DRAFT INTERNATIONAL STANDARD ISO/DIS 6358-3.2

ISO/TC **131**/SC **5** Secretariat: **AFNOR**

Voting begins on: **2009-10-29** Voting terminates on: **2009-12-29**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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

Part 3: Discharge test as an alternate test method

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

Partie 3: Essai de décharge comme méthode d'essai alternative

(Revision of ISO 6358:1989)

ICS 23.100.01

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Contents

Page

Foreword

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ISO 6358-3 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

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: Simplified method*

— *Part 2: Precision method*

— *Part 3: Discharge test as an alternate test method*

— *Part 4: Charge test as an alternate test method*

Introduction

Many components that make up a pneumatic circuit operate under conditions of choked flow. In recognition of this, ISO 6358:1989 defined test methods covering the whole range of flow from choked flow to subsonic flow and the definition of two characteristics parameters, sonic conductance, *C*, and critical pressure ratio, *b*. However, since the size of the pressure-measuring tubes connected upstream and downstream were the same as the connecting ports of the component under test, it was not possible to measure the flow-rate characteristics under stagnation condition, and also when components with large flow capacity were used, it was not possible to achieve choked flow for measurement. Furthermore, it was revealed that for some components, the flow-rate characteristics should not be approximated only with the characteristics parameters *C* and *b*.

This Internal Standard improves the above-mentioned shortcomings regarding measurement by using a pressure-measuring tube whose internal diameter is larger than the connecting port of the component under test. At the same time, it defines a characteristic equation, to which new characteristic parameters subsonic index, *m*, and cracking pressure, Δp_c, have been added, in order to accurately indicate the flow-rate characteristics of any kinds of pneumatic components.

This part of ISO 6358 defines a discharge test to determine the flow-rate characteristics of pneumatic components as an alternate to the test method specified in ISO 6358-2. This alternate test method tests a component by discharging compressed air to atmosphere from a tank that is pre-charged with compressed air at a specified pressure. The method allows the determination of sonic conductance, *C*, critical back-pressure ratio, *b*, and subsonic index, *m*, of the component under test, based on pressure response in the tank during discharge.

The discharge test method specified in this part of ISO 6358 has the following advantages over the test method specified in ISO 6358-2:

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) air consumption is minimised; and

d) test time is shortened.

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

Part 3: Discharge test as an alternate test method

1 Scope

This part of ISO 6358 specifies discharge test as an alternate method for testing pneumatic fluid power components that use compressible fluids, i.e. gases. 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. Requirements for a method to test the volume of an isothermal tank are given in Annex B. Requirements for a method to test isothermal performance are given in Annex C. Guidance on the tank is given in Annex D. Guidance on the equation for calculation of characteristics is given in Annex E. Guidance on the procedures for calculating flow-rate characteristics is given in Annex F.

This part of ISO 6358 applies to the following components:

a) directional control valves, such as solenoid valves;

b) flow control valves;

c) air treatment components, such as silencers;

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

e) other devices and combined systems that have ports.

f) piping components, such as connectors and tubes;

NOTE This part of ISO 6358 can be applied to the components listed in item f) with limitations as described herein.

This part of ISO 6358 does not apply to any components whose flow coefficient is unstable during use (i.e., those that exhibit hysteretic behaviour or have an internal feedback phenomenon) and components that have a cracking pressure, such as non-return (check) valves and quick-exhaust valves.

This part of ISO 6358 allows the determination of three sets of characteristic parameters: C, b and m, which may be calculated from the test results. The sonic conductance, C, represents the choked flow rate. The critical back-pressure ratio, b, represents the range of choked flow. The subsonic index, m, represents several conditions of flow in a component such as variable orifice.

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 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, *Fluid power systems and components — Vocabulary*

ISO 6358-2, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 2: Precision method*

3 Terms and definitions

For the purpose of this International Standard, the terms and definitions in ISO 5598 and ISO 6358-2 apply.

4 Symbols and units

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

Table 1 — Symbols and units

Reference	Description	Symbol	Dimension [a]	SI units	Practical units
6.3	Time	t	T	s	s
5.3.3	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 6358-2 except as given in Table 2.

Table 2 — Subscripts

Subscript	Meaning
3	Tank conditions

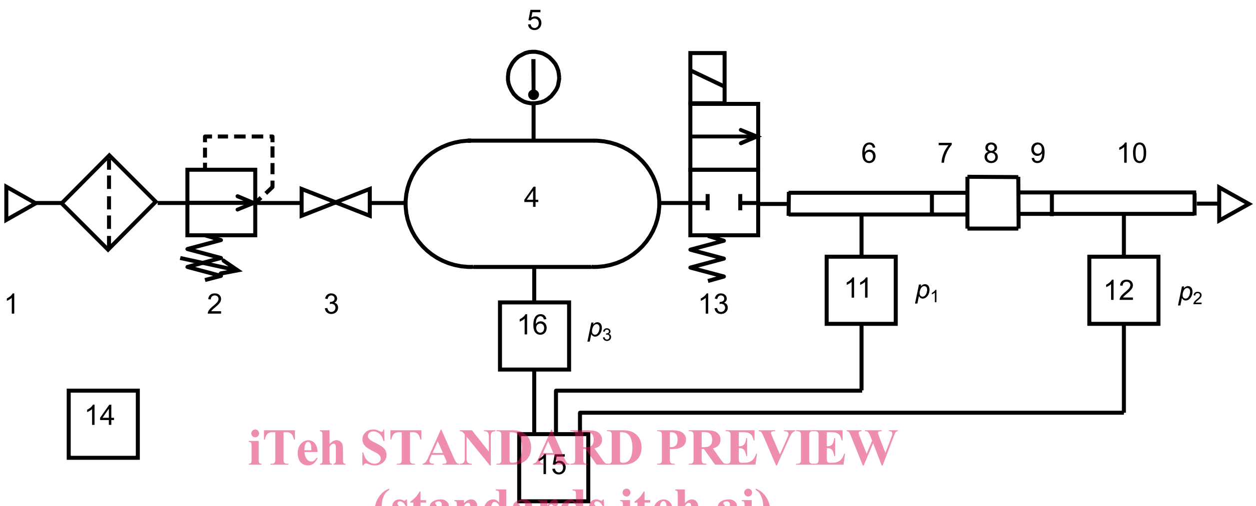
4.3 The graphical symbols used in Figure 1 are in accordance with ISO 1219-1.

5 Test installation

5.1 Test circuit

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

NOTE Figure 1 illustrates basic circuit that does 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.



NOTE See Table 3 for the key to this figure.

Figure 1 — Test circuit

Table 3 — Key to test circuit components

Reference letter	Relevant subclause or paragraph	Description
1	5.2.2 and 5.2.3	Compressed gas source and filter
2	5.2.3 and 6.2.1	Adjustable pressure regulator
3	5.2.3 and 6.2.1	Shut-off valve
4	5.2.3 and 5.3	Tank
5	5.2.3 and 6.2.2	Temperature-measuring instrument
6	5.2.3 and 5.2.7	Upstream pressure-measuring tube
7	5.2.3 and 5.2.7	Upstream transition connector
8	5.2.3, 5.2.4 and 6.2.3	Component under test
9	5.2.3, 5.2.5 and 5.2.7	Downstream transition connector
10	5.2.3, 5.2.5 and 5.2.7	Downstream pressure-measuring tube
11	5.2.3 and 6.2.3	Pressure transducer
12	5.2.3, 5.2.5 and 6.2.3	Pressure transducer
13	5.2.3, 5.2.4, 5.2.9 and 6.2.3	Solenoid valve
14	5.2.3 and 6.2.2	Barometer
15	5.2.3 and 6.2.3	Digital recorder
16	5.2.3 and 6.2.3	Pressure transducer

5.2 General requirements

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

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

5.2.3 A test set-up shall be constructed from the items listed in Table 3. Items 1 through 8, 11 and 14 through 16 are required, and the remaining items 9, 10, 12 and 13 may be chosen in accordance with 5.2.4 and 5.2.5.

5.2.4 If the component under test 8 has no control mechanism for shifting its position, install a solenoid valve 13 upstream of pressure-measuring tube 6 in order to shift the component under test and start the test. The sonic conductance of solenoid valve 13 shall be about four times as large as that of the component under test.

5.2.5 Items 9, 10 and 12 are not required if the component under test does not have a downstream port.

5.2.6 The distance between tank 4 and upstream pressure-measuring tube 6 shall be as short as possible.

5.2.7 The pressure-measuring tubes 6 and 10 and transition connectors 7 and 9 shall be in accordance with ISO 6358-2. It is not necessary to have a temperature-measuring connection in the pressure-measuring tubes because, in this test method, the temperature is measured in the tank.

5.2.8 For the places where liquid is collected, installation of drain exhaust valve is preferred.

5.2.9 The solenoid valve 13 shall have a shifting time that ensures that test data collection starts only after the solenoid valve 13 shifts.

5.3 Requirements for the tank (item 4)

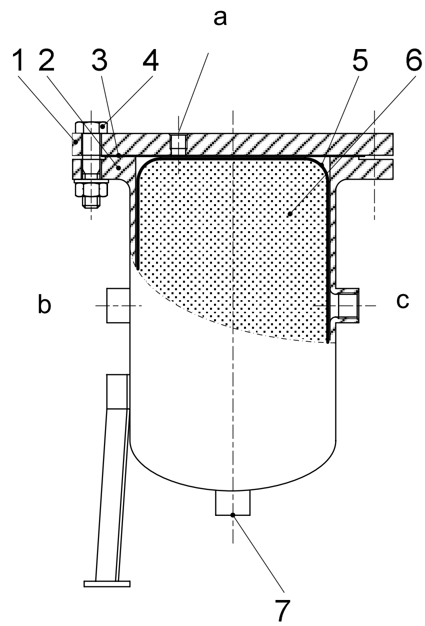
5.3.1 Structure

The tank shall be suitably structured as shown in Figure 2 and consist of the components listed in Table 4. Dimensions of the flow port shall conform to the dimensions given in Table 5.

NOTE 1 The tank shall conform to local, national and/or regional regulations and standards related to pneumatic containers.

NOTE 2 The junction of the flow port with the internal surface of the tank shall be convergent shaped so as to avoid pressure loss.

NOTE 3 The dimensions and arrangement of connection ports other than the flow port are determined by the test operator.



a Measuring port
b Source port
c Flow port

Figure 2 — Structure of the tank

Table 4 — Key to tank components

Key number	Description	Comments
1	Lid	
2	Tank body	
3	Gasket	
4	Flange fastener (nut and bolt)	Six to eight pieces, equally arranged
5	Metal net	See 5.3.2.
6	Stuffed material	See 5.3.2.
7	Drain exhaust valve	

Table 5 — Thread size of flow port

Tank volume, in dm^3	Thread size
≤2,5	G 1/8
≤6,3	G 1/4
≤14	G 3/8
≤32	G 1/2
≤66	G 3/4
≤100	G 1
≤190	G 1 1/4
≤310	G 1 1/2
≤510	G 2
≤730	G 2 1/2
≤1100	G 3

5.3.2 Stuffed material

The stuffed material, which is used for reducing the change in air temperature, shall be corrosion-resistant and pressure-resistant and shall be distributed evenly in the tank. If copper wires are used as the stuffed material, wires of equivalent diameter 30 to 50 µm shall be stuffed in the tank at a density of 0,3 kg/dm^3.

NOTE The equivalent diameter means the diameter of the cross-sectional area of a noncircular shape assumed as equivalent to the diameter of the cross-sectional area of a circular shape.

The stuffed material shall be wrapped with a metallic net to prevent it from flowing out of the flow port. It is desirable that a suitable frame supports the stuffed material to prevent it from leaning inside the tank. Further information is given in Annex D.

5.3.3 Volume

The volume of the tank, V, should be calculated using Equation (1):

$$V \geq 5 \times 10^5 C \qquad (1)$$

where

C is the estimated sonic conductance of the component under test, in $kg \cdot m^4/s$;

V is the volume of the tank, in m^3.

NOTE 1 The tank volume is the net value obtained by subtracting the volume of the stuffed material from the volume of the empty air tank.

NOTE 2 The test method to determine the tank volume is given in Annex B.

NOTE 3 The ratio of the height of the tank to its diameter should not exceed 2:1.