**DRAFT INTERNATIONAL STANDARD** ISO/DIS 6358-4.2

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

## Part 4:
## Charge test as an alternate test method

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

*Partie 4: Essai de charge comme méthode d'essai alternative*



(Revision of ISO 6358:1989)

ICS 23.100.01



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## Foreword

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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 6358-4 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, $\Delta p_c$, 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 charge 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 charging the atmospheric air to a tank which has already been evacuated. This 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 charge.



The charge 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) energy consumption is minimised; and

d) noise level is lower.

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

## Part 4:
## Charge test as an alternate test method

## 1 Scope

This part of specifies charge test as an alternate test 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 measurements is divided into two classes (A and B), which are explained in Annex A. Guidance on the equation for calculation of characteristics is given in Annex B. Guidance on the procedures for calculating flow-rate characteristics is given in Annex C.

This part of ISO 6358 applies to the following components with inlet and outlet ports:

a) directional control valves, such as solenoid valves;

b) flow control valves;

c) other devices and combined systems that have ports; and

d) piping components, such as connectors and tubes.



NOTE This part of ISO 6358 can be applied to the components listed in item d) 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 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*

ISO 6358-3, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 3: Discharge test as an alternate test 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 and ISO 6358-3.

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

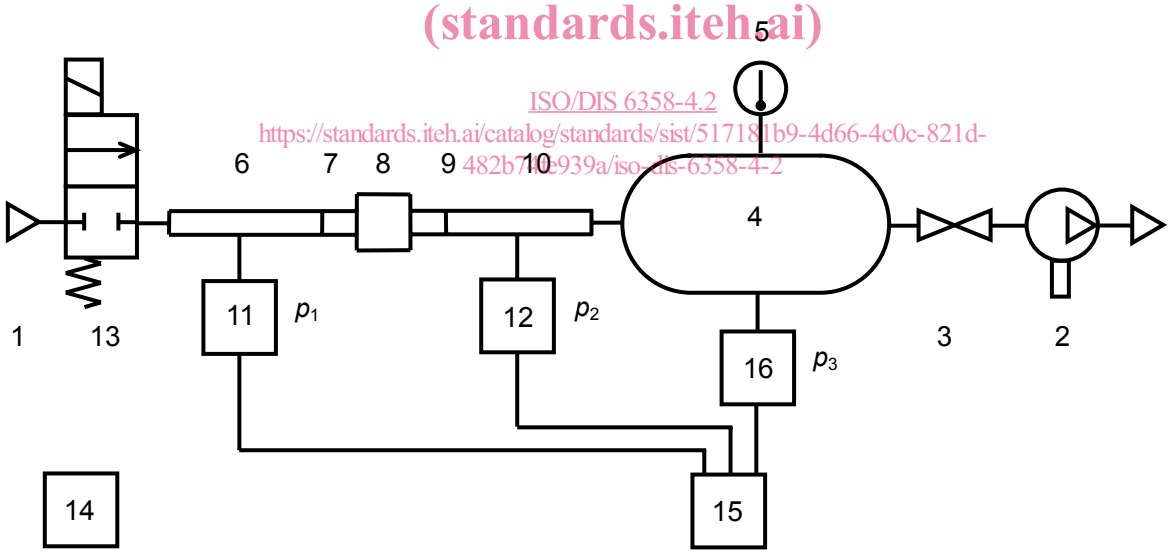
## 5 Test installation

### 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 1 for the key to this figure.

**Figure 1 — Test circuit – *Leader lines need to be added.***

**Table 1 — Key to test circuit components**

| Reference letter | Relevant subclause or paragraph | Description |
|---|---|---|
| 1 | 5.2.2 | Suction port |
| 2 | 5.2.2 | Vacuum pump |
| 3 | 5.2.2 and 6.2.1 | Shut-off valve |
| 4 | 5.2.2 and 5.3 | Tank |
| 5 | 5.2.2 and 6.2.1 | Temperature-measuring instrument |
| 6 | 5.2.2 and 5.2.5 | Upstream pressure-measuring tube |
| 7 | 5.2.2 and 5.2.5 | Upstream transition connector |
| 8 | 5.2.2, 5.2.3 and 6.2.2 | Component under test |
| 9 | 5.2.2 and 5.2.5 | Downstream transition connector |
| 10 | 5.2.2 and 5.2.5 | Downstream pressure-measuring tube |
| 11 | 5.2.2 and 6.2.2 | Pressure transducer |
| 12 | 5.2.2 and 6.2.2 | Pressure transducer |
| 13 | 5.2.2, 5.2.3, 5.2.7 and 6.2.2 | Solenoid valve |
| 14 | 5.2.2 and 6.2.1 | Barometer |
| 15 | 5.2.2 and 6.2.2 | Digital recorder |
| 16 | 5.2.2, 6.2.1 and 6.2.2 | Pressure transducer |



## 5.2 General requirements



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

**5.2.2** A test set-up shall be constructed from the items listed in Table 3 of ISO 6358-3 and Table 1. Items 1 through 12 and 14 to 16 inclusive are required, and the remaining item solenoid valve 13 may be chosen in accordance with 5.2.3.

**5.2.3** 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.

**5.2.4** The distance between tank 4 and downstream pressure-measuring tube 10 shall be as short as possible.

**5.2.5** 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 at the tank.

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

**5.2.7** 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)

The structure, stuffed material and volume of the tank shall be in accordance with ISO 6358-3. The test method to determine the tank volume is given in Annex B of ISO 6358-3 and the dimensions of the flow port of the tank shall conform to the dimensions given in Table 2.

**Table 2 — 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 |

## 5.4 Special requirements

**5.4.1** The special requirements given in 5.6 of ISO 6358-2 apply for this part of ISO 6358.

**5.4.2** The digital recorder shall be set to sample pressure at a time interval determined in accordance with Equation (1). Approximately 1000 pressure data points will be obtained during charge.



$$\Delta t \approx 1.5 \times 10^{-8} \frac{V}{C} \quad (1)$$



where

$\Delta t$ is the time interval for sampling pressure, in s;

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

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

# 6 Test procedures

## 6.1 Test conditions

### 6.1.1 Gas supply

The gas supply shall conform to the requirements of ISO 6358-2.

### 6.1.2 Checks

The checks shall be conducted in accordance with ISO 6358-2.

### 6.1.3 Test measurements

**6.1.3.1** Measurement shall be started after steady-state conditions of temperature and pressure in the tank have been reached.

**6.1.3.2** Parameters shall be maintained within the tolerances specified in Table 3.

**Table 3 — Permissible variation of indicated values of parameters**

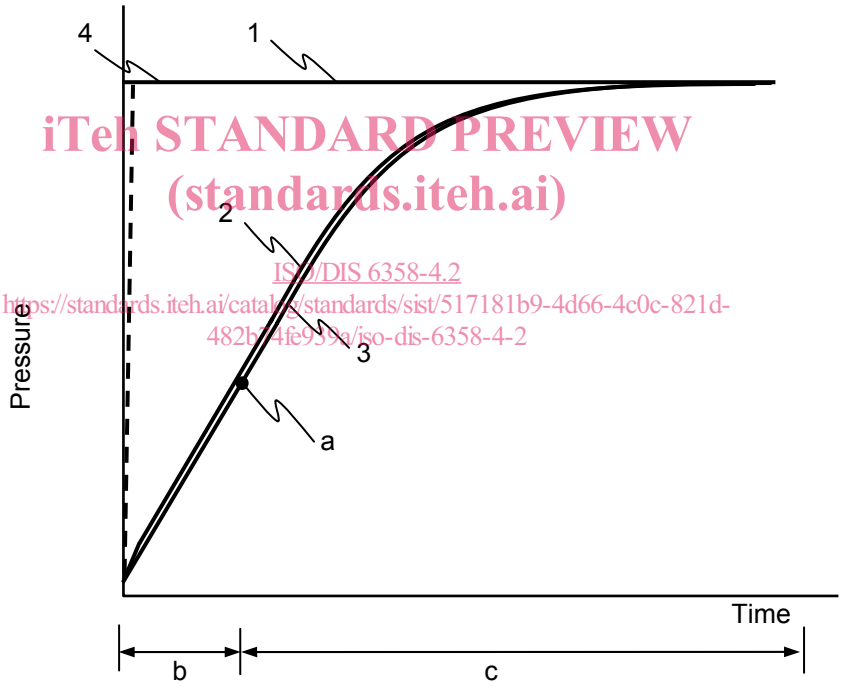
| Class of measurement accuracy | A | B |
|---|---|---|
| Variation in volume indication, % | ±1 | ±2 |
| Variation in time indication, % | ±1 | ±2 |
| Variation in pressure indication, % | ±0,1 | ±0,5 |
| Variation in temperature indication, K | ±1 | ±2 |

## 6.2 Measuring procedures

**6.2.1** Reduce the pressure in tank 4 to approximately 2 kPa absolute (0,02 bar absolute) using vacuum pump 2. Then, close shut-off valve 3 and leave the tank in this state until the pressure in the tank reach steady-state conditions. Measure the initial pressure, $p_3$, using pressure transducer 16, initial temperature, $T_3$, using temperature-measuring instrument 5 in the tank and the atmospheric pressure, $p_a$, using barometer 14.

**6.2.2** Open component under test 8 or solenoid valve 13 to charge the air from the atmosphere into the tank. Detect pressure in the tank, $p_3$, upstream pressure, $p_1$, and downstream pressure, $p_2$, during charge using pressure transducers 16, 11 and 12, and record the values using digital recorder 15 as shown in Figure 2.






1 Upstream pressure
2 Downstream pressure
3 Pressure in the tank
4 Atmospheric pressure
a Critical point
b Choked flow
c Subsonic flow

NOTE The broken line indicates the upstream pressure, $p_1$, when a solenoid valve 13 is opened to start the test. The solid line indicates the upstream pressure, $p_1$, if the component under test can perform the shift instantaneously that starts the test.

**Figure 2 — Pressure response in the tank during charge**