Acoustics - Determination of sound absorption coefficient and impedance in impedances tubes - Part 1: Method using standing wave ratio

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EESTI STANDARDI EESSÕNA **NATIONAL FOREWORD**

Käesolev Eesti standard EVS-EN ISO 10534-1:2002 sisaldab Euroopa standardi EN ISO 10534-1:2001 ingliskeelset teksti. Käesolev dokument on jõustatud 16.01.2002 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN ISO 10534-1:2002 consists of the English text of the European standard EN ISO 10534-1:2001. This document is endorsed on 16.01.2002 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: This standard specifies a method for the determination of the sound absorption coefficient, the reflection factor and the surface impedance or surface admittance of materials and objects. The values are determined for normal sound incidence by an evaluation of the standing wave pattern of a plane wave in a tube, which is generated by the superposition of an incident sinusoidal plane wave with the plane wave reflected from the test object.	**Scope:** This standard specifies a method for the determination of the sound absorption coefficient, the reflection factor and the surface impedance or surface admittance of materials and objects. The values are determined for normal sound incidence by an evaluation of the standing wave pattern of a plane wave in a tube, which is generated by the superposition of an incident sinusoidal plane wave with the plane wave reflected from the test object.

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Võtmesõnad: absorption, acoustic absorption, acoustic measurement, acoustic testing, acoustics, buildings, definition, definitions, impedance, reflectance factor, sound absorption coefficient

EUROPEAN STANDARD
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English version

Acoustics

Determination of sound absorption coefficient and impedance in impedance tubes

Part 1: Method using standing wave ratio
(ISO 10534-1: 1996)

Acoustique – Détermination du facteur d'absorption acoustique et de l'impédance acoustique à l'aide du tube d'impédance – Partie 1: Méthode du taux d'ondes stationnaires
(ISO 10534-1 : 1996)

Akustik – Bestimmung des Schallabsorptionsgrades und der Impedanz in Impedanzrohren – Teil 1: Verfahren mit Stehwellenverhältnis
(ISO 10534-1 : 1996)

This European Standard was approved by CEN on 2001-05-13.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

International Standard

ISO 10534-1 : 1996 Acoustics – Determination of sound absorption coefficient and impedance in impedance tubes – Part 1: Method using standing wave ratio,

which was prepared by ISO/TC 43 'Acoustics' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 126 'Acoustic properties of building products and of buildings', the Secretariat of which is held by AFNOR, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by December 2001 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 10534-1 : 1996 was approved by CEN as a European Standard without any modification.

Contents

1 Scope

1.1 This part of ISO 10534 specifies a method for the determination of the sound absorption coefficient, reflection factor and surface impedance or surface admittance of materials and objects. The values are determined for normal sound incidence by evaluation of the standing wave pattern of a plane wave in a tube, which is generated by the superposition of an incident sinusoidal plane wave with the plane wave reflected from the test object.

This method can be used for the determination of the sound absorption coefficient of sound absorbers for normal sound incidence. It can further be used for the determination of the acoustical surface impedance or surface admittance of sound-absorbing materials. It is well suited for parameter studies and for the design of sound absorbers, because only small samples of the absorber material are needed.

1.2 There are some characteristic differences between this method and the measurement of sound absorption in a reverberation room (see ISO 354).

The impedance tube method can be used for the determination of the reflection factor and also the impedance or admittance. The sound is incident normally on the object surface. The reverberation room method will (under idealized conditions) determine the sound absorption coefficient for random sound incidence.

The impedance tube method relies on the existence of a plane incident sound wave and gives exact values under this condition (measuring and mounting errors excluded). The evaluation of the sound absorption coefficient in a reverberation room is based on a number of simplifying and approximate assumptions concerning the sound field and the size of the absorber. Sound absorption coefficients exceeding the value 1 are therefore sometimes obtained.

The impedance tube method requires samples of the test object which are the size of the cross-sectional area of the impedance tube. The reverberation room method requires test objects which are rather large and can also be applied to test objects with pronounced structures in the lateral and/or normal directions. Measurements with such objects in the impedance tube must be interpreted with care (see 9.1).

For the computational transformation of the test results from the impedance tube method (normal incidence) to the situation of diffuse sound incidence, see annex D.

1.3 This part of ISO 10534 gives preference to numerical methods of evaluation instead of graphical methods, because computers which can perform these computations are assumed to be available. Some of the quantities in the formulae are complex. The arguments of trigonometric functions are in radians.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10534. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10534 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 266:—[1], *Acoustics — Preferred frequencies.*

ISO 354:1985, *Acoustics — Measurement of sound absorption in a reverberation room.*

3 Definitions

For the purposes of this part of ISO 10534, the following definitions apply.

3.1 sound absorption coefficient, α: Ratio of the sound power entering the surface of the test object (without return) to the incident sound power for a plane wave at normal incidence.

3.2 sound pressure reflection factor at normal incidence, r: Complex ratio of the pressure amplitude of the reflected wave to the incident wave in the reference plane for a plane wave at normal incidence.

3.3 reference plane: Cross-section of the impedance tube for which the reflection factor r or the impedance Z or the admittance G are determined and which is usually the surface of flat test objects. It is assumed to be at $x = 0$.

3.4 field impedance, $Z(x)$: Ratio of the sound pressure $p(x)$ to the particle velocity $v(x)$ (directed into the test object) at a point x in the sound field.

3.5 impedance in the reference plane, Z_r: Ratio at the reference plane of the sound pressure p to the sound particle velocity v:

$$Z_r = p/v$$

3.6 surface impedance, Z: Complex ratio of the sound pressure $p(0)$ to the normal component of the sound particle velocity $v(0)$ at the reference plane.

3.7 surface admittance, G: Complex ratio of the normal component of the sound particle velocity $v(0)$ to the sound pressure $p(0)$ in the reference plane.

3.8 surface admittance, G_s: Admittance component at, and normal to, the surface of the test object.

3.9 characteristic impedance, Z_0: Field impedance (in the direction of propagation) in a single plane wave:

$$Z_0 = \rho_0 c_0$$

where

ρ_0 is the density of the medium (air);

c_0 is the speed of sound in the medium.

3.10 normalized impedance, z: Ratio of the impedance Z to the characteristic impedance Z_0:

$$z = Z/Z_0$$

3.11 normalized admittance, g: Product of the admittance G and the characteristic impedance Z_0:

$$g = Z_0 G$$

3.12 standing wave ratio, s: Ratio of the sound pressure amplitude at a pressure maximum, $|p_{max}|$, to that at an adjacent pressure minimum, $|p_{min}|$ (if necessary after correction for varying values at the minima due to sound attenuation in the impedance tube):

$$s = |p_{max}|/|p_{min}|$$

3.13 standing wave ratio with attenuation, s_n: Standing wave ratio of the n^{th} maximum to the n^{th} minimum.

3.14 free-field wave number, k_0:

$$k_0 = \omega/c_0 = 2\pi f/c_0$$

where

ω is the angular frequency;

f is the frequency;

c_0 is the speed of sound.

In general the wave number is complex, so

$$k_0 = k_0' - jk_0''$$

where

k_0' is the real component ($k_0' = 2\pi/\lambda_0$);

k_0'' is the imaginary component which is the attenuation constant in nepers per metre.

3.15 phase of reflection (factor), Φ: Results from the representation of the complex reflection factor by magnitude and phase:

$$r = r' + jr'' = |r| \cdot e^{j\Phi} = |r|(\cos\Phi + j\sin\Phi)$$

$$|r| = \sqrt{r'^2 + r''^2}$$

$$\Phi = \arctan\frac{r''}{r'}$$

$$r' = |r|\cos\Phi$$

$$r'' = |r|\sin\Phi$$

1) To be published. (Revision of ISO 266:1975)