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Acoustics — Determination of airflow resistance —

Part 1:
Static airflow method

Acoustique — Détermination de la résistance à l'écoulement de l'air —

Partie 1: Méthode statique

Reference number
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Foreword

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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).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This first edition of ISO 9053-1 cancels and replaces ISO 9053:1991, which has been technically revised. The main changes are as follows:

— title changed;

— alternating airflow method deleted.

A list of all parts in the ISO 9053 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Acoustics — Determination of airflow resistance —

Part 1: Static airflow method

1 Scope

This document specifies the measurement of the determination of the static airflow resistance[1,2], in a laminar flow regime, of porous materials for acoustical applications.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
airflow resistance
R
quantity defined by

$$R = \frac{\Delta p}{q_V}$$

where

Δp is the air pressure difference, in pascal, across the test specimen with respect to the atmosphere;

q_V is the volumetric airflow rate, in cubic metre per second, passing through the test specimen.

Note 1 to entry: It is expressed in pascal second per cubic metre.

3.2
specific airflow resistance
R_s
quantity defined by

$$R_s = R \times A$$

where

R is the airflow resistance, in pascal second per cubic metre, of the test specimen;

A is the cross-section area, in square metre, of the test specimen perpendicular to the direction of flow.

Note 1 to entry: It is expressed in pascal second per metre.

3.3
airflow resistivity
σ
quantity defined by the following formula if the material is considered as being homogeneous

$$\sigma = \frac{R_s}{d}$$

where

R_s is the specific airflow resistance, in pascal second per metre, of the test specimen;

d is the thickness, in metre, of the test specimen in the direction of flow.

Note 1 to entry: lt is expressed in pascal second per square metre.

3.4
linear airflow velocity
u
quantity defined by

$$u = \frac{q_V}{A}$$

where

q_V is the volumetric airflow rate, in cubic metre per second, passing through the test specimen;

A is the cross-sectional area, in square metre, of the test specimen.

Note 1 to entry: lt is expressed in metre per second.

3.5
permeability
k_0
quantity defined by the following equation if the material is considered as being homogeneous

$$k_0 = \frac{\eta}{\sigma}$$

where

η is the dynamic viscosity of air in newton second per square metre (approximately $1{,}82 \times 10^{-5}$ for the air at 20 °C and 1 atmosphere of static pressure);

σ is the static airflow resistivity in pascal second per square metre, of the test specimen.

Note 1 to entry: lt is expressed in square metres.

4 Principle

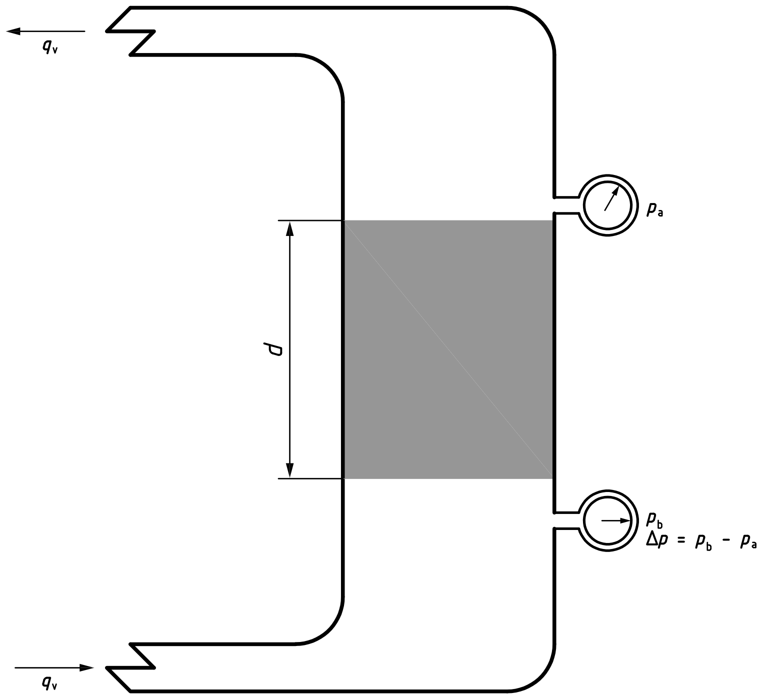

Figure 1 — Basic principle

The principle of the method, as described in Figure 1, is to measure the pressure drop between the two free faces of a test specimen (in the form of a circular cylinder or a rectangular parallelepiped) while it is subjected to a controlled unidirectional airflow.

5 Equipment

5.1 General

The equipment shall consist of:

a) a measurement cell into which the test specimen is placed;

b) a device for producing a steady airflow;

c) a device for measuring the volumetric airflow;

d) a device for measuring the pressure difference across the test specimen;

e) a device for measuring the thickness of the test specimen when it is in position for the test.

All devices used for measurements [c), d), e)] should be calibrated using their conventional calibration methods at least once every 2 years.

5.2 Measurement cell

The measurement cell shall be in the shape of a circular cylinder or a rectangular parallelepiped (preferably with a square cross-section in this latter case). The diameter or smallest edge of the measurement cell shall be chosen depending on the test specimens (see 6.2.1). In any case, the minimum diameter or smallest edge of the measurement cell shall be 29 mm. Different measurement cells can be used independently as long as they fulfil all the requirements of this document.

The total height of the cell should be such that there is essentially laminar unidirectional airflow entering and leaving the test specimen. Thus, its height should be such that a free space equivalent to, at least, one diameter (or larger transverse dimension) is present in front of the test specimen. A length greater than the diameter (or larger transverse dimension) of the sample holder is recommended behind the test specimen, in particular for thin test specimens with a low porosity (for which the flow distortion has a non-negligible impact on the measurements).

The test specimen shall rest inside the measurement cell (on a perforated support or preferably a grid made of thin wires, if necessary), positioned far enough above the base of the cell to meet the above requirement. This support shall have a minimum open area of 50 %, evenly distributed. The holes in the support shall have a diameter not less than 3 mm. The tapping points for the measurement of pressure and airflow shall be leak-free.

In some cases, it can be necessary to increase the percentage of the open area of the perforated support in order not to restrict the airflow through the test specimen. The airflow resistance of the support should be less than 1 % of the flow resistance measured when testing the specimen. The specific airflow resistance of a perforated support with circular perforations can be calculated as:

$$R_S = h8\eta/(\phi r^2)$$

where

h is the thickness of the perforated support in metres;

η is the dynamic viscosity of air (approximatively $1{,}82 \times 10^{-5}$ Nsm^{-2} for a room temperature of 20 °C and an atmospheric pressure of 1 atmosphere, i.e. 101 325 Pa);

ϕ is the perforation rate of the perforated support;

r is the perforation radius in metres.

5.3 Device for producing airflow

It is recommended that pressure depression systems of the water reservoir or vacuum pump type be used. Alternatively, pressurization systems (air compressor, etc.) may be used if they do not contaminate the air.

Whatever airflow source is used, the installation shall permit fine control of the flow and shall ensure the stability of the flow in the lower part of the test cell.

The airflow source should provide airflow rates such that the resulting velocities are low enough to ensure that the measured airflow resistances are independent of velocity.

It is recommended that the source be such as to permit airflow velocities down to $0{,}5 \times 10^{-3}$ ms^{-1} to be obtained.

5.4 Device for measuring volumetric airflow

The pressure tap of the instrument for measuring the volumetric airflow shall be placed between the source and the test specimen.

The arrangement used shall permit measurement of the airflow to an accuracy of ±5 % of the indicated value.

5.5 Device for measuring differential pressure

The equipment used for measuring differential pressure shall permit measurements of pressures as low as 0,1 Pa.

The arrangement used shall permit measurement of the differential pressure to an accuracy of ±5 % of the indicated value.

5.6 Use of calibration test specimens

The measurement of at least one calibrated test specimen shall be carried out before a series of measurements to ensure the proper functioning of the hardware and the software.

This measurement shall be carried out at least once a day and after each significant modification of the pressure, temperature and hygrometry conditions (0,5 kPa or more, 5 °C or more, 5 % or more).

This measurement shall also be carried out after each operation or modification concerning the hardware or the software.

The calibration test specimen can be made of straight cylindrical pores for which the measured value can be validated with a theoretical one. The measured value using the calibration test specimen should correspond to the theoretical value within ±10 % before measurements with test specimens of unknown static airflow resistivity as described in Clause 7 are performed.

As a reminder, the specific airflow resistance of a perforated support with circular perforations can be calculated as:

$$R_s = h 8 \eta \, / \, (\phi r^2)$$

where

h is the thickness of the perforated support in metres;

η is the dynamic viscosity of air (approximatively $1{,}82 \times 10^{-5}$ Nsm^{-2} for a room temperature of 20 °C and an atmospheric pressure of 1 atmosphere, i.e. 101 325 Pa);

ϕ is the perforation rate of the perforated support;

r is the perforation radius in metres.

6 Test specimens

6.1 Shape

The test specimen may be circular or rectangular, depending on the type of measurement cell available.

6.2 Dimensions

6.2.1 Lateral dimensions

The lateral dimensions of a test specimen shall contain a minimum of 10 pores for a foams test specimen, 10 fibres for a fibrous test specimen, 10 grains for a granular test specimen. In case no information about the microstructure of the material (number of pores, fibres or grains per mm) is available, a minimum diameter of 95 mm or a smaller edge of 90 mm minimum is required for the test specimens.

The measurement cell shall have the same lateral dimensions than a test specimen. See 7.2 to avoid leaks between the measurement cell and a test specimen.

Care should be taken to avoid distortion of the test specimen.