Ventilation for buildings — Performance testing of components/products for residential ventilation

Part 9: Externally mounted humidity controlled air transfer device

ICS 91.140.30,

British Standards

National foreword

This British Standard is the UK implementation of EN 13141-9:2008.

The UK participation in its preparation was entrusted to Technical Committee RHE/2, Ventilation for buildings, heating and hot water services.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Lüftung von Gebäuden - Leistungsprüfung von Bauteilen/Produkten für die Lüftung von Wohnungen - Teil 9: Feuchtegeregelte Zuluftdurchlässe

This European Standard was approved by CEN on 11 April 2008.

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Foreword

This document (EN 13141-9:2008) has been prepared by Technical Committee CEN/TC 156 "Ventilation for buildings", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2008, and conflicting national standards shall be withdrawn at the latest by November 2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document is one of a series of standards on residential ventilation. The performance characteristics of the components/products for residential ventilation are given in EN 13142.

The position of this document in the field of mechanical building services is shown in Figure 1.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

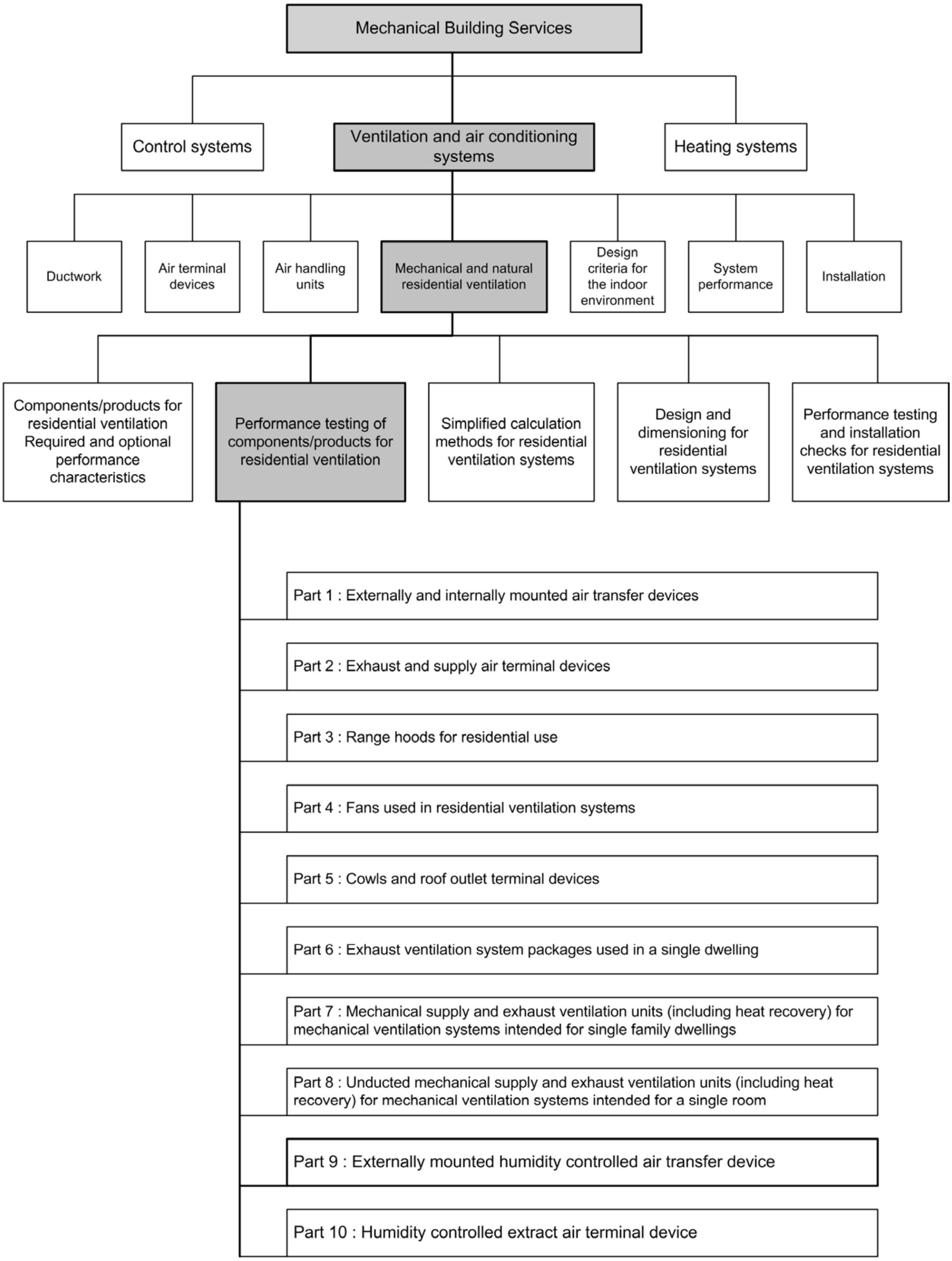


Figure 1 — Position of EN 13141-9 in the field of mechanical building services

1 Scope

This European Standard specifies laboratory methods for testing humidity controlled air inlets operating under pressure differences.

It applies to all devices located between one room and outside and controlled on indoor humidity. For instance, devices of the following types:

— humidity controlled devices with fixed setting;

— manually openable or closable humidity controlled devices;

— humidity controlled devices self-adjusting on pressure difference.

It describes tests intended to characterise:

— aero and hygro-dynamic performance;

— air tightness when closed (for closable humidity controlled air inlet);

— air diffusion in the occupied zone;

— sound insulation;

— time response.

This European Standard does not apply to the evaluation of air filtration, condensation risk and noise production.

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.

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13141-1:2004, *Ventilation for buildings — Performance testing of components/products for residential ventilation — Part 1: Externally and internally mounted air transfer devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792:2003, EN 13141-1:2004 and the following apply.

3.1
hysteresis
value defined as the difference of relative humidity, read on the response curve for the same flow, in % RH

4 Symbols and abbreviations

For the purposes of this document the symbols and units given in EN 12792:2003 and the symbols and units given in Table 1 apply.

Table 1 — Symbols and units

Term	Symbol	Unit
humidity	φ	
minimum airflow	$q_{v\,\mathrm{min}}$	l. s^{-1}
maximum airflow	$q_{v\,\mathrm{max}}$	l. s^{-1}
relative humidity	φ_{p}	% RH
maximum relative humidity for minimum airflow	$\varphi_{\mathrm{p\,min}}$	% RH
minimum relative humidity for maximum airflow	$\varphi_{\mathrm{p\,max}}$	% RH

5 Performance testing of aerodynamic characteristics

5.1 Aero and hygro-dynamic performance

5.1.1 Principle

This test consists of measuring several volume flow rates induced through a device controlled by humidity conditions, under an applied static pressure difference, to define the flow rate/humidity characteristic curve.

5.1.2 Test installation, conditions and uncertainty of measurement

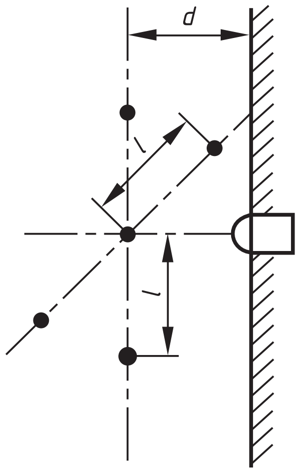
5.1.2.1 Test installation and conditions

The test facility shall include two rooms controlled both in humidity and temperature, the first one representing outside conditions, the other one indoor conditions as described in Figure 3.

The test installation and the indoor room shall comply with 4.1.2.1 of EN 13141-1:2004.

The test facilities shall have a range from 0 Pa to + 100 Pa.

Special care to limit air velocities around the inlet in the test box should be taken: air velocities shall be measured at locations specified in Figure 2. The measures shall not exceed 0,10 m.s^{-1} at these points without air flow through the air inlet.



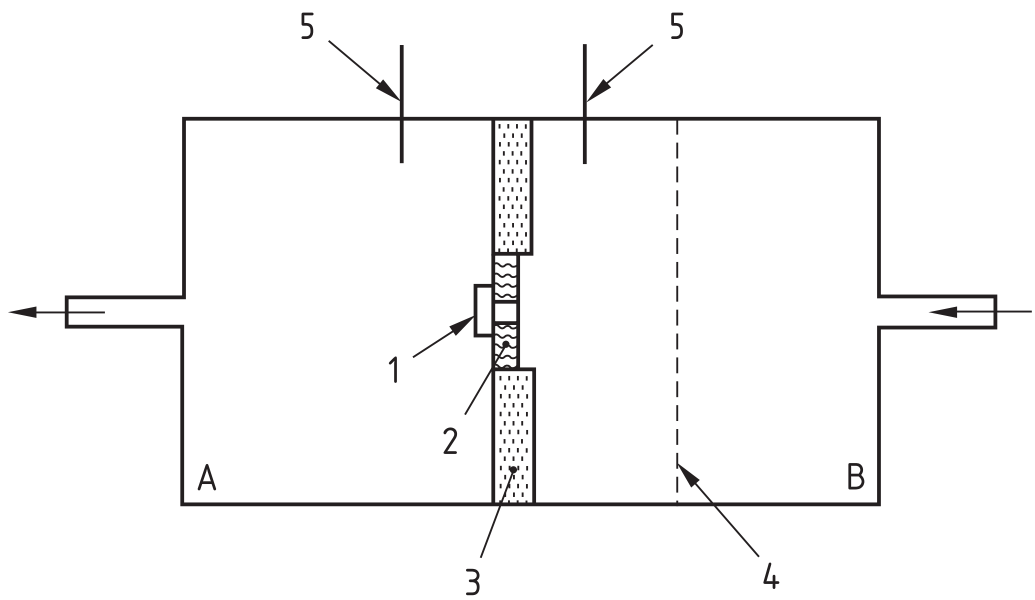
Key

● Locations of the measurement points

d = 0,04 m

l = 0,20 m

Figure 2 — Locations of measurement points



Key

A humidity and temperature controlled room for indoor conditions

B humidity and temperature controlled room for outdoor conditions

1 device under test

2 test plate dimensions as in EN 13141-1 (see Figure 4)

3 insulated wall to avoid condensation in room A

4 avoid high air velocity around the air intake of the device under test e.g. a perforated plate can be used

5 static pressure probes or piezometric ring

Figure 3 — Test installation

To avoid difficulties in the control of the room (A), the volume shall be big enough, especially for non-isothermal conditions measurements for which the “outside air” room (B) may strongly interfere with the climate in room (A).

The size of room (B) is normally of lesser importance as the climate conditions are not to be so accurate as in room (A), nevertheless it shall not affect the low velocity on the air intake of the device under test.

The wall between room (A) and room (B) shall be insulated to avoid low temperature radiation on the device under test.

Test plates shall conform to EN 13141-1.

The air permeability of the test equipment between the air inlet and the airflow/pressure measurement devices shall be measured with the test specimen sealed, over the same range of pressure differences used during the performance testing of the specimen.

The air permeability of the test equipment shall be reported and shall generate a leakage lower than 1 l. s^{-1} at 100 Pa.

For low airflow measurements, it may be necessary to introduce some additional by-pass flow. This by-pass flow shall be measured alone and reported.

In all cases, the leakage airflow shall be measured and used in the test report for correction of values and for uncertainty calculations.

5.1.2.2 Uncertainty of measurement

The pressure shall be measured with an uncertainty lower than:

$0,2 + 0,03 \times$ (measured value) (Pa)

The volume flow rate shall be measured with an uncertainty lower than:

$0,3 + 0,03 \times$ (measured value) ($l \cdot s^{-1}$)

The temperature shall be measured with an uncertainty lower than ± 0,5 K.

The relative humidity shall be measured with an uncertainty lower than 2 % RH.

5.1.3 Test procedure

5.1.3.1 Choice of tests to be performed

To check the humidity control of the devices, the measurements shall be taken in isothermal conditions (see 5.1.3.2) for at least one pressure difference (chosen by the manufacturer) in the following pressure difference ranges (bands) given in Table 2: 1, 2, 4, 10 or 20 Pa. Measurements in non-isothermal conditions (see 5.1.3.3) at the same chosen pressure shall be made if the sensor can be influenced by outdoor air temperature.

Table 2 — Pressure difference ranges

Pressure difference, Δp Pa	**Permissible deviation during test** Pa
1	± 0,25
2	± 0,5
4	± 1
10	± 1
20	± 1

For manually openable or closable devices, in addition, the tests of EN 13141-1 shall be done in open and closed conditions.

For pressure difference controlled devices, in addition self regulation shall be verified (see 5.1.3.4) in isothermal conditions.

For non pressure difference controlled devices, an additional test shall be done according to EN 13141-1 to determine the flow exponent at the middle point of the response curve to measure the impact of pressure on the aperture. The test procedure of 5.1.3.4 of this document and 4.1.3 of EN 13141-1:2004 shall be used for fixed devices.

The report shall give values of the flow exponent for the corresponding pressure difference as shown in Table 3. If the regression law coefficient is lower than or equal to 0.95, a unique value of the flow exponent shall be provided.

Table 3 — Values of the flow exponent for the corresponding pressure difference

Pressure difference, Δp (Pa)	**Flow exponent,** Kp
1	Kp1
2	Kp2
4	Kp4
10	Kp10
20	Kp20

The values Kp1 to Kp20 shall be calculated according to the following:

$$q_v(\Delta p) = q_v(\Delta p_{nom}) \times (\Delta p / \Delta p_{nom})^{Kp}$$

The environmental conditions existing during the tests such as temperature, barometric pressure shall be recorded.

For humidity controlled air inlet without self regulating device, the following correction shall be applied:

$$q_v = q_{vmeas} \times \sqrt{\frac{\Delta p_{nom}}{\Delta p_{meas}}}$$

where

$q_{v\ meas}$ is the measured value at Δp_{meas}, in l·s^{-1}

Δp_{meas} is the test pressure, in Pa

Δp_{nom} is the nominal test pressure given by the manufacturer, in Pa

With q_v is the corrected value for the nominal pressure, in l·s^{-1}

For humidity controlled air inlet with self regulating device, this correction shall not be applied.

5.1.3.2 Isothermal tests of humidity control

5.1.3.2.1 General

In this test the outdoor air conditions (temperature, humidity) shall be fixed. The indoor temperature shall be fixed and the relative humidity varies. Indoor and outdoor temperature shall be equal.

5.1.3.2.2 Outdoors conditions

Fixed temperature: (21 +/- 1) °C

Fixed relative humidity: (55 +/- 5) % RH

5.1.3.2.3 Indoors conditions

The characteristic curve airflow vs indoor relative humidity shall be measured at the pressure difference defined by the inlet manufacturer.

The range of humidity during the test shall also be defined in the manufacturer's declaration.

The minimum value of humidity φ_{p1} shall be the minimum declared less 20 % RH, so that

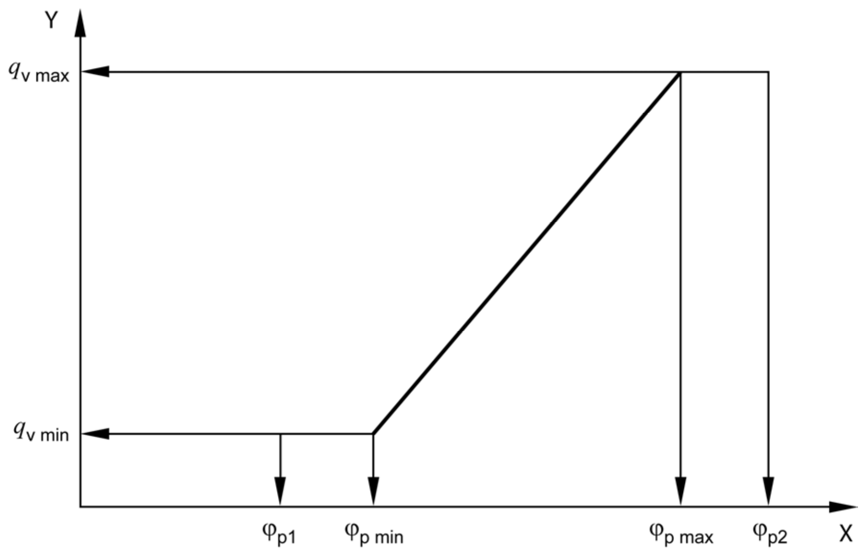
$$\varphi_{p\,min} - 20\%RH \leq \varphi_{p1} \leq \varphi_{p\,min}$$

NOTE If this value is lower than 30 % RH, a minimum value of 30 % may be accepted for test conditions due to the difficulty of realisation.

The maximum value of humidity shall be the maximum declared plus 20 % RH, so that

$$\varphi_{p\,max} \leq \varphi_{p2} \leq \varphi_{p\,max} + 20\%RH$$

The tests shall be performed with first an increase of humidity from minimum φ_{p1} to maximum φ_{p2}, then a decrease back. This test shall be done in the same conditions as for isothermal measurements. The measurements shall be done at minimum humidity, in three humidity regularly spaced in between minimum and maximum (one in the middle point) and then at maximum for the increasing cycle. If necessary, more points shall be tested to avoid steps of humidity larger than 10 % RH. Similar points shall be measured while decreasing, which induces a minimum of nine test points. Before measurements, the inlet shall at least realise such one cycle of humidity.



Key

X humidity

Y airflow

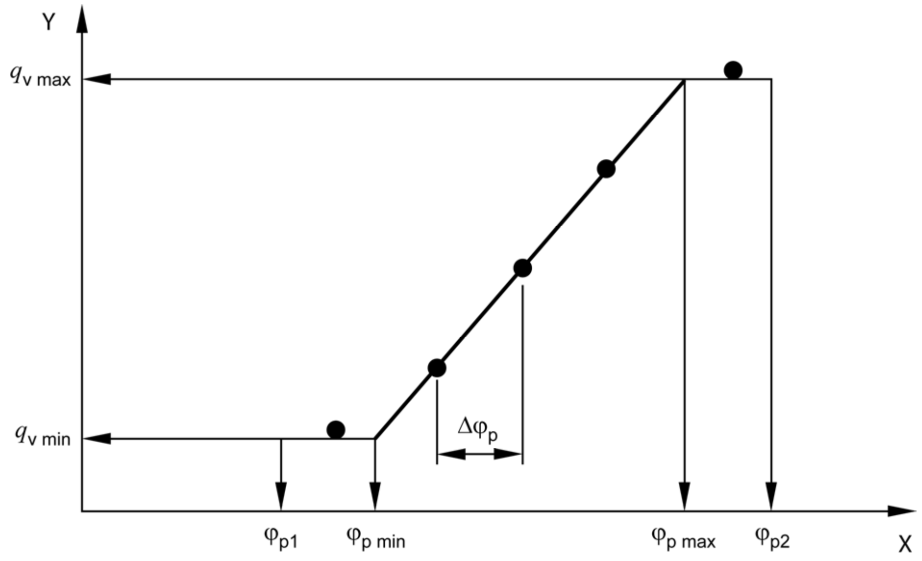
If φ_{p1} < 30 % RH, the minimum measurement point shall be limited at 30 % RH.

If φ_{p2} > 85 % RH, then the maximum measurement point shall be limited at 85 % RH.

Figure 4 — Test parameters

The humidity declared range [φ_{pmin}, φ_{pmax}] and the declared airflow range [$q_{v\,min}$, q_{vmax}] under the test pressure difference shall be given by the manufacturer.

The repartition of the measurement points shall be equally distributed on the declared range.



Key

X humidity

Y airflow

Figure 5 — Example of distribution of measurement points

The condition [[$\Delta\varphi_p \leq$ 10 % RH] shall be applied: the number of measurement points shall be chosen to ensure a relative humidity difference lower than 10 % RH between 2 points. (See Figure 5). The number of measurement points shall be chosen accordingly if the declared range is wider than 40 % RH.

The nine minimum measurement points shall be detailed as follows:

— one measurement point for $q_{v\ min}$;

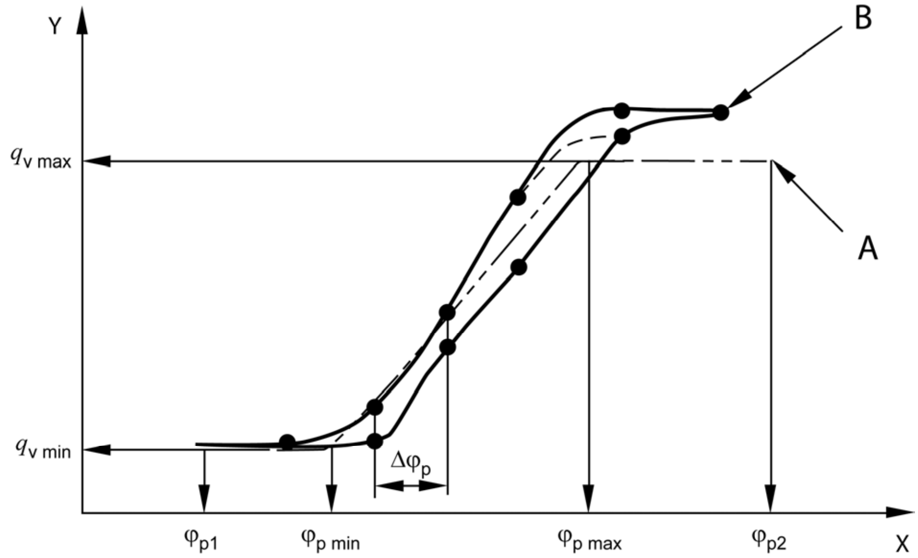
— three measurement points for the increasing humidity within the range ((φ_{pmin},φ_{pmax});

— one measurement point for $q_{v\ max;}$

— three measurement points for the decreasing humidity within the range ((φ_{pmin},φ_{pmax});

— one for $q_{v\ min}$.

NOTE If the hysteresis of the curve is relatively important, it should be checked that all the relevant points are measured. In Figure 6, the last measurement point (B) is necessary to get the upper part of the curve. Without this point, the curve would be limited to the dotted one (from point A).



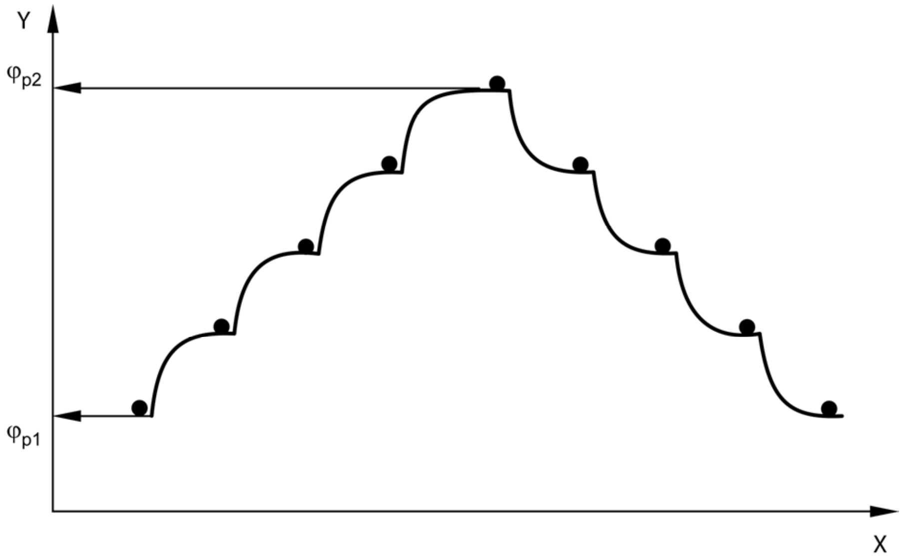
Key

X humidity

Y airflow

Figure 6 — Example of hysteresis curve

Figure 7 gives an example of measurement cycle.



Key

X time

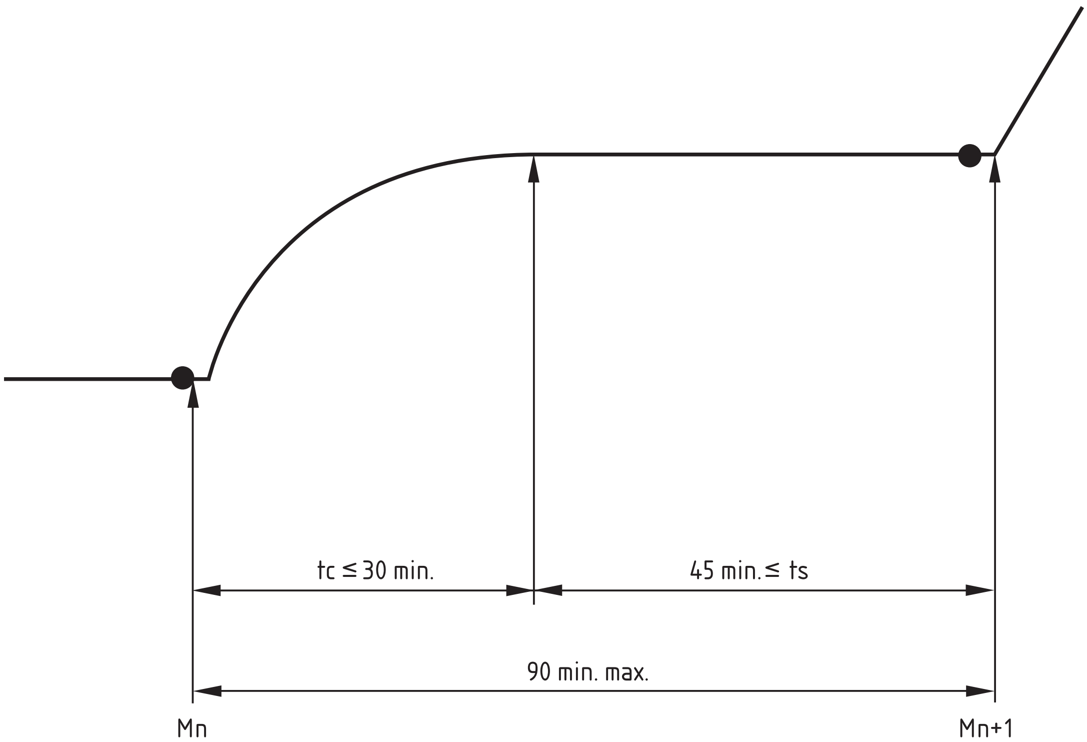
Y humidity

Figure 7 — Example of measurement cycle

The relative humidity shall be stable for a certain time between measurement of the flow across the device to allow the humidity sensitive element to come to an equilibrium.

The stable level shall be kept for 45 min to 60 min and the maximum time between 2 measurements shall be less than 90 min, as illustrated in Figure 8.

The stability at a given level shall be satisfied with a fluctuation of +/- 2 % RH.



Key

Mn	n measure
Mn+1	n+1 measure
tc	necessary time to increase/decrease the relative humidity (one step)
ts	stable time before measurement.

Figure 8 — Example of measurement stabilisation

Indoor air temperature shall be measured at three points around the sensor (one of them at maximum 5 cm from the component and being the reference one), but anyway not in the airflow. The three temperatures shall have the same value (± 1 K).

Each indoor air temperature and outdoor air temperature shall be 21 °C. During the test, each of these temperatures shall not vary more than ± 1 K.

Indoor relative humidity shall be measured at the point situated at (5 ± 1) cm maximum of the component.

5.1.3.3 Non-isothermal tests of humidity control

5.1.3.3.1 General

The temperature of the humidity sensor of the device is different from the temperature in the room. The impact of the outdoor temperature on the device shall be characterized according to the following method.

This test shall be realised only if the sensor or the sensible element is influenced by outdoor temperature.

The pressure difference through the air inlet shall be the same as for the isothermal test.

In this test the outdoor air conditions (temperature, humidity) shall be fixed. The indoor temperature shall be fixed and the relative humidity varies.

5.1.3.3.2 Outdoor conditions

Two outdoor temperatures shall be chosen by the manufacturer from the following values: [- 5 °C, - 3 °C], [3 °C, 5 °C] and [10 °C, 12 °C].

The permissible deviation during the test shall not exceed +/- 0,5 K.

Fixed relative humidity shall be (85 +/- 5) % RH.

5.1.3.3.3 Indoor conditions

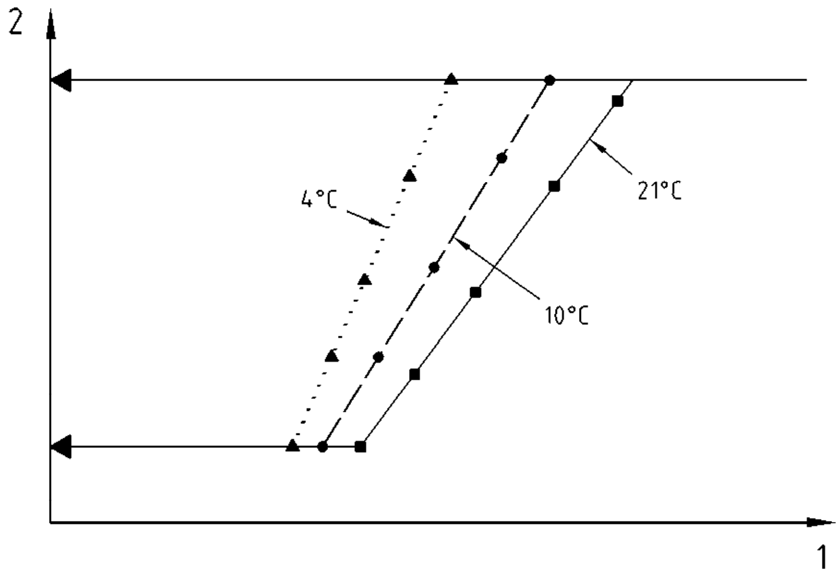
Indoor temperature shall be measured in 3 points and shall be (21 ± 1) °C as described in 5.1.3.2.

For each chosen outdoor temperature, a first cycle of increase and decrease of humidity shall be performed and hence shall define the new minimum and maximum values.

NOTE 1 Non-isothermal conditions generally translate the minimum value of the characteristic curve and change the slope of the curve.

NOTE 2 It may be necessary to limit the humidity range to avoid condensation on the sensible part of the inlet. Unnecessarily high levels of humidity should be avoided because they are not representative of normal levels in a habitable room when outside temperatures are low.

Tests points during the measurement cycle shall be chosen as indicated in 5.1.3.2. Figure 9 gives an example of a non-isothermal curve.



Key

X relative humidity in % RH

Y airflow in $l.s^{-1}$

Figure 9 — Example of non-isothermal curve

NOTE 3 The impact of the outside air temperature is to change the settings and the slope of the nominal range at 21 °C.

NOTE 4 The cold outside air refreshes the environment of the sensor, thus increases the relative humidity locally. This effect is essential for the efficiency of the air inlet, allowing to change automatically the settings according to the season (at least partly).

The curves at different outside temperatures shall be analysed and translated into a thermal coefficient for each temperature, the effect is correct if the coefficients are close together.

5.1.3.4 Self regulation tests in isothermal conditions

Air temperatures shall be 21 °C. During the test, temperature shall not vary more than ± 1 K.

One test shall be performed at the minimum airflow and maximum airflow of the declared range and at a mean value (middle point of the response curve, humidity increasing).

The setting of the device corresponding to the three different humidity levels can be obtained by mechanical locking of the regulating component.

When the humidity conditions have to be controlled, they shall be stable at +/- 2 % during a minimum of 30 minutes before testing and during testing.

Then, each aerodynamic test (airflow variation according to pressure) shall be carried out according to the method described in EN 13141-1.

5.1.4 Analysis of results

The measured result shall be corrected if temperature and barometric pressure are different from standard conditions (20 °C and 101325 Pa), as follows:

$$q_{\text{v cor}} = q_{\text{v meas}} \times \frac{293}{273+\theta_{\text{a}}} \times \frac{p_{\text{a}}}{101325} \quad (1)$$

where

p_a is the atmospheric pressure, in Pa

θ_a is the ambient temperature, in °C (average when there are 3 measurements)

$q_{\text{v meas}}$ is the measured volume airflow rate, in l s^{-1}

$q_{\text{v cor}}$ is the corrected volume airflow rate, in l s^{-1}

5.1.5 Test report

The test report shall include the following elements for each test performed:

— ambient conditions (barometric pressure);

— range of humidity (declared and measured);

— pressure chosen by the manufacturer according to Table 1;

— indoor temperature(s);

— for isothermal test of humidity control, a curve plotting airflows vs indoor φ_p. Declared limits of range shall be indicated on the curve. The curve shall be completed by a complete table indicating the measured sets of points (increasing, decreasing) and the pressure at which the measures have been performed;

— for non-isothermal test of humidity control, two curves (for each outdoor temperature) plotting airflows vs indoor φ_p;

— temperature coefficient (see Annex A for calculation method);

— for self regulation tests (if needed), 3 characteristic curves according to EN 13141-1 mentioning the 3 indoor φ_p tested;

— characteristic curve flow vs pressure if additional test has been performed for non self regulated component. The characteristics *K* and *n* (as determined in EN 13141-1:2004, section 4.1.4) shall be presented if the regression coefficient was greater than 0,98.

5.2 Other tests

5.2.1 Time response test

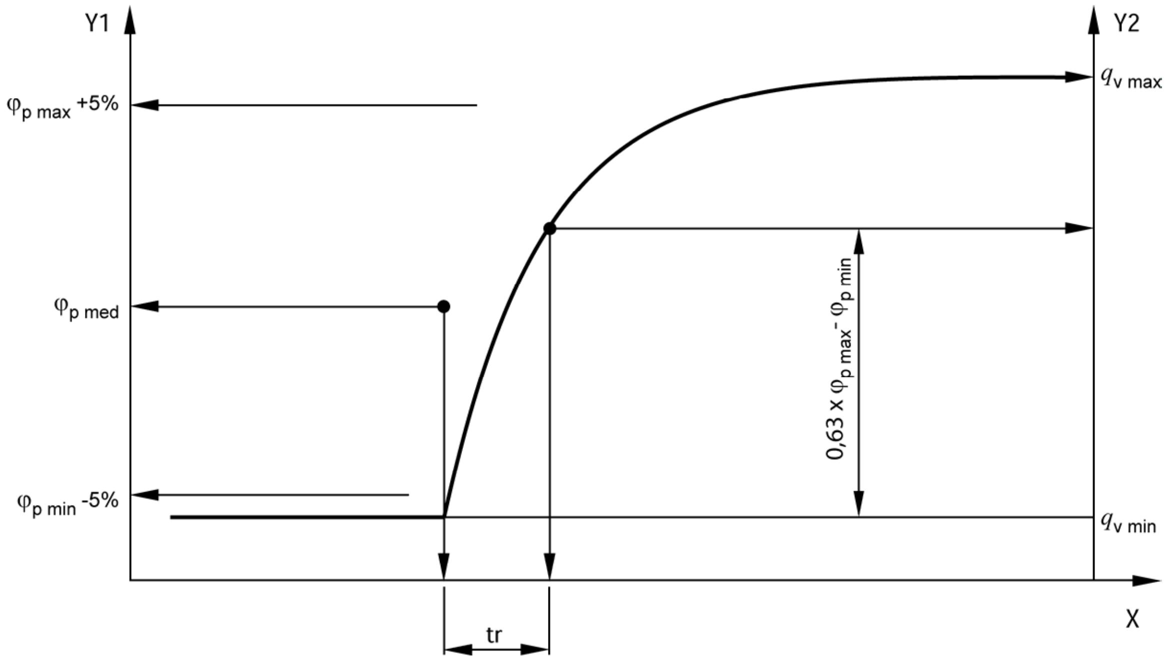
To assess the reactivity of the component, an additional test on the time response shall be performed.

The test shall be performed in the same conditions than for isothermal measurements.

The humidity in the room shall vary from φ_{pmin} – 5 % RH to φ_{pmax} + 5 % RH with an equivalent minimum slope of 5 % per minute.

Maximum time between the extremum points shall be [(φ_{pmax} + 5% RH) – (φ_{pmin} – 5% RH)]/ 5

Figure 10 gives an example of the time response *tr* as the time from the moment where the humidity reaches φ_{pmin} to the moment the response curve has reached 63 % of its maximum change.



Key

Y1 relative humidity in % RH

Y2 airflow in $l.s^{-1}$

X time

Figure 10 — Example of time response curve

The time response curve shall be given in the report.

The time response *tr* shall always be linked to the absolute change in $l.\ s^{-1}$ and the humidity range involved (φ_{pmin};φ_{pmax}):

EXAMPLE:

tr (63 %) = 4 min 25 s

airflow change from 1,5 $l.\ s^{-1}$ to 7,2 $l.\ s^{-1}$

humidity step: 30 % RH from 20 % RH to 50 % RH

5.2.2 Air tightness when closed (for closeable externally mounted air transfer device)

For closable externally mounted air transfer device, the air tightness "when closed'" shall be tested according to EN 13141-1.

5.2.3 Air diffusion in the occupied zone

Supply air may create adverse comfort conditions in the occupied zone.

The air diffusion tests should be performed to assess the possibility of draughts due to externally mounted air transfer devices.

The air diffusion tests shall be performed according to EN 13141-1 with the device forced open if the difference of indoor/outdoor temperature is 0 K, and forced closed if the difference of temperature is 40 K.

5.2.4 Sound insulation

For all devices, the characterisation of the sound insulation shall be done with maximum aperture of the device. Tests shall be performed according to EN 13141-1.

Annex A
(normative)

Calculation method for the temperature coefficient

A.1 General

For application of this calculation method for the temperature coefficient, the test depression shall be the same.

A.2 Analysis

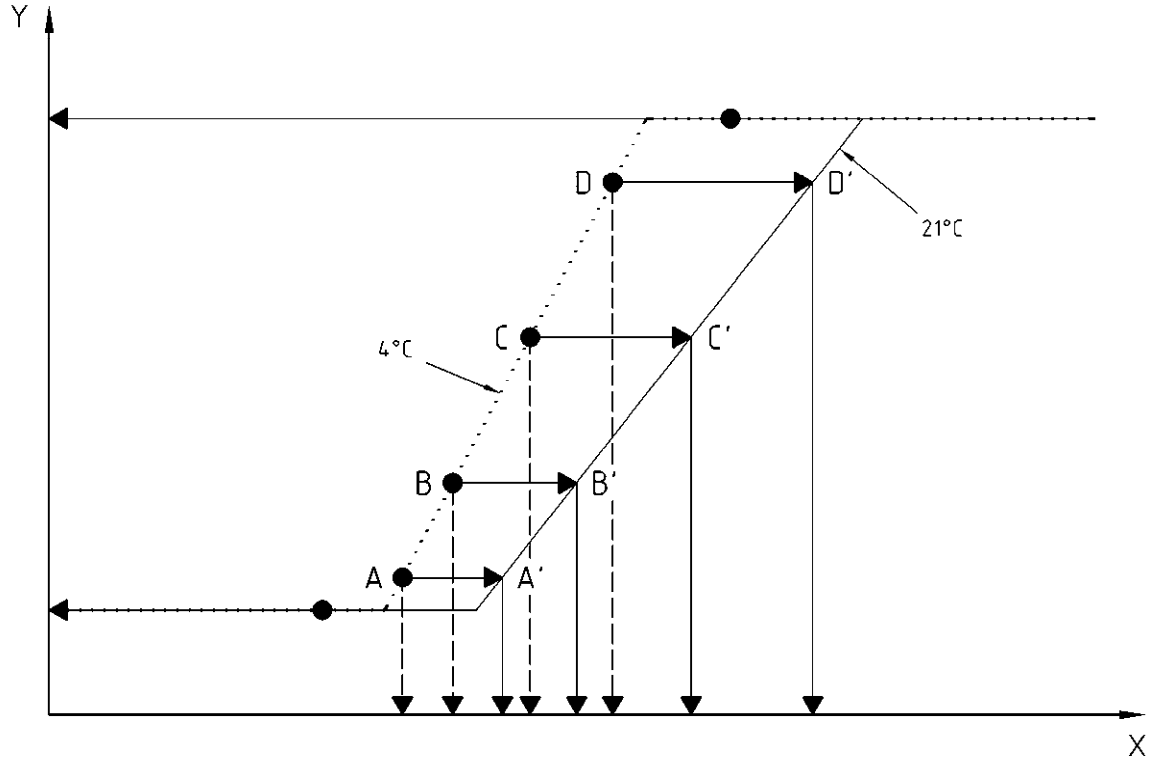
For each measured point ([A] to [D]) in non-isothermal conditions:

A: [φ_p(A), q_v(A)] for θ_{out}, θ_{in}

Translate the point (A) to the point (A') with the same vertical value (flow), to the equivalent point on the curve measured at θ_{in} (normally 21 °C), in isothermal conditions.

A': [φ_p(A'), q_v(A)]

Calculate the equivalent temperature to have φ_p(A') value with the same absolute humidity than obtained by the conditions: {φ_p(A) and θ_{in}} and derive the temperature coefficient from it.



Key

X relative humidity in % RH

Y airflow in $l.s^{-1}$

Figure A.1 — Example of temperature coefficient curve

A.3 Procedure

Measure φ_p(A) in non-isothermal conditions (θ_{out}, θ_{in})

Read φ_p(A') on the curve in isothermal conditions (θ_{in}, θ_{out})

Calculate φ = f1 (φ_p(A), θ_{in}) (through any usual method such as linear interpolation method)

Calculate θ_{eq} = f2 (φ_p(A'), φ), (through any usual method such as linear interpolation method)

Calculate θCoef = (θ_{in}-θ_{eq}) / (θ_{in}-θ_{out})

NOTE 1 The calculation is done for the points on the slopes (when the points are on the levelling plates, it is not possible to have a correct interpretation).

NOTE 2 The coefficients calculated with this method may be different from one point to another at the same outside temperature.

NOTE 3 The coefficients calculated with this method may be different from one point to another at different pressure differences (use the same pressure as isothermal conditions).

NOTE 4 The coefficients calculated with this method may be different for the different outside temperatures.

NOTE 5 The real curves are not straight lines but generally have a hysteresis, it may be difficult to interpret the value of the coefficient if this hysteresis is too important.

All curves (isothermal and non-isothermal for the different temperatures) shall be displayed in the report, as well as a table (see Table A.1) giving the flows and the relative humidity measured.

Table A.1 — Example of table

Measured point	Outdoor temperature in °C	Indoor temperature in °C	Relative indoor humidity in % RH	Flow in l. s^{-1}	Measured point	Outdoor temperature in °C	Indoor temperature in °C	Relative indoor humidity in % RH	Flow in $l.s^{-1}$
Ainc	21,2	21,3	27	1,3	Adec	21	21	27	1,3
Binc	21,1	21,2	36	1,8	Bdec	21	21	36	2,1
Cinc	21,2	21,3	45		Cdec	21	21	45	
…					…				
…				9	…				9
Jinc	4,1	20,8	21	1,4	Jdec	3	21	21	…
Kinc	4,3	21,0	24	2,3	Kdec	3,8	21	24	
...					...				
...	10,4	21,2	25	1,3	...	10	21	25	
Rinc	10,3	21,2	32	1,7	Rdec	10	21	32	
Sinc	10,4	20,8	42		Sdec	10	21	42	
…					…				

The coefficients shall be calculated from the simple average curves (increase/decrease) for both isothermal and non-isothermal conditions.

The report shall give the table of all calculated coefficients for each set of measured points.

A single value of the coefficient shall be given only if:

— the hysteresis is less than 10 % for all the curves (for the same flow at the same pressure);

— the coefficients for a single temperature are within a tolerance of ± 0,1 (from simple average value of the coefficients at this temperature);

— the coefficients for the different temperatures are within a tolerance of ± 0,1 (from simple average value of the coefficients at different temperatures).

Bibliography

[1] EN 13142, Ventilation for buildings – Components/products for residential ventilation – Required and optional performance characteristics

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