MÜLLER-BBM

Müller-BBM GmbH
Robert-Koch-Str. 11
82152 Planegg bei München

Telephone +49(89)85602 0
Telefax +49(89)85602 111

www.MuellerBBM.de

M. Eng. Philipp Meistring
Telephone +49(89)85602 228
Philipp.Meistring@mbbm.com

2019-05-08
M100827/198 MSG/STEG

Fabric Type Basel
Manufacturer Kvadrat A/S

Determination of sound absorption in impedance tubes according to EN ISO 10534-2

Test Report No. M100827/198

Client:	Kvadrat A/S Lundbergsvej 10 8400 Ebeltoft Denmark
Consultant:	M. Eng. Philipp Meistring Jan-Lieven Moll
Date of report:	2019-05-08
Delivery date of test object:	2017-04-26
Date of test:	2019-04-29
Total number of pages:	In total 7 pages: 4 pages text, 1 page Appendix A and 2 pages Appendix B.

Table of contents

1	**Task**	**3**
2	**Basics**	**3**
3	**Test objects**	**3**
4	**Execution of measurements**	**3**
5	**Measurement results**	**4**
6	**Remarks**	**4**

Appendix A: Test certificate of the sound absorption

Appendix B: Test procedure and test equipment

1 Task

On behalf of Kvadrat A/S, 8400 Ebeltoft, Denmark, the sound absorption coefficient in the impedance tube according to EN ISO 10534-2 [1] was to be determined for the fabric type Basel.

2 Basics

This test report is based on the following document:

[1] DIN EN ISO 9053-1: Acoustics –Determination of airflow resistance – Part 1: Static airflow method (ISO 9053-1:2018); German version EN ISO 9053-1:2018. March 2019

[2] EN ISO 10534-2: Acoustics – Determination of sound absorption coefficient and impedance in impedance tubes - Part 2: Transfer-function method. June 2001 with EN ISO 10534-2 Corrigendum 1 of November 2007

3 Test objects

The tested material is described by the manufacturer as follows:

- manufacturer Kvadrat A/S
- type Basel
- material 90 % new wool, 10 % nylon

Testing was done for different configurations of the fabric.

The thickness, the area specific mass as well as the airflow resistance according DIN EN ISO 9053-1 [1] were determined by the testing laboratory as indicated in the test certificate in Appendix A.

4 Execution of measurements

The sound absorption coefficients at vertical sound incidence $\alpha(0)$ were determined according to EN ISO 10534-2 [1].

The circular test object with a diameter of 100 mm was placed without stretching the material with a distance of 100 mm to the sound-reflecting back plate of the sample holder. The joints between the edge of the test object and the wall of the sample holder were sealed air-tight.

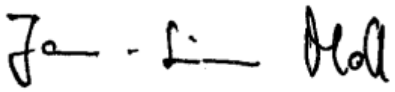
The test method, the test facility and the test equipment used are described in Appendix B.

5 Measurement results

The measurement results are shown in graphical and tabular form in the test certificate in Appendix A.

6 Remarks

The test results exclusively relate to the investigated subjects and conditions described.



M. Eng. Philipp Meistring
(Project manager)

Jan-Lieven Moll
(Responsible)

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-14119-07-00

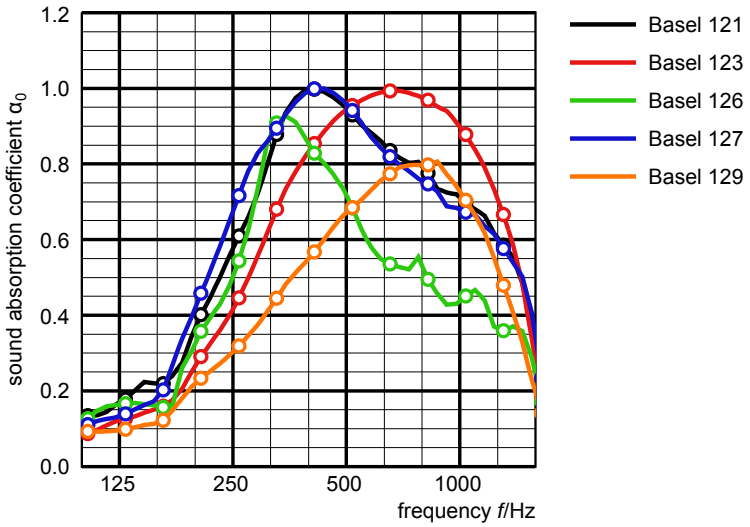
Durch die DAkkS Deutsche Akkreditierungsstelle GmbH
nach DIN EN ISO/IEC 17025 akkreditiertes Prüflaboratorium.
Die Akkreditierung gilt für die in der Urkunde aufgeführten Prüfverfahren.

Sound absorption coefficient in accordance with ISO 10534-2

Measurement with impedance tube

Client:	Kvadrat A/S 8400 Ebeltoft, Denmark
Order number:	M100827
Müller-BBM Sample number:	13409-13412
Test object:	Material description: - material composition (all fabrics): 90 % new wool, 10 % nylon - fabric type Basel 121 by Kvadrat, thickness: 0.86 mm, area-specific mass: 357 g/m², airflow resistance: 1129 Pa s/m - fabric type Basel 123 by Kvadrat, thickness: 0.99 mm, area-specific mass: 366 g/m², airflow resistance: 353 Pa s/m - fabric type Basel 126 by Kvadrat, thickness: 0.73 mm, area-specific mass: 351 g/m², airflow resistance: 2771 Pa s/m - fabric type Basel 127 by Kvadrat, thickness: 0.87 mm, area-specific mass: 353 g/m², airflow resistance: 1256 Pa s/m - fabric type Basel 129 by Kvadrat, thickness: 1.15 mm, area-specific mass: 360 g/m², airflow resistance: 129 Pa s/m
Test setup:	100 mm airgap to the sound-reflecting back plate of the tube

f/Hz 1/12 octave	α_0 Basel 121	α_0 Basel 123	α_0 Basel 126	α_0 Basel 127	α_0 Basel 129
100	0.13	0.08	0.12	0.11	0.09
125	0.17	0.12	0.16	0.14	0.10
160	0.22	0.16	0.16	0.19	0.12
200	0.39	0.28	0.34	0.44	0.23
250	0.60	0.43	0.53	0.70	0.31
315	0.86	0.66	0.90	0.88	0.44
400	1.00	0.84	0.84	1.00	0.56
500	0.94	0.95	0.70	0.95	0.68
630	0.84	0.99	0.54	0.82	0.77
800	0.78	0.97	0.51	0.75	0.80
1000	0.71	0.89	0.44	0.67	0.72
1250	0.60	0.70	0.36	0.60	0.52
1600	0.31	0.26	0.23	0.33	0.18



Person in charge: Moll
Laboratory: Müller-BBM GmbH
Date: 2019-04-29

Description of the test procedure for the determination of the sound absorption in the impedance tube

1 Measurand

The sound absorption coefficient was calculated from the averaged complex reflection factor *r* as follows:

$$\alpha_0 = 1 - |r|^2$$

$$r = \frac{1}{3}\left(\sum_{i=1}^{3} w_i \,\mathrm{Re}(r_i) + j \sum_{i=1}^{3} w_i \,\mathrm{Im}(r_i) \right)$$

Where:

α_0 sound absorption coefficient at normal incident

r averaged reflection factor

r_i reflection factor of microphone pair i

w_i normalized window function of microphone pair i

The frequency resolution was 0.25 Hz. The averaging in 1/12 octave bands of the equidistant spectrum of the sound absorption coefficient were carried out arithmetically. The graphical presentation is effected in 1/12 octave bands. In tabular form the values at the center frequencies of the one-third octave bands are listed.

The reflection factor of microphone pair i was calculated from the transfer function between the microphones:

$$r_i = \frac{H_i - e^{-jk_0 s_i}}{e^{jk_0 s_i} - H_i} e^{2jk_0 x_i}$$

Where:

H_i transfer function between the microphones of microphone pair i

s_i Distance between the microphones of microphone pair i

x_i Distance between the reference plane of the test object and the first microphone of the microphone pair i

k_0 wave number

Taking into consideration the frequency limits, resulting from the distance of the microphone pairs according to EN ISO 10534-2 [1], for each pair of microphones the frequency-dependent complex reflection factor was determined. In overlapping areas of several microphone pairs an arithmetical averaging of the real and imaginary parts of the reflection factors of the individual microphone pairs was executed.

2 Test procedure

2.1 Description of the impedance tube

The measuring arrangement consists of a precision aluminum tube with an inner diameter of 100 mm that is closed on one side by a dynamic loudspeaker. On the opposite side there is a sample holder with the specimen to be tested and the sound-reflecting back plate. In the wall of the tube three fixed microphone ports are integrated.

Depending on the system the frequency range is limited to 90 Hz up to 1940 Hz.

2.2 Measurement of the transfer function

For the measurements the one-microphone method was used. For this, a sinusoidal sweep with pink noise spectrum was irradiated by the loudspeaker and the sound pressure was recorded at three microphone positions. From these measured values the complex transfer functions between all microphone pairs were calculated.

3 List of test equipment

The test equipment used is listed in Table B.1.

Table B.1. Test equipment.

Name	Manufacturer	Type	Serial-No.
Impedance tube ∅ 100 mm	Müller-BBM	abstubeD100AL	353621
AD-/DA-converter	RME	Multiface II	22475191
Microphone	G.R.A.S.	40BF	141769
Pre-amplifier	G.R.A.S.	26AB	237770
Battery power supply	MFA	MS10	250111
Amplifier	img Stage Line	AKB-60	B08/001023-07
Hygro-/Thermo-/Barometer	Lufft	Opus 20	097.1113.0802.020
Software	Müller-BBM	m|abstube	Version 2.0.5973.25332