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

Part 2: Alternative test methods

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

Partie 2: Méthodes d'essai alternatives

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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

This first edition of ISO 6358-2, together with ISO 6358-1 and ISO 6358-3, cancels and replaces ISO 6358:1989, which has been technically revised. However, ISO 6358-2 and ISO 6358-3 are new standards whose scopes were not included in ISO 6358:1989.

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

— *Part 1: General rules and test methods for steady-state flow*

— *Part 2: Alternative test methods*

— *Part 3: Method for calculating steady-state flow-rate characteristics of assemblies*

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 to the flow of the gas and it is necessary, therefore, to define and determine the flow-rate characteristics that describe their performance.

ISO 6358:1989 was developed to determine the flow-rate characteristics of pneumatic valves, based upon a model of converging nozzles. The method included two characteristic parameters: sonic conductance, C, and critical pressure ratio, b, used in a proposed mathematical approximation of the flow behaviour. The result described flow performance of a pneumatic valve from choked flow to subsonic flow, based on static pressure. This new edition uses stagnation pressure instead, to take into account the influence of flow velocity on the measurement of pressures.

Experience has demonstrated that many pneumatic valves have converging–diverging characteristics that do not fit the ISO 6358:1989 model very well. Furthermore, new developments have allowed the application of this method to additional components beyond pneumatic valves. However, this now requires the use of four parameters (C, b, m, and Δp_c) to define the flow performance in both the choked and subsonic flow regions.

This part of ISO 6358 describes a set of three flow-rate characteristic parameters determined from test results. These parameters are described as follows and are listed in decreasing order of priority:

— The sonic conductance, C, corresponding to the maximum flow rate (choked) is the most important parameter. This parameter is defined by the upstream stagnation conditions.

— The critical back-pressure ratio, b, representing the boundary between choked and subsonic flow is second in importance. Its definition differs here from the one in ISO 6358:1989 because it corresponds to the ratio of downstream to upstream stagnation pressures.

— The subsonic index, m, is used if necessary to represent more accurately the subsonic flow behaviour. For components with a fixed flow path, m is distributed around 0,5. In these cases, only the first two characteristic parameters C and b are necessary. For many other components, m will vary widely. In these cases, it is necessary to determine C, b, and m.

Several changes to the test equipment were made to overcome apparent violations of the theory of compressible fluid flow. This included expanded inlet pressure-measuring tubes to satisfy the assumptions of negligible inlet velocity to the item under test and to allow the inlet stagnation pressure to be measured directly. Expanded outlet tubes allow the direct measurement of downstream stagnation pressure to better accommodate the different component models. The difference between stagnation pressure at upstream and downstream of component means a loss of pressure energy.

ISO 6358-3 can be used to calculate without measurements an estimate of the overall flow-rate characteristics of an assembly of components and piping, using the characteristics of each component and piping determined in accordance with this part of ISO 6358 or ISO 6358-1.

The discharge and charge test methods specified in this part of ISO 6358 have the following advantages over the test method specified in ISO 6358-1:

a) an air source with a large flow-rate capacity is not required;

b) components with larger flow-rate capacity can be tested more easily;

c) energy consumption is minimised; and

d) test time is shortened in the discharge test, and noise level is decreased in the charge test.

It should be noted that performance characteristics measured in accordance with this edition of ISO 6358 will differ from those measured in accordance with ISO 6358:1989.

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

Part 2: Alternative test methods

1 Scope

This part of ISO 6358 specifies a discharge test and a charge test as alternative methods 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 in size to determine their flow-rate characteristics. However, this part of ISO 6358 does not apply to components whose flow coefficient is unstable during use, i.e. components that exhibit remarkable hysteretic behaviour (because they can contain flexible parts that deform under the flow) or that have an internal feedback phenomenon (such as regulators), or components that have a cracking pressure such as non-return (check) valves and quick-exhaust valves. In addition, it does not apply to components that exchange energy with the fluid during flow-rate measurement, e.g. cylinders, accumulators, etc.

NOTE This part of ISO 6358 does not provide a method to determine if a component has hysteretic behaviour; ISO 6358-1 does provide such a method.

Table 1 provides a summary of which parts of ISO 6358 can be applied to various components.

Table 1 — Application of ISO 6358 test methods to components

Components		Constant upstream pressure test		Variable upstream pressure test	
		ISO 6358-1 constant upstream pressure test	ISO 6358-2 charge test	ISO 6358-1 variable upstream pressure test	ISO 6358-2 discharge test
Group 1	Directional control valves	yes	yes	yes	yes
	Flow control valves	yes	yes	yes	yes
	Connectors	yes	yes	yes	yes
	Valve manifolds	yes	yes	yes	yes
	Group of components	yes	yes	yes	yes
Group 2	Filters and lubricators	yes	no	no	no
	Non-return (check) valves	yes	no	no	no
	Tubes and hoses	yes	no	no	no
Group 3	Silencers and exhaust oil mist separators	no	no	yes	yes
	Blow nozzles	no	no	yes	yes
	Quick-exhaust valves	no	no	yes	yes
	Cylinder end heads	no	no	yes	yes

The charge test cannot be performed on components that do not have downstream port connections.

This part of ISO 6358 specifies requirements for the test installation, the test procedure, and the presentation of results.

Evaluation of measurement uncertainties is described in Annex A. Requirements for a method to test the volume of an isothermal tank are given in Annex B. Guidance on the isothermal tank is given in Annex C. Requirements for a method to test isothermal performance are given in Annex D. Guidance on the equation for calculating characteristics is given in Annex E. Guidance on calculating flow-rate characteristics is given in Annex F.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 5598, *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 and test methods for steady-state flow*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 5598 and ISO 6358-1 apply.

4 Symbols and units

4.1 The symbols and units shall be in accordance with ISO 6358-1 and Table 2.

Table 2 — Symbols and units

Reference	Description	Symbol	Dimension [a]	SI units	Practical units
5.5.2	Time	t	T	s	s
5.4.3	Tank volume	V	L^3	m^3	dm^3
[a] T = time; L = length					

4.2 The numerals used as subscripts to the symbols shall be in accordance with ISO 6358-1 and Table 3.

Table 3 — Subscripts

Subscript	Meaning
3	Tank conditions

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

5 Test installation

CAUTION — 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.