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

Part 3: Method for calculating steady-state flow-rate characteristics of systems

Transmissions pneumatiques — Détermination des caractéristiques de débit des composants —

Partie 3: Méthode de calcul des caractéristiques de débit stationnaire des assemblages

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

This first edition of ISO 6358-3, together with ISO 6358-1 and ISO 6358-2, cancels and replaces ISO 6358:1989 which has been technically revised. However, Parts 2 and 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 systems*

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 characteristics that describe their flow-rate performance.

ISO 6358:1989 specified a method 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 (sonic) flow to subsonic flow.

Experience has demonstrated that many pneumatic valves have converging-diverging characteristics that do not fit the ISO 6358:1989 model very well. A change was necessary to take into account the influence of the flow velocity on pressure measurements. 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 (sonic) and subsonic regions.

This part of ISO 6358 uses a set of four 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 (i.e. one that does not vary with pressure or flow rate), 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 varies widely; in these cases, it is necessary to determine C, b and m.

— The parameter Δp_c, is the cracking pressure. This parameter is used only for pneumatic components that open with increasing upstream pressure, such as non-return (check) valves or one-way flow control valves.

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 allowed the direct measurement of downstream stagnation pressure to better accommodate different component models. The difference between stagnation pressure upstream and downstream of a component means a loss of pressure energy.

For testing a component with a large nominal bore, to shorten testing time or to reduce energy consumption, it is desirable to apply the methods specified in ISO 6358-2, which covers a discharge test and a charge test as alternative test methods.

This part of ISO 6358 can be used to calculate without measurements an estimate of the overall flow rate characteristics of a system of components and piping. In most cases, the flow rate characteristics of components are determined in accordance with Parts 1 or 2 of ISO 6358; however, the flow rate characteristics of some components are expressed by flow rate coefficients other than those defined in ISO 6358. Formulas to calculate nearly equivalent flow rate characteristics are given.

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

Part 3: Method for calculating steady-state flow-rate characteristics of systems

1 Scope

This part of ISO 6358 specifies a method that uses a simple numerical technique to estimate without measurements the overall flow-rate characteristics of a system of components and piping with known flow-rate characteristics.

The formulae used in this part of ISO 6358 describe the behaviour of a compressible fluid flow through a component for both subsonic and choked flows.

NOTE The conductance of a tube, silencer or filter is influenced by the upstream pressure, so the values of C and b are only valid for the upstream pressure at which they are determined.

This part of ISO 6358 also provides methods to obtain equivalent flow-rate characteristics for components whose flow-rate characteristics differ from those defined in the ISO 6358 series.

2 Normative references

The following referenced 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 5598, *Fluid power systems and components — Vocabulary*

ISO 6358-1:2013, *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 given in ISO 5598 and ISO 6358-1 apply. For the purposes of this part of ISO 6358, the term ‘component’ also includes piping.

4 Symbols and units

The symbols and units used in this part of ISO 6358 shall be in accordance with ISO 6358-1 and Table 1.