BS EN 16430-2:2014

BSI Standards Publication

Fan assisted radiators, convectors and trench convectors

Part 2: Test method and rating for thermal output

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee RHE/6, Air or space heaters or coolers without combustion.

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

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Fan assisted radiators, convectors and trench convectors - Part 2: Test method and rating for thermal output

Radiateurs assistés par ventilateur, convecteurs et convecteurs de caniveaux - Partie 2: Méthode d'essais et d'évaluation de la puissance thermique

Gebläseunterstützte Heizkörper, Konvektoren und Unterflurkonvektoren - Teil 2: Prüfverfahren und Bewertung der Wärmeleistung

This European Standard was approved by CEN on 9 November 2014.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 16430-2:2014) has been prepared by Technical Committee CEN/TC 130 “Space heating appliances without integral heat sources”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by June 2015 and conflicting national standards shall be withdrawn at the latest by June 2015.

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.

The European Standard "Fan assisted radiators, convectors and trench convectors" consists of the following parts:

- Part 1: Technical specifications and requirements

- Part 2: Test method and rating for thermal output

- Part 3: Test method and rating for cooling capacity

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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard applies to the thermal output testing of fan assisted radiators, convectors and trench convectors which are factory assembled or kits, i.e.

— fan assisted radiators and convectors, provided the heater has a dedicated fan or fans;

— trench convectors with and without fan(s), provided the heater and the fan(s) are dedicated;

— ventilation radiators and convectors.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 442-2, *Radiators and convectors - Part 2: Test methods and rating*

EN 636, *Plywood - Specifications*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN 442-2 and the following apply.

3.1
trench convectors
convectors installed in a trench in the floor mostly in front of glass facades, including the covering of the trench

3.2
fan assisted radiators and convectors
radiators and convectors according to EN 442-2 and trench convectors according to 3.1 equipped with fans to increase the convective thermal output/ cooling capacity of the radiator, convector or trench convector

3.3
ventilation radiators and convectors
radiators or convectors, which, apart from heating rooms normally, also heat the incoming air (outside air)

Note 1 to entry: In this context, the air is led directly to the radiator and, once heated by the radiator, fed to the room. The controlled air feed is performed mechanically, either using a fan in the primary air system or through an exhaust air system.

3.4
primary air unit
unit connected to the radiator, convector or trench convector which supplies primary air to the room, preheated or pre-cooled by the radiator, convector or trench convector

3.5
basic units
regularly repeated sections of the radiator/convector equipped with fans

3.6
extension units
parts of the fan assisted radiator/convector in addition to the basic units which are not equipped with a fan

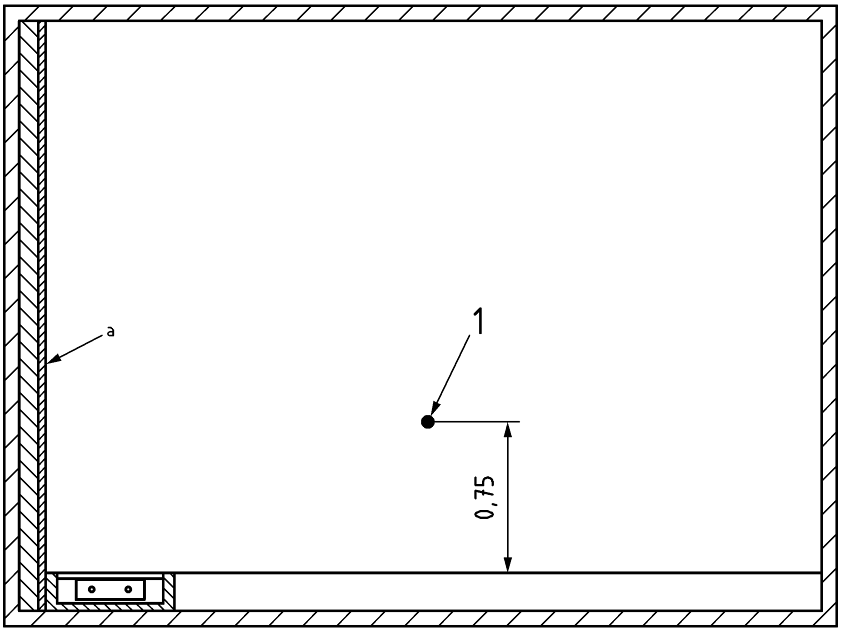
4 Radiators and convectors with fan(s) and trench convectors with and without fan(s)

4.1 Preparation of the closed test room

4.1.1 Trench convectors

The back wall of the test room shall be cooled to a surface temperature of 16 °C ± 0,5 K during the test (see Figure 1). This can be done either by the back wall itself or by a flat cooling surface (emission coefficient has to be at least 0,9) covering the whole width and height of the room placed in front of the back wall of the closed test room in accordance with EN 442-2. The space between the cooling plate and the booth back wall shall be closed off to prevent air from flowing through.

Dimensions in metres



Key

a cooling surface, temperature 16 °C ± 0,5 K

1 reference air temperature t_r

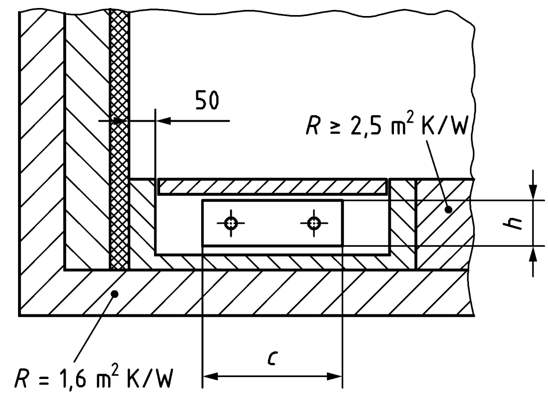
Figure 1 — Positioning of the cooling surface in the test room

The trench convector with its associated trench and the intended covering is installed in the booth floor in front of this cooling surface, flush with the finished floor level, in accordance with the manufacturer's instructions. Unless other dimensions have been given by the manufacturer, the distance between the trench and the cooled back wall shall be 0,05 m (see Figure 2). For the purposes of the test, the trench in itself is covered with a thermal insulation shown in Figure 2 which has a thermal resistance of at least R =1,0 m^2K/W.

If the floor of the test booth is cooled then the floor has to have a thermal resistance of at least R =2,5 m^2K/W.

If the floor of the test booth is not cooled then there is no requirement for such a thermal resistance.

Dimensions in millimetres

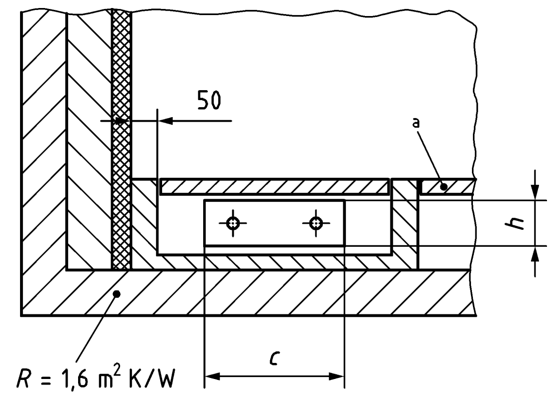


Key

h height

c depth

Figure 2a — Positioning of the trench convector, cooled floor



Key

h height

c depth

a without requirement

Figure 2b — Positioning of the trench convector, without requirement

If it is possible to allocate the models to a certain type with a characteristic size (e. g. height of the convector and/or height of the casing) whose changes point to the fact that a continuous dependence of the thermal output can be expected, the smallest and the largest sizes each and so many intermediate sizes shall be tested that a ratio of 1:2 is not exceeded.

In the case of trench convectors without fan(s) the convector length to be tested (finned length) should be 2 m; if that length is not available, the next available length > 2 m shall be tested. The length of the sample under test shall be adapted if the requirements for either the minimum or maximum thermal output according to 4.2.1 are not fulfilled.

In the case of finned tube convectors, a finned length of 1 m is assumed as the module. In the case of trench convectors with fan(s) the convector length to be tested (finned length) should be at least 1 m, if that length is not available, the next available length > 1 m shall be tested. The length of the sample under test shall be adapted if the requirements for either the minimum or maximum thermal output according to 4.2.1 are not fulfilled.

The convector as such is installed in the trench, applying the manufacturer's fixing material, spacers, covering, etc. and following the manufacturer's instructions. The testing application shall be accompanied by drawings showing the dimensions of the trench and the convector as well as the convector's positioning in the trench and the design of the covering.

4.1.2 Fan assisted radiators and wall mounted convectors

Radiators and wall mounted convectors shall be installed according to EN 442-2. Unless other dimensions have been given by the manufacturer, the distance between the radiator / convector and the back wall of the test room shall be 0,05 m, the distance between the radiator / convector and the floor of the test room shall be 0,11 m.

If it is possible to allocate the models to a certain type with a characteristic size (e. g. height) whose changes point to the fact that a continuous dependence of the thermal output can be expected, the smallest and the largest sizes each and so many intermediate sizes shall be tested that a ratio of 1:2 is not exceeded.

In the case of radiators / convectors the length of the sample to be tested (in case of convectors: finned length) should be 1 m, if that length is not available, the next available length > 1 m shall be tested. The length of the sample under test shall be adapted if the requirements for either the minimum or maximum thermal output according to 4.2.1 are not fulfilled.

The radiator / convector as such is installed in the test room, applying the manufacturer's fixing material, spacers, covering, etc., and following the manufacturer's instructions. The testing application shall be accompanied by drawings showing the dimensions of the trench and the convector as well as the radiator's / convector's positioning in the test room and the design of the covering.

4.2 Test procedure

4.2.1 Scope of testing

The selection of the samples and the scope of testing shall be to specifications analogous to EN 442-2.

The standard heating output is to be determined at different water flow rates with the following limitations:

Thermal output: min. 200 W; max. 3 500 W (according at standard conditions).

4.2.2 Determination of the thermal output

4.2.2.1 General

The procedure of the test and the determination of the thermal output are performed in accordance with EN 442-2. EN 442-2, applies analogously with regard to the requirements for measuring instruments.

Here, a characteristic formula:

$$\Phi = K_m \cdot \Delta T^{n} \tag{1}$$

Where:

- Φ is the thermal output
- K_m is the constant of the model
- ΔT is the excess temperature
- n is the exponent

shall be determined on the basis of at least three measuring points, at a constant water flow rate and excess temperatures of

ΔT = (60 ± 2,5) K;

ΔT = (50 ± 2,5) K;

ΔT = (30 ± 2,5) K.

The standard rated thermal output results at ΔT = 50 K.

Inlet water temperature t_1: 75 °C;

Outlet water temperature t_2: 65 °C;

Reference air temperature t_r: 20 °C.

The standard low thermal output results at ΔT = 30 K.

4.2.2.2 Influence of mass flow on the characteristic curve

In case of an influence of the mass flow on the thermal output, it shall be estimated by performing all of the subsequent tests at standard mass flow and – additionally – at 50% and 200% of the standard mass flow.

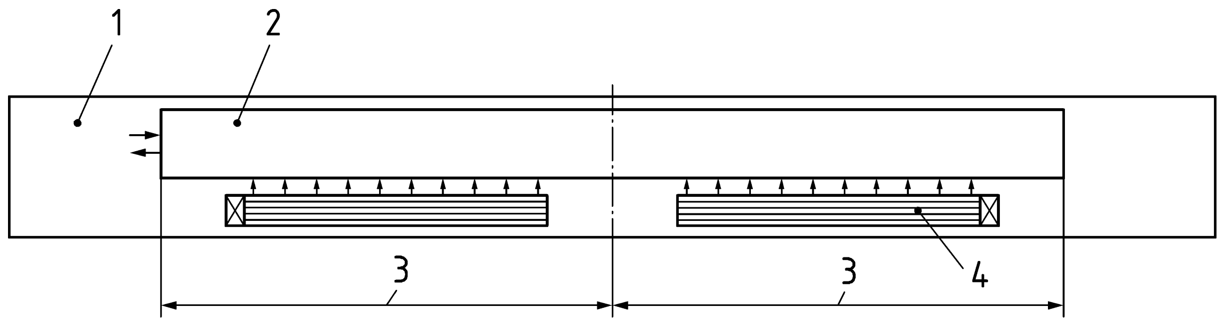
4.2.2.3 Fan assisted radiators and convectors

If the fans do not cover the entire radiator / convector, the performance of the radiator / convector is the sum of the performance of the basic units plus those of extension units. The basic unit is considered as the smallest combination of a regularly repeating radiator / convector section with fan(s). This basic section shall be indicated by the manufacturer. Examined is a combination of basic units of a length of at least 1 m (see 4.1). The performance of a basic unit is determined from this calculation.

If the total length of all basic units is less than the total length of the radiator / convector, the standard heat output of the remaining length (difference) shall be determined with a fan speed of 0. (see Figure 6 and Figure 7).

If a fan acts upon different lengths of a radiator / convector (e. g, a fan at the end of the radiator / convector), at least 3 lengths (small, medium, longest) shall be measured. Hence a linear characteristic is determined (see Figure 8).

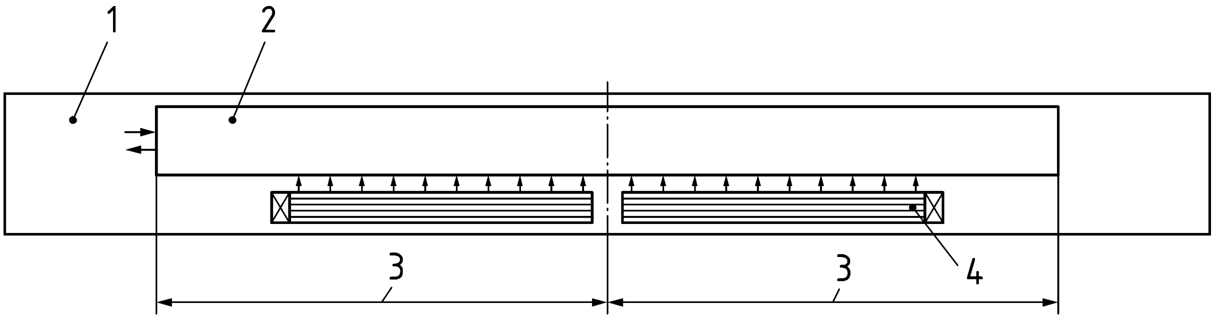
See the following examples (Figure 3 – Figure 9):



Key

1 trench convector - trench
2 convector / radiator
3 basic unit
4 fan

Figure 3 — Example for two basic units, symmetrical fan positioning



Key

1 trench convector - trench

2 convector / radiator

3 basic unit

4 fan

Figure 4 — Example for two basic units, asymmetrical fan positioning

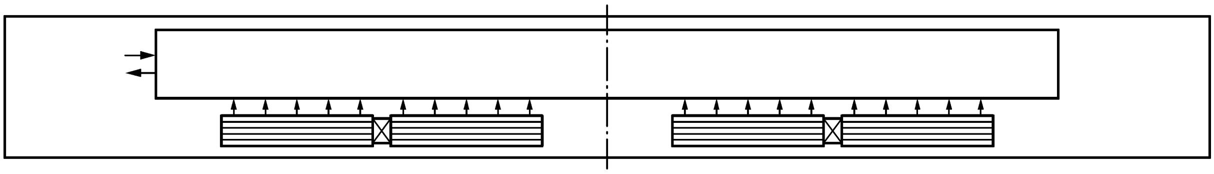
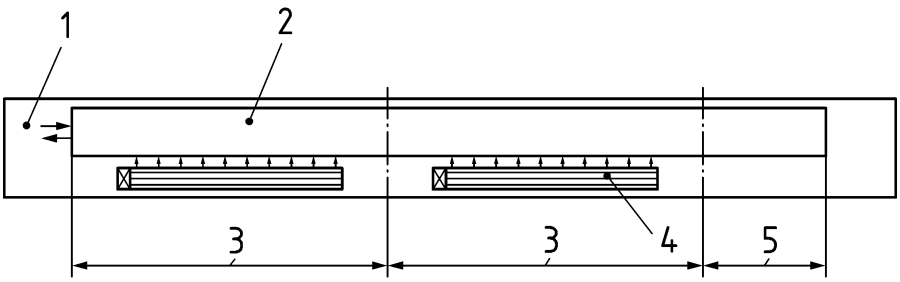


Figure 5 — Example for two basic units with two fans each, symmetrical fan positioning



Key

1 trench convector - trench

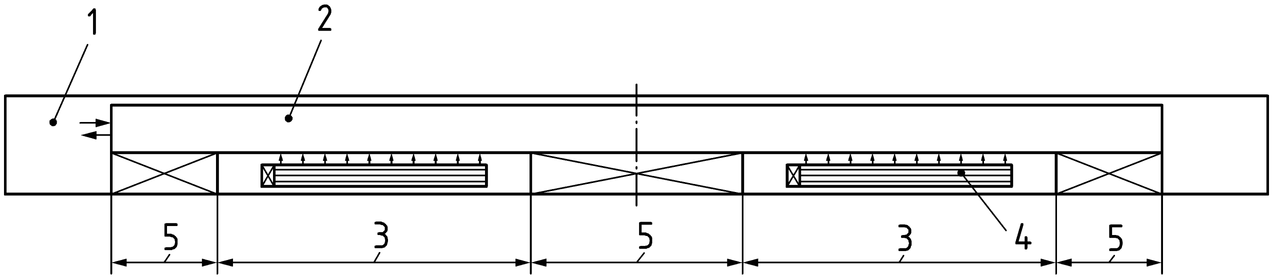
2 convector / radiator

3 basic unit

4 fan

5 extension unit

Figure 6 — Example for two basic units, one extension unit



Key

1 trench convector - trench

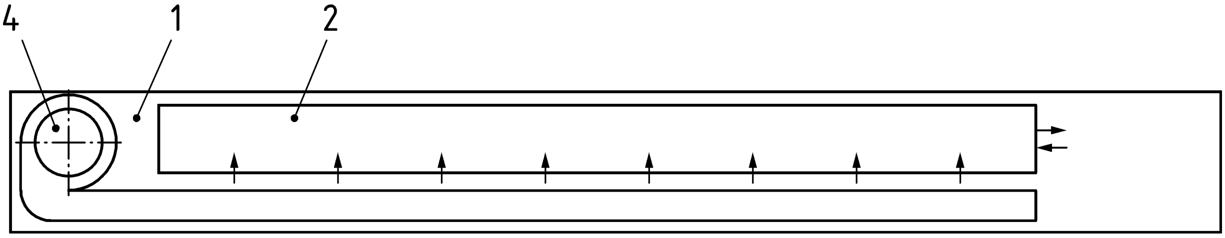
2 convector / radiator

3 basic unit

4 fan

5 extension unit

Figure 7 — Example for two basic units, three extension units



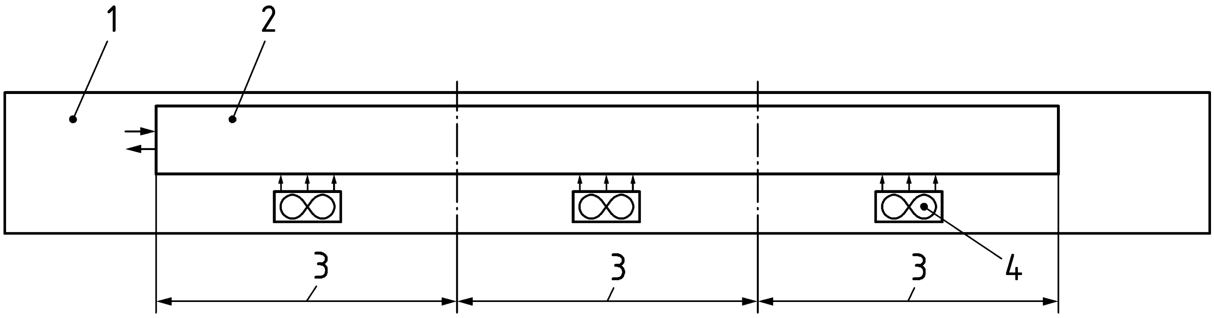
Key

1 trench convector - trench

2 convector / radiator

4 fan

Figure 8 — Example for radial fan at one end of the convector



Key

1 trench convector - trench

2 convector / radiator

3 basic unit

4 fan

Figure 9 — Example for three basic units, symmetrical fan positioning

In case of fan assisted products two possible cases shall be considered:

<u>Case 1: The fan speed is not variable:</u>

A full characteristic curve shall be determined based on the three measuring points mentioned in 4.2.2.1.

1. … with fan(s) off,

2. … with fan(s) on.

<u>Case 2: The fan speed is variable (continuous or multi stage):</u>

A full characteristic curve shall be determined based on the above mentioned three measuring points at a mean speed of the fan(s). For the lowest and the highest fan speed it is sufficient to determine the heat output at ΔT = (50 ± 2,5) K only.

For the characteristic curves at the lowest and highest fan speed it is assumed, that the exponent n is the same as determined for the mean fan speed.

Based on the three measuring points for the mean fan speed a characteristic equation shall be determined as follows:

$\Phi = f(\mathrm{R_{fan}})$ at $\Delta T = 50$ K (2)

$\Phi = K \cdot \mathrm{R_{fan}}^{m}$ (3)

Where:

K is the constant of the characteristic equation;
$\mathrm{R_{fan}}$ is the measured fan rotation speed;
m is the exponent.

The standard output results at $\Delta T = 50$ K and mean fan speed.

For all measuring points of the characteristic equation, the following applies:

Reference air temperature:- t_r = 20 °C ± 0,5 K,

Set point of the water flow: - ± 5 %,

Rotation speed of the fan(s): - measuring accuracy: ± 1 %,

- 5 % speed constancy for the whole characteristic equation,

- 2 % speed constancy for each measuring point.

In a deviation from EN 442-2 for fan assisted trench convectors, the air temperature shall be measured at two points 2 m from the back wall, at the ends of lines corresponding to the left and right sides of the floor trench. The reference temperature then is the average value of the two measured values.

The set point of the water flow results from a standard excess temperature of 50 K and a temperature spread of 10 K between the inlet and the outlet water temperatures and shall be kept constant with a tolerance of ± 5 % for all measuring points.

Additionally the electrical power of the fan(s) shall be measured with an accuracy of at least ± 5 %. The relevant system boundary for this measurement is the electrical mains connector of the tested sample.

4.3 Test report

The test report shall be structured in accordance with EN 442-2 and shall contain, in addition to the information required by EN 442-2, a declaration that the claimed standard output Φ_S for extension units has been determined.

The test report shall give the structural dimensions and material of the trench and the installed trench convector as well as of the convector's covering.

In the case of radiators / convectors with fan(s) the test report shall give, in addition to the information required by EN 442-2, the fan rotation speed as well as the corresponding electrical power of the fan(s). The thermal outputs shall be given for the measured construction size and fan speed levels.

The test report shall be accompanied by manufacturer's drawings showing the structure and dimensions of the convector.

The output values of construction sizes of a particular type that have not been measured can be obtained by interpolation or extrapolation of the tested thermal outputs plotted against the characteristic size, e.g. the radiator length / finned convector length. The output values for all construction sizes and speed levels shall be determined by the testing institute and stated in the test report.

5 Ventilation radiators and trench convectors

5.1 Design

5.1.1 Wall mounted radiators

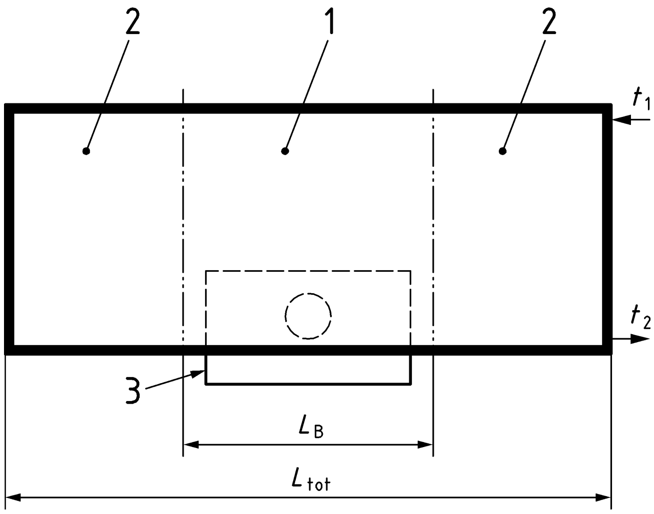
Ventilation radiators generally consist of a serially-produced radiator model of differing lengths, combined with a primary air inlet unit for controlled air feed. In this context, this standard differentiates between the following sections:

- The basic unit of a model consists of the primary air unit and the shortest radiator which can be combined with the primary air unit.

- The radiator extension consists of the total length Ltot of the ventilation radiator, minus the length of the basic unit LB. For the radiator extension, the thermal output /m of the radiator extension applies according to EN 442-2.

The design of the whole radiator, basic unit and radiator extension, is symmetrical.

(See Figure 10).



Key

1 basic unit
2 radiator extension
3 primary air unit
L_B length of the basic unit
L_{tot} total length of the ventilation radiator
t_1 supply temperature
t_2 return temperature

Figure 10 — Wall – ventilation radiator

5.1.2 Trench convectors

Trench convectors with ventilation are supplied with air from an external ventilation unit and have no dedicated fan.

If the supply air only passes part of the convector, the output of the part which has no air supplied is to be considered according to clause 4.2.2 of this standard without ventilation.

Ventilation and trench convectors are generally installed in the floor. They consist of a convector and a primary air unit which is arranged under or beside the convector (see Figure 11, Figure 12 and Figure 13).

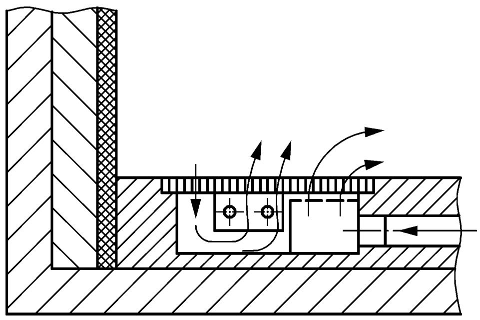


Figure 11 — Displacement ventilation trench convector

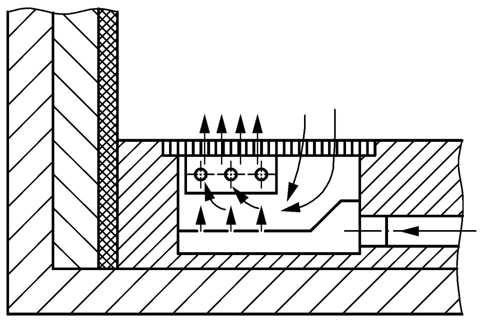


Figure 12 — Ventilation trench convector

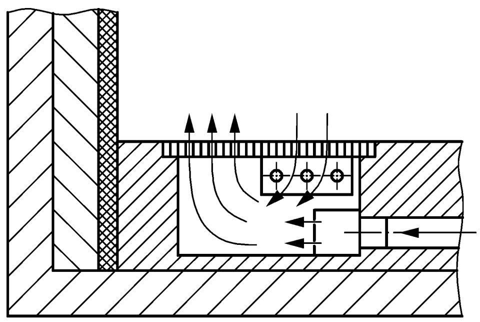


Figure 13 — Inductive ventilation trench convector

5.2 Thermal output testing for ventilation radiators and trench convectors

The thermal output test is performed in a testing system, which consists of a closed testing booth according to EN 442-2.

Contrary to the specifications relating to a testing booth according to EN 442-2, in the left and right walls of the testing booth, an air inflow and outflow shall be installed to enable cool air to be fed to the ventilation radiator and to be drawn out again through the second opening. Additional to the measurements according to EN 442-2, the following measurements shall be recorded:

- Primary air temperature tL1 1 m before entering the primary air unit in the centre of the duct;
- Air outlet temperature tL2 in the centre of the exhaust duct immediately after the exit;

− Air flow rate VL in l/s.

The tolerance requirements of EN 442-2 apply to the temperature measurements including the primary air temperature. The primary air flow rate shall be determined in the area between 5 l/s and 20 l/s with a tolerance of ± 5% or ± 0,5 l/s.

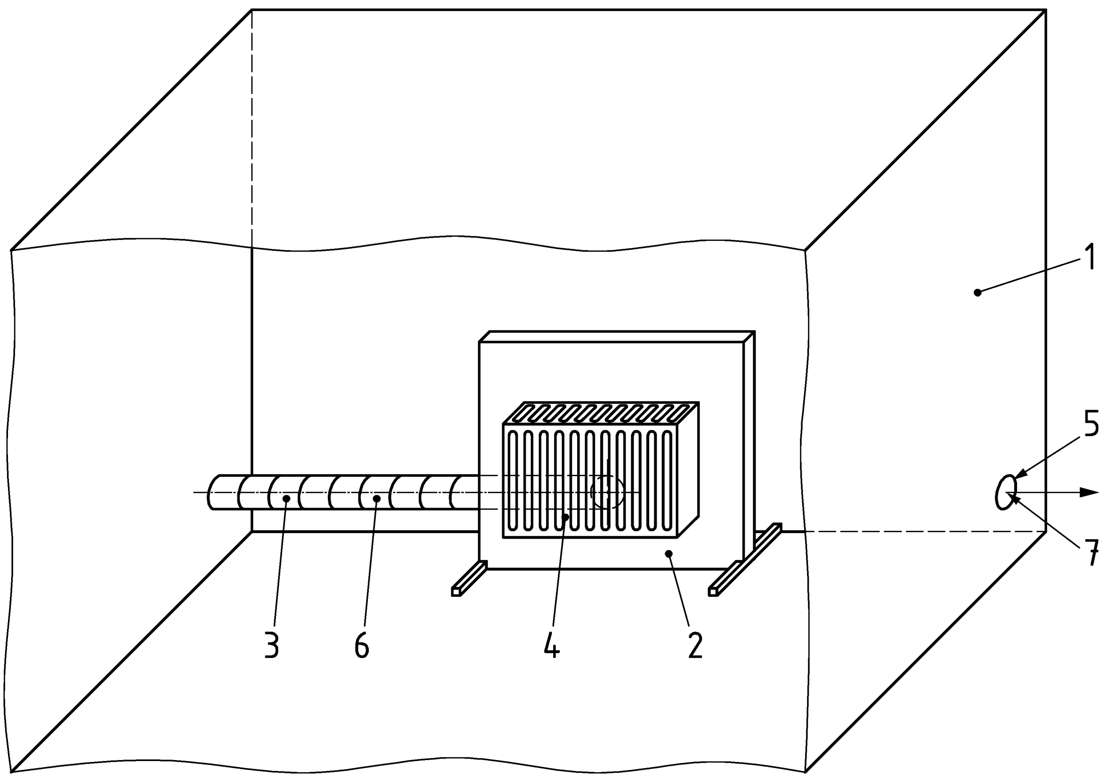
The measuring process for determining the thermal output consists of measuring the water flow rate and the enthalpy difference between the water inlet and outlet (weighing method). Other measuring methods shall at least equal the precision of the weighing method.

All testing laboratories performing tests according to this standard shall perform comparative measurements with other testing laboratories (according to EN 442-2).

5.3 Test facilities

5.3.1 General

For testing wall positioned ventilation radiators a stud wall is installed approximately 200 mm parallel to the non-cooled back wall of the testing booth, which enables the radiator to be mounted and the air connection to be installed (see Figure 14).



Key

1 Test booth according to EN 442-2

2 Stud partition to mount the test specimen

3 Flexible, insulated primary air pipe

4 Ventilation radiator

5 Air outlet

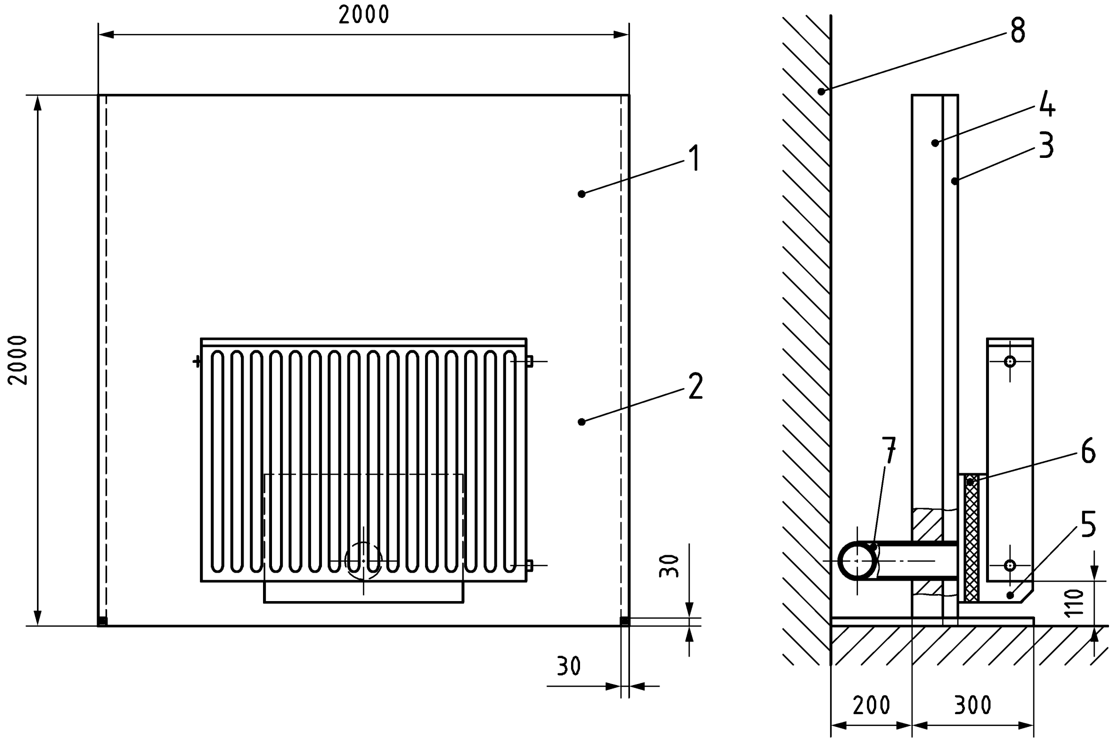
6 t_{L1} Primary air temperature measuring location

7 t_{L2} Exhaust air temperature measuring location

Figure 14 — Test booth with installation of a wall-mounted ventilation radiator

The stud wall (see Figure 15) consists of wooden panels with a metal section stand, on which the wall positioned ventilation radiator to be tested is mounted according to the manufacturer's specifications and to which the primary air feed can be connected from the back. In order to have room for the air connection, the stud wall shall be placed centrally, at a distance of 200 mm, in front of the non-cooled wall of the testing booth.

Dimensions in millimetres



Key

1 Stud partition

2 Radiator

3 Wooden mounting panel (requirements see below) and primary air inlet (according to manufactures instruction)

4 Metal profile stand

5 Primary air inlet unit

6 Primary air filter

7 Primary air inlet

8 Back wall of test booth

Figure 15 —Stud wall with example of the installation of a wall-mounted ventilation radiator

The requirements for the mounting panel are as follows:

— material: plywood (see EN 636),

— density: at least 400 kg/m³,

— thickness: at least 19 mm,

— length/width:

  — basic units up to a length of 1 m: 2 m,

  — basic units of a length > 1 m: length of the basic unit + 1 m,

— height:

    — basic units up to a height of 1 m: 2 m,

    — basic units of a height > 1 m: height of the basic unit + 1 m,

— position in the cabin: parallel and central to the back wall at a distance of 200 mm,

— emission coefficient: at least 0,9 (see EN 442-2).

For trench convectors the inlet air tube shall be installed in the floor in order not to disturb the airflow towards the convector. (see Figure 16).

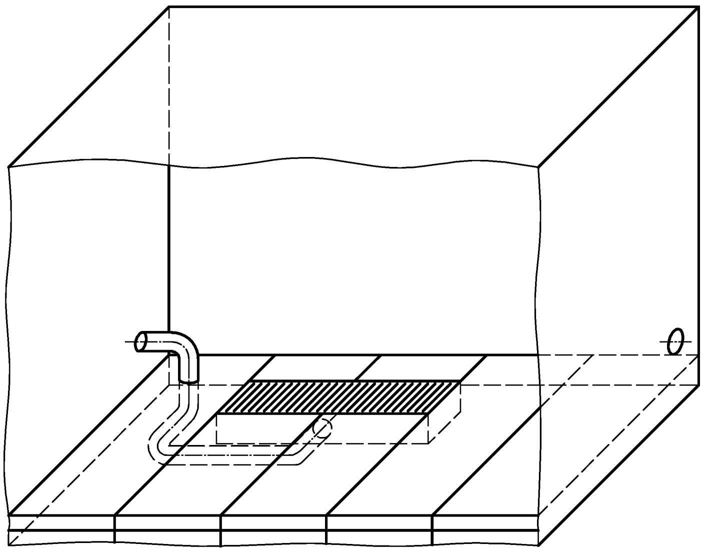
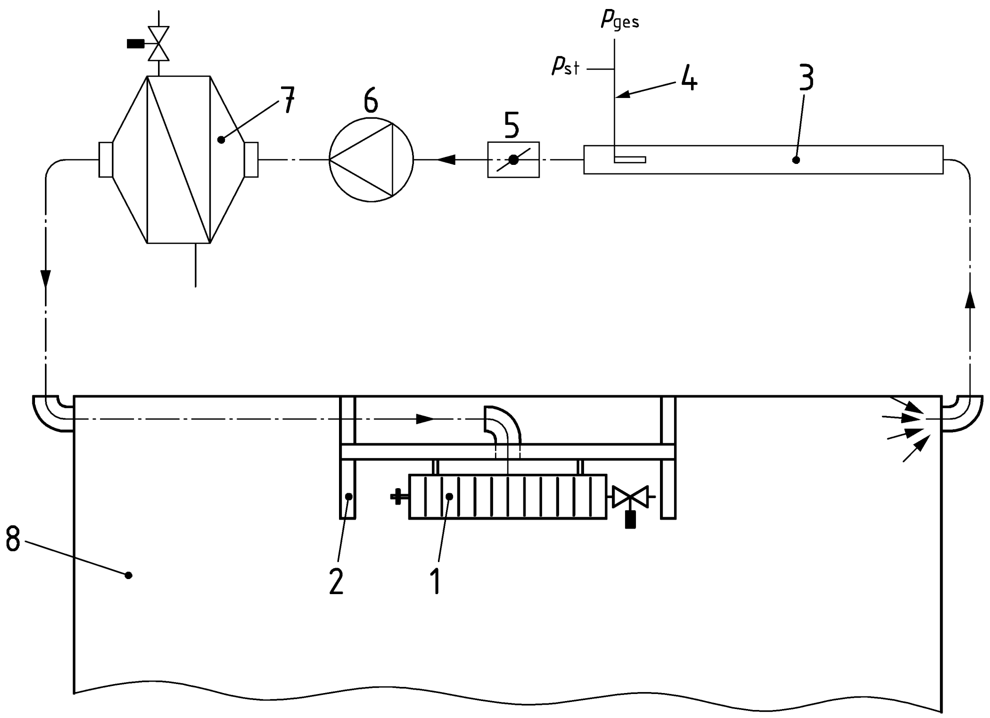


Figure 16 — Installation of the inlet air duct for trench convectors

5.3.2 Ventilation facility

As shown in Figure 17 by way of example, the ventilation facility consists of a primary air duct system with the following functional units: air flow measuring unit, air regulator unit, ventilator and air cooling unit. First the air flow extracted from the test booth by the ventilator is measured, is then cooled to the desired primary air temperature in an air cooler before finally being fed to the ventilation radiator via a thermally insulated duct system (conductivity at least 0,04 W/(m·K), thickness at least 30 mm). The ventilation unit shall be dimensioned in such a way that air flow rates between 5 l/s (18 m³/h) and 20 l/s (72 m³/h) can be extracted from the test booth, cooled down to -10°C ± 1K and then fed back to the test booth. The entire primary air assembly shall be airtight.



Key

1	Ventilation radiator	5	Air regulator unit
2	Stud wall	6	Ventilator
3	Speed measuring duct	7	Air cooler
4	Pitot tube according to Prandtl or measuring orifice	8	Test booth

Figure 17 — Ventilation facility

5.4 Test method

The test method is performed in accordance with EN 442-2.

5.5 Test

5.5.1 General

The natural convection within the test booth shall not be influenced by additional installations.

5.5.2 Test structure

The test sample shall be installed in the test booth according to the manufacturer's instructions.

5.5.3 Selection of heating appliances to be tested

The heights of a type to be tested are selected according to EN 442-2.

As far as the lengths are concerned, the basic unit of the model shall be selected, i.e. the shortest radiator length, which the manufacturer combines with the relevant ventilation unit. (Definition of basic unit: see Clause 4). The lengths of the models to be tested within a type shall, if possible, be selected uniformly.

5.5.4 Standard reference point and standard water flow rate

The standard reference point (t1/ t2/ tr / tL1) is based on the following parameters:

— inlet water temperature t1=75°C,

— outlet water temperature t2=65°C ,

— reference air temperature tr=20°C ,

— primary air temperature tL1=-10°C, for ventilation radiators with a direct connection to the outside air

— primary air temperature tL1 = +18 °C for trench convectors with displacement or inductive ventilation or similar,

— excess temperature to room air temperature ΔT = tm-tr = 50 K, (*t*m = mean water temperature)

— excess temperature to the air inlet temperature ΔT_{L1} = tm-tL1 = 80 K,

— standard primary air flow rate VL,S = 10 l/s.

The water flow rate (standard water flow rate) shall be set so that at the standard reference point, there is a temperature difference between the inlet and outlet temperatures of approx. 10 K. This water flow rate shall then be kept constant for all tested points.

When determining all measuring points of a characteristic curve, the flow rate shall be constant for each measuring point and it shall not differ from the standard water flow rate by more than 5 %.

For primary air systems with regenerative primary air pre-warming, tests can be performed with additional primary temperatures if the manufacturer requests this. The chosen primary air temperature shall be specified in the test report.

5.5.5 Test temperatures and test scope

A characteristic curve field with 3 characteristic curves each for the following primary air volume flow rates shall be determined, as long as there are no other requests from the manufacturer.

— standard primary air flow rate VL,S = 10 l/s,

— maximum primary air flow rate VL,max according to manufacturer's instructions,

— without primary air flow rate VL,0 = 0 l/s.

In order to determine a characteristic curve, measurements shall be taken for three different excess temperatures for the ventilation radiator. The excess temperatures shall be within the following ranges:

— $\Delta T/\Delta T_{L1}$ = 60K±2,5K / 90K ± 2,5K,

— $\Delta T/\Delta T_{L1}$ = 50K±2,5K / 80K ± 2,5K,

— $\Delta T/\Delta T_{L1}$ = 30K±2,5K / 60K ± 2,5K.

5.5.6 Steady state conditions

During the entire test duration, the steady state conditions shall be maintained in the test booth. The test values shall be recorded at regular intervals by using a data acquisition system. The steady state conditions can be seen to be achieved if the standard deviations of all (at least 12) individual measurements in at least 30 min are smaller than half of the ranges named below:

— water temperatures ± 0,1 K,

— reference air temperature ± 0,1 K,

— primary air temperature ± 0,2 K,

— water flow rate ± 1,0 %,

— primary air flow rate ± 2,5 %.

There is no requirement for the primary air humidity given in this standard.

5.5.7 Correction due to the air pressure

Taking account of an atmospheric pressure deviating from p_O = 101,3 kPa, the thermal output measured Φme shall be corrected as follows:

$$\Phi = \Phi_{me}\left(S^* + \left(1 - S^*\right)\left(\frac{p_0}{p}\right)^{np}\right) \tag{4}$$

$S^* = S_k$ for ventilation radiator without primary air,

$S^* = 0,6 \cdot S_k$ for ventilation radiator with primary air.

Where:

S_k is the radiated heat output factor of the radiator according to EN 442-2,

np is the air pressure correction exponent according to EN 442-2,

p is the barometric pressure measured during the test,

p_O is the atmospheric pressure,

Φ_{me} is the thermal output measured during the test.

5.5.8 Test results – characteristic curves field

The values of the thermal output corrected according to 5.5.7 are plotted against the heating water excess temperature ΔT, see Figure 18. For the primary air flow rates VL,0, VL,S and VL,max , the characteristic curves and their mathematical functions are determined. The characteristic curve field for a model is:

Characteristic equations for the test sample:

$$\Phi_0 = K_0 \cdot \Delta T^{n_0} \tag{5}$$

$$\Phi_{10} = K_{10} \cdot \Delta T^{n_{10}} \tag{6}$$

$$\Phi_{max} = K_{max} \cdot \Delta T^{n_{max}} \tag{7}$$

Where:

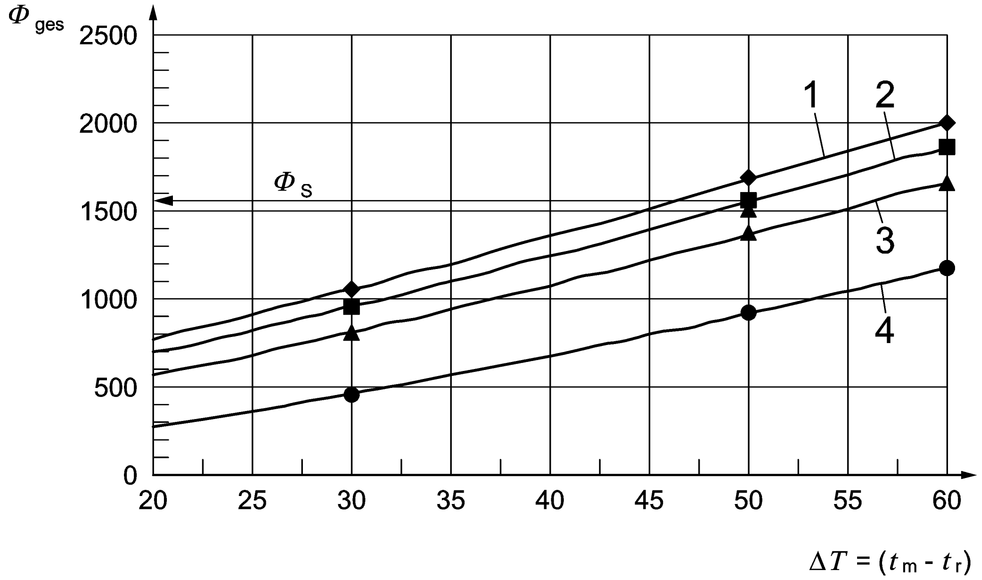
Φ_0, Φ_{10} Φ_{max} are the thermal outputs at a primary air flow rate VL,0, VL,S and VL,max,

K_0, K_{10} K_{max} are the constants at a primary air flow rate VL,0, VL,S and VL,max,

n_0, n_{10} n_{max} are the exponents at a primary air flow rate VL,0, VL,S and VL,max.

At the manufacturer´s request a further characteristic curve for $V_{L,S}/2$ = 5 l/s can be measured.

The constants K and the exponent n are determined using least square regression. The standard thermal output is calculated based on the characteristic formula (6).



Key

1 Φ_{max} ($V_{L,max}$=15 l/s)

2 Φ_{10} ($V_{L,S}$=10 l/s)

3 Φ_5 ($V_{L,S}/2$ = 5 l/s)

4 Φ_0 ($V_{L,0}$ = 0 l/s)

Figure 18 — Example of a characteristic curve field of the total thermal output of a test sample

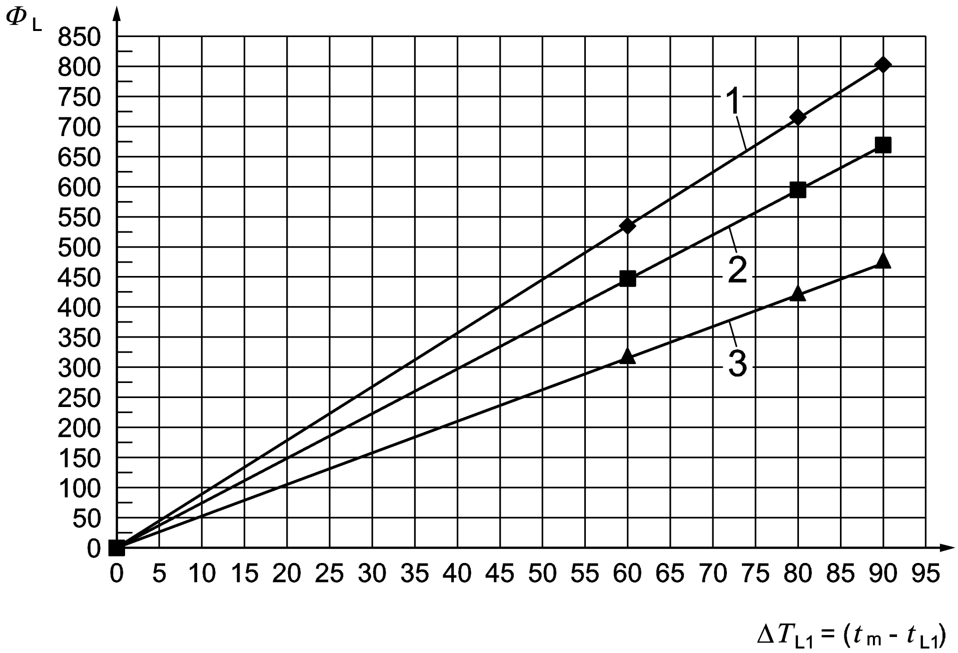
5.5.9 Standard thermal output

5.5.9.1 General

The standard thermal output Φ_S is the thermal output of the basic unit at the standard conditions according to 5.5.4.

5.5.9.2 Determining the thermal output Φ_{ZL} to the primary air flow

The thermal output relating to the primary air is based on the difference between the thermal output with primary air flow and the thermal output without primary air flow. The thermal output Φ_{ZL} determined in this way results in a characteristic curve field according to Figure 19 depending on the difference between the medium water temperature tm and the primary air temperature t_{L1} for different primary air flow rates.



Key

1 V_L= 15 l/s, Φ_{ZL}=8,96·ΔT_{L1}

2 V_L= 10 l/s, Φ_{ZL}=7,44·ΔT_{L1}

3 V_L= 5 l/s, Φ_{ZL}=5,27·ΔT_{L1}

Figure 19 — Example of a characteristic curve field for thermal output relating to primary air

Based on the data in Figure 19 regression can be used in order to create an equation for the thermal output relating to the primary air flow rate V_L in l/s

$$\Phi_{ZL} = K_L \cdot \Delta T_{L1} \cdot V_L^{nL} \quad (8)$$

Where:

K_L is the constant of the equation relating to the primary air,

n_L is the exponent,

ΔT_{L1} is the excess temperature to the air inlet temperature,

V_L is the air flow rate.

5.5.9.3 Determining the thermal output of the ventilation radiator

For the basic unit, this results in the overall thermal output from formula 5 plus formula 8

$$\Phi_B = \Phi_0(\Delta T) + \Phi_{ZL}(\Delta T_{L1}, V_L) = K_0 \cdot (t_m - tr)^{n0} + K_L \cdot (t_m - t_{L1}) \cdot V_L^{nL} \quad (9)$$

Where:

Φ_0 is the thermal output of the radiator at a primary air flow rate $V_{L,0}$,

Φ_{ZL} is the thermal output of the radiator at a primary air flow rate V_L.

The thermal output of a ventilation radiator Φ_{LHK} with a total length Ltot consisting of several basic units can then be calculated on the basis of the thermal output of the basic units $z_n \cdot \Phi_B$ plus the thermal output of the extension Φ_E. The thermal output of the extension can be calculated using the characteristic equation of the model from the radiator test according to EN 442-2.

$$\Phi_{LHK} = z_n \cdot \Phi_B + \Phi E \quad (10)$$

Where:

z_n is the number of basic units.

$$\Phi E = \Phi_L \, (\Delta T / \Delta T_S)^n \cdot (L_{tot} - z_n \cdot L_B) \quad (11)$$

Where:

Φ_L is the thermal output of the radiator without primary air unit according to EN 442-2,

n is the exponent of the radiator without primary air unit according to EN 442-2,

ΔT is the excess temperature,

ΔT_S is the standard excess temperature of 50K,

L_{tot} is the total length of the radiator,

L_B is the length of the basic unit,

z_n is the number of basic units.

5.6 Test report

5.6.1 General

The test laboratory shall compile a test report based on the processes and calculations contained in this standard. The test report shall meet the requirements of EN ISO/IEC 17025.

5.6.2 Data

Apart from the test values according to EN 442-2, the test report shall contain the following data:

— Primary and exhaust temperature tL1, t_{L2},

— Primary air flow rates V_L,

— The characteristic curve field of the tested model,

— The characteristic curve field for thermal output relating to the primary air,

— The standard thermal output of the tested model,

— The length of the basic unit L_B of the wall ventilation radiator or convector and the length of the part of the basic unit or convector receiving primary air L_L ,

— A detailed construction drawing of the test sample.

The thermal outputs of the model shall be mathematically rounded, to one decimal place for values under 100 W, otherwise to the whole number.

The functional exponents ≥1,00 shall be rounded to two decimal places or otherwise to 3 decimal places.

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