which covers an alternative charge test method.

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

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

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 5598[1)], *Fluid power systems and components — Vocabulary*

ISO 6358-1, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 1: General rules for components with internal flow passage that are fixed*

ISO 6358-3, *Pneumatic fluid power — Components using compressible fluids — Determination of flow-rate characteristics — Part 3: Alternative test methods — Discharge test*

ISO 6358-4, *Pneumatic fluid power — Components using compressible fluids — Determination of flow-rate characteristics — Part 4: Alternative test methods — Charge test*

ISO 8778, *Pneumatic fluid power — Standard reference atmosphere*

ISO 14743:2004, *Pneumatic fluid power — Push-in connectors for thermoplastic tubes*

ISO 16030, *Pneumatic fluid power — Connections — Ports and stud ends*

3 Terms and definitions

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

NOTE The mass flow rate of the gas is proportional to the upstream pressure, p_1, and independent of the downstream pressure, p_2.

3.2
subsonic flow
flow whose velocity is lower than local speed of sound

3.3
critical pressure ratio, *b*
pressure ratio (p_2/p_1) below which flow becomes choked

1) Under revision.

3.4
sonic conductance, *C*
ratio of volume flow rate, q_v*, and upstream pressure, p_1^*, at T_0

3.5
subsonic index, *m*
index for expressing the characteristic function of the mass flow rate, q_m*, and the pressure ratio, p_2/p_1, in the subsonic flow range

3.6
cracking pressure, Δp_c
differential pressure between upstream and downstream pressures, when mass flow-rate, q_m becomes 0 after gradually reducing flow rate in the component under test

4 Symbols and units

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

Table 1 — Symbols and units

Reference	Description	Symbol	Dimension [a]	SI unit [b]
3.3	Critical pressure ratio	b	pure number	
3.4	Sonic conductance	C	L^4TM^{-1}	$s{\cdot}m^4/kg$
3.5	Subsonic index	m	pure number	
-	Absolute static pressure	p	$ML^{-1}T^{-2}$	Pa [c]
-	Mass flow rate	q_m	MT^{-1}	kg/s
-	Volume flow rate at standard reference conditions	q_v	L^3T^{-1}	$m^3/s(ANR)$
-	Gas constant (for a perfect gas)	R	$L^2T^{-2}\Theta^{-1}$	$J/(kg{\cdot}K)$
-	Absolute temperature	T	Θ	K
3.6	Cracking pressure	Δp_c	$ML^{-1}T^{-2}$	Pa [c]
-	Mass density	ρ	ML^{-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 C.

[c] 1 Pa = 1 N/m^2

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

Table 2 — Subscripts and superscripts

Superscript	Subscript	Meaning
	0	Standard reference conditions defined in ISO 8778, i.e.: T_0 = 293,15 K; p_0 = 100 kPa (1 bar [a]); ρ_0 = 1,185 kg / m^3; 65% relative humidity
	1	Upstream conditions
	2	Downstream conditions
*		Conditions during sonic flow tests

[a] 1 bar = 100 kPa = 0,1 MPa; 1 Pa = 1 N/m^2

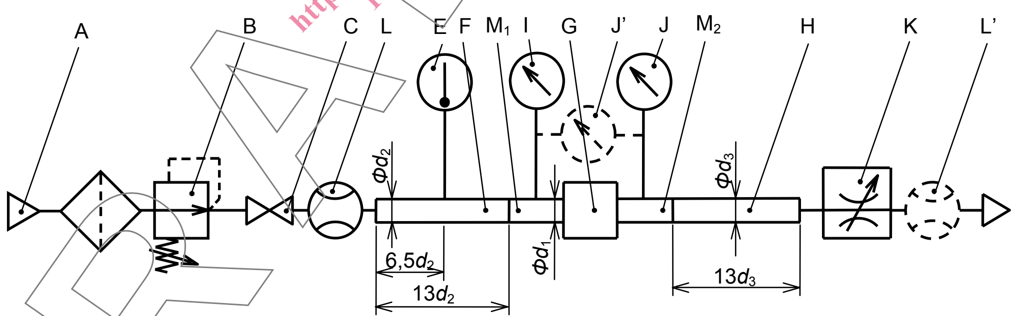
4.3 The graphical symbols used in Figures 1 and 2 are in accordance with ISO 1219-1.

5 Test installation

NOTE Figures 1 and 2 illustrate basic circuits that 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.

5.1 Test circuit for in-line test

If pressure-measuring tubes are connected on the upstream and downstream sides of the component under test, a suitable test circuit as shown in Figure 1 shall be used.

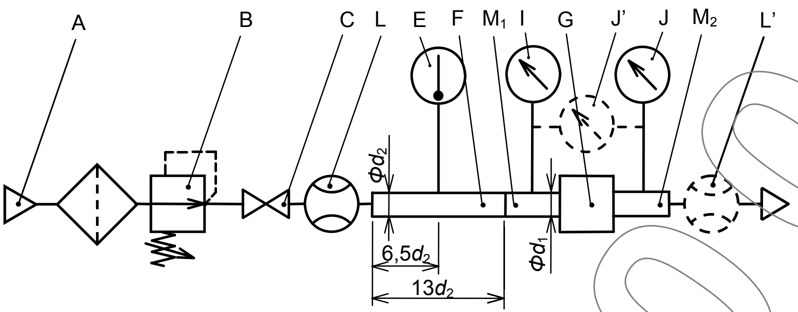


NOTE See Table 3 for the key to test circuit components.

Figure 1 — Test circuit for in-line test

5.2 Test circuit for exhaust-to-atmosphere test

If the component under test exhausts directly to atmosphere on its downstream side, a suitable test circuit as shown in Figure 2 shall be used



NOTE See Table 3 for the key to test circuit components.

Figure 2 — Test circuit for exhaust-to-atmosphere test

Table 3 — Key to test circuit components shown in Figures 1 and 2

Reference letter	Relevant subclause	Description	Comments
A	5.3.2	Compressed gas source and filter	
B	-	Adjustable pressure regulator	
C	-	Shut-off valve	Preferably with straight path
E	-	Temperature-measuring instrument	Sensor located on axis of F
F	5.4	Upstream rectifier tube	
G	-	Component under test	
H	5.4	Downstream rectifier tube	
I	-	Upstream pressure gauge or transducer	
J	-	Downstream pressure gauge or transducer	Alternative a differential pressure gauge or transducer, J', may be used.
K	-	Flow control valve	To have a flow-rate capacity greater than the component under test
L	-	Flow-rate measuring device	May also be placed in position L' (i.e. downstream of K.
M_1	5.5	Upstream pressure-measuring connector	Apply to tube or thread connector
M_2	5.5	Downstream pressure-measuring connector	Apply to tube or thread connector

5.3 General requirements

5.3.1 The component under test shall be installed and operated in the test circuit in accordance with the manufacturer's operating instructions.

5.3.2 A filter shall be installed which provides a standard of filtration specified by the manufacturer of the component under test.

