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

Part 1:

**General rules and test methods for  
steady-state flow**

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**AMENDMENT 1: Effective conductance**

ISO 6358-1:2013/Amd 1:2020

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

*Partie 1: Règles générales et méthodes d'essai en régime stationnaire*

*AMENDEMENT 1: Conductance effective*



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This document was prepared by Technical Committee ISO/TC 131, *Pneumatic fluid power*, Subcommittee SC 5, *Control products and components*.

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

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

### AMENDMENT 1: Effective conductance

#### *Scope*

Add the following sentence at the end of the paragraph:

A method for evaluating the flow ability of pneumatic components using effective conductance,  $C_a$ , is given in Annex I.

#### *Annex I*

Add the following annex after Annex H, before the Bibliography.

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## Annex I (informative)

### Method for evaluating the flow ability of pneumatic components using “effective conductance, $C_a$ ”

#### I.1 General

This annex describes a method for evaluating the flow ability of pneumatic components, taking a global point of view by using a simplified parameter “effective conductance,  $C_a$ ”.

The normal set of four flow-rate characteristic parameters, sonic conductance,  $C$ , critical back-pressure ratio,  $b$ , subsonic index,  $m$ , and cracking pressure,  $\Delta p_c$ , are used to accurately describe the flow-rate characteristics of pneumatic components. However, this annex describes an option for capturing a representative feature of flow characteristics of a component with a single value and for comparing the flow ability of similar components. The flow ability of components using the normal four parameters is complicated. But, the effective conductance,  $C_a$ , integrates these four parameters and can be used as a simplified parameter to evaluate the average flow ability of pneumatic components (variation of the back-pressure ratio from 0 to 1).

Although effective conductance,  $C_a$ , can compare the flow ability of components easily, it cannot compare them accurately. A cautionary example is shown in [Figure I.5](#).

NOTE 1 This annex does not apply to components that have pressure dependence.

NOTE 2 When the working range of a component is precisely known and in particular when its flow variations are limited, the four flow-rate characteristic parameters given in ISO 6358-1 (this document) and ISO 6358-2 are preferred for comparing similar components.

#### I.2 Definition of effective conductance, $C_a$

Effective conductance,  $C_a$ , is defined by [Formula \(I.1\)](#). This value is obtained by integrating the conductance characteristic curve of a component and using its average over the range of back-pressure ratios (from 0 to 1), as shown in [Figure I.1](#).

$$C_a = \int_0^1 C_e d\left(\frac{p_2}{p_1}\right) \tag{I.1}$$

where

$C_a$  is the effective conductance in the same units as  $C_e$ .

For choked flow, i.e. when  $p_2/p_1 \leq b$ , [Formula \(I.2\)](#) applies:

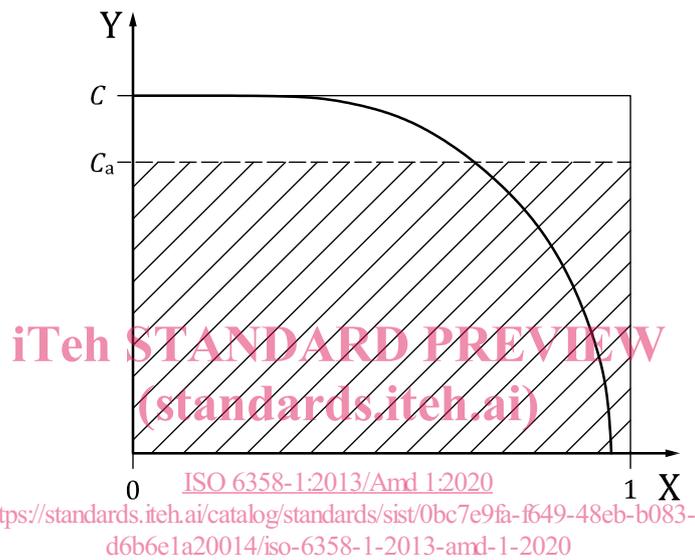
$$C_e = C \tag{I.2}$$

For subsonic flow, i.e. when  $b < p_2/p_1 \leq 1 - \Delta p_c/p_1$ , [Formula \(I.3\)](#) applies:

$$C_e = C \left[ 1 - \left( \frac{p_2/p_1 - b}{1 - \Delta p_c/p_1 - b} \right)^2 \right]^m \tag{I.3}$$

For the case when:  $1 - \Delta p_c/p_1 < p_2/p_1 \leq 1$ , then [Formula \(I.4\)](#) applies:

$$C_e = 0 \tag{I.4}$$



**Key**

- X back-pressure ratio,  $p_2/p_1$
- Y conductance,  $C_e$

**Figure I.1 — Definition of effective conductance,  $C_a$**

**I.3 Calculation of effective conductance,  $C_a$**

Effective conductance,  $C_a$ , is calculated using [Formula \(I.5\)](#), based on the [Formulae \(I.1\)](#) to [\(I.4\)](#):

$$C_a = C \left[ b + \int_b^{1 - \Delta p_c/p_1} \left( 1 - \left( \frac{p_2/p_1 - b}{1 - \Delta p_c/p_1 - b} \right)^2 \right)^m d \left( \frac{p_2}{p_1} \right) \right] \tag{I.5}$$

where the ratio  $\Delta p_c/p_1$  is treated as a constant.

As a special case, when  $m = 0,5$ , the flow-rate characteristic in the subsonic region is an elliptic function, and the effective conductance,  $C_a$ , is calculated using [Formula \(I.6\)](#):

$$C_a = C \left[ b + \frac{\pi}{4} \left( 1 - \frac{\Delta p_c}{p_1} - b \right) \right] \tag{I.6}$$

As another special case, when  $m = 1,0$ , the flow-rate characteristic in the subsonic region is a parabolic function, and the effective conductance,  $C_a$ , is calculated using [Formula \(I.7\)](#):

$$C_a = C \left[ b + \frac{2}{3} \left( 1 - \frac{\Delta p_c}{p_1} - b \right) \right] \tag{I.7}$$

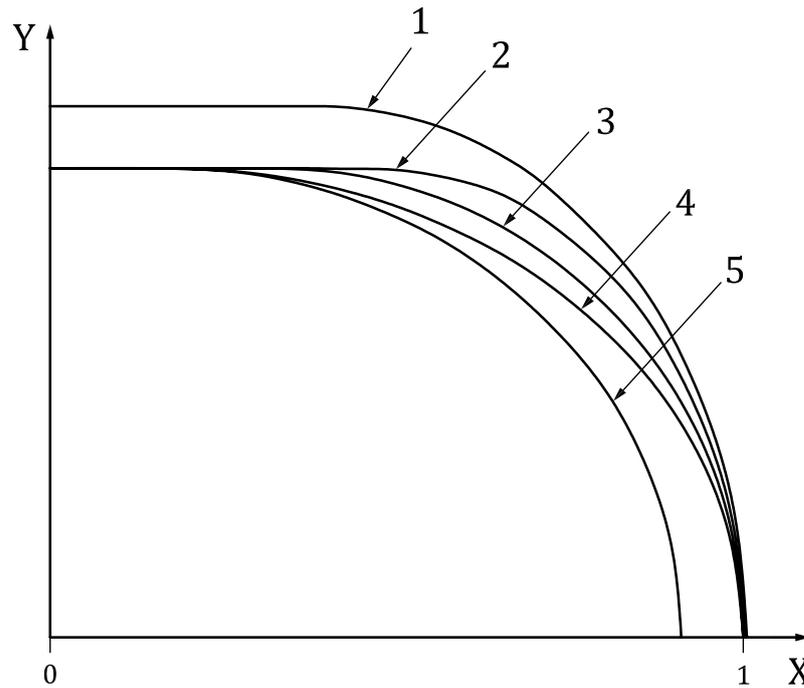
When the working range of pressure ratio of a component is precisely known and, particularly, when its variation is limited, the four flow-rate characteristic parameters are preferable for comparing similar components.

## I.4 Judgment of component flow ability

### I.4.1 Judgment of ranking

[Figure I.2](#) shows the flow-rate characteristics of five components. The larger the values  $C$  and  $b$ , and the smaller the values  $m$  and  $\Delta p_c$ , the larger will be the value  $C_a$ , i.e. it can be understood how the flow ability of the component could be greater. The ranking order of the flow ability for five components is regarded as Component 1 > Component 2 > Component 3 > Component 4 > Component 5. This is also described in the Introduction to this document. This confirms the order of priority given in the Introduction of this document when comparing pneumatic components and recalled here:

- $C$  values have to be compared first, [ISO 6358-1:2013/Amd 1:2020](https://standards.iteh.ai/catalog/standards/sist/0bc7e9fa-f649-48eb-b083-d6b6e1a20014/iso-6358-1-2013-amd-1-2020)
  - for a same  $C$  value,  $b$  has to be compared first, <https://standards.iteh.ai/catalog/standards/sist/0bc7e9fa-f649-48eb-b083-d6b6e1a20014/iso-6358-1-2013-amd-1-2020>
- then  $m$  and  $\Delta p_c$  have to be compared.



**Key**

- X back-pressure ratio  $p_2/p_1$
- Y conductance  $C_e$
- 1 component 1: larger  $C$
- 2 component 2: larger  $b$
- 3 component 3: smaller  $m$
- 4 component 4: smaller  $\Delta p_c$
- 5 component 5: larger  $\Delta p_c$

NOTE Flow ranking for Component 1 > Component 2 > Component 3 > Component 4 > Component 5.

**Figure I.2 — Component flow ability**

**I.4.2 Example of ranking**

Figure I.3 shows the test results of 5-port directional control valves from seven manufacturers, which are compliant with size 1 of ISO 5599-1. The ranking order of sonic conductance is A>B>C>D>E=F>G. However, when effective conductance,  $C_a$ , is used, it will be judged to be A>C>B>D>F=G>E. Thus, the ranking of components whose flow-rate characteristics are different from each other can be judged by the single value of effective conductance,  $C_a$ . Thus, the component flow ability can be easily compared.

Figure I.4 shows the corresponding conductance characteristic curves of the 5-port directional control valves shown in Figure I.3. It confirms that when comparing pneumatic components, it is not sufficient to compare only the sonic conductance, because in the subsonic region, a component with a lower sonic conductance can show locally (for a certain range of back-pressure ratio) a better flow ability due to a larger value of  $b$ . This is the case when comparing components B and C, or components E, F and G in the subsonic region. Looking at effective conductance,  $C_a$ , is a simple way to compare the components globally, but when the working range of pressure ratio of a component is precisely known and, particularly, when its variation is limited in the subsonic region, Figure I.4 confirms that the four flow-rate characteristic parameters are preferable for comparing similar components. A simple method is then to compare graphically the conductance curves as shown in Figure I.4.