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Prezraļ evanje stavb ï Hladni stropi ï Preskuģanje in vrednotenje

Ventilation for buildings - Chilled ceilings - Testing and rating

Lüftung von Gebäuden - Kühldecken - Prüfung und Bewertung

Ventilation de bâtiments - Plafonds refroidis - Essais et évaluation

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Ventilation for buildings - Chilled ceilings - Testing and rating

Ventilation de bâtiments - Plafonds refroidis - Essais et évaluation

Lüftung von Gebäuden - Kühldecken - Prüfung und Bewertung

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Foreword

This document (EN 14240:2004) 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of an identical text or by endorsement, at the latest by July 2004, and conflicting national standards shall be withdrawn at the latest by July 2004.

Annex A is informative.

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

1 Scope

This European Standard specifies test conditions and methods for the determination of the cooling capacity of chilled ceilings and other extended chilled surfaces.

The purpose of the standard is to give comparable and repeatable product data.

The test method applies to all types of surface cooling systems using any medium as energy transport medium.

NOTE The result is valid only for the specified test set up. For other conditions (i.e. different positions of heat loads, forced flow around the test object, variations in surface area) the producer should give guidance based on full-scale tests.

This standard refers to water as the cooling medium throughout, however wherever water is specified any other cooling medium can also be used in the test. Where air is the transport medium this air may not be discharged into the test room. In addition, this standard refers to chilled surfaces and where "surfaces" are specified this should be taken to include ceiling, wall or floor as appropriate.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendment to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12792, *Ventilation for buildings – Symbols, terminology and graphical symbols.*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions in EN 12792 together with the following apply.

3.1.1
chilled surfaces
surfaces that are part of the room periphery (such as ceiling, walls and floor) and cooled with water

3.1.2
test room
room in which the test object is mounted

3.1.3
room air temperature (θ_a)
air temperature measured with radiation shielded sensor

3.1.4
globe temperature (θ_g)
dry resultant temperature of the room, measured with a temperature sensor placed in the centre of the globe as in 4.3

3.1.5
reference room temperature (θ_r)
average of the measured globe temperature, measured in the middle of the room at a height of 1,1 m above the floor, during the test period

3.1.6
cooling water flow rate (q_w)
average of the measured water flow rate during the test period

3.1.7
cooling water inlet temperature (θ_{w1})
average of the measured water temperature into the test object during the test period

3.1.8
cooling water outlet temperature (θ_{w2})
average of the measured water temperature out of the test object during the test period

3.1.9
mean cooling water temperature (θ_w)
the mean value of the sum of the cooling water inlet and outlet temperatures

3.1.10
temperature difference ($\Delta\theta$)
difference between reference room temperature and mean cooling water temperature [$\Delta\theta=\theta_r-\theta_w$]

3.1.11
specific heat capacity (c_p)
heat required to raise the temperature of a unit mass of the cooling medium by 1 K

NOTE c_p for water = 4,187 kJkg^{-1}K^{-1} at 15°C.

3.1.12
test room area (A_t)
area of the test room surface (ceiling, wall or floor) on which the test object is located (see Figure 1).

3.1.13
installation area (A_i)
projection of the total test object onto the room surface, including all intermediate surface channel supports and air gaps, associated with normal panel installation (see Figure 1)

3.1.14
panel area (A_p)
projection of the panels onto the room surface, excluding intermediate surface channel supports and air gaps associated with normal panel installation (see Figure 1)

3.1.15
active area (A_a)
reference area to calculate the specific cooling capacity of the test object (see Figure 2)

3.1.16
cooling capacity (P)
total cooling capacity of the test object calculated from the measured cooling water flow rate and the cooling water temperature rise

3.1.17
specific cooling capacity of a chilled surface (P_a)
cooling capacity divided by the active area of the chilled surface

3.1.18
nominal temperature difference ($\Delta\theta_N$)
temperature difference between the reference room temperature and the mean cooling water temperature

3.1.19
nominal cooling water flow rate (q_{wN})
flow rate that gives a cooling water temperature rise of (2 ± 0,2) K at the nominal temperature difference of 8 K

3.1.20
nominal cooling capacity (P_N)
cooling capacity calculated from the curve of best fit for the nominal cooling water flow rate at the nominal temperature difference ($\Delta\theta_N$)

3.2 Symbols and units

For the purposes of this European Standard, the symbols in CR 12792 together with those given in Table 1 apply.

Table 1 – Symbols and units

Symbol	Quantity	Unit
A_a	Active area	m^2
A_i	Projection area of the total test object onto the room surface	m^2
A_p	Projection area of the panels on to the room surface	m^2
A_t	Area of test room surface	m^2
c_p	Specific heat capacity	KJkg^{-1}K^{-1}
h	Height from floor to under side of false ceiling [$h = h_r - h_v$]	m
h_r	Inside room height including void depth	m
h_v	Void depth	m
l_r	Inside room length	m
n_r	Number of dummies in one row	
P	Total cooling capacity [$P = c_p \cdot q_m \cdot (\theta_{w2} - \theta_{w1})$]	W
P_a	Specific cooling capacity re active area [$P_a = P/A_a$]	Wm^{-2}
P_i	Specific cooling capacity re projection area of total test object [$P_i = P/A_i$]	Wm^{-2}
P_t	Specific cooling capacity re area of test room surface [$P_t = P/A_t$]	Wm^{-2}
P_B	Total thermal transfer through all boundaries	W
P_N	Nominal cooling capacity	W
$P(R_a)$	Statement of measured performance for tested active area - R_a - For example expressed as $P(85)$	Wm^{-2}
P_s	Total heating capacity of the dummies	W
P_t	Specific cooling capacity [$P_t = P/A_t$]	Wm^{-2}
q_m	Cooling medium mass flow [$q_m = \rho_w . q_w$]	Kgh^{-1}
q_w	Cooling medium flow rate	Lh^{-1}
R_a	Active area ratio [A_a / A_i x 100]	%
s	Thickness of insulation	m
w_r	Inside room width	m
ρ_w	Density of cooling medium at θ_w	Kgl^{-1}
θ_a	Room air temperature	°C
$\Delta\theta$	Temperature difference	K
$\Delta\theta_N$	Nominal temperature difference [$\Delta\theta_N = \theta_r - \theta_w = 8K$]	K
θ_g	Globe temperature	°C

θ_r	Reference room temperature	°C
θ_{W1}	Cooling water inlet temperature	°C
θ_{W2}	Cooling water outlet temperature	°C
θ_W	Mean cooling water temperature [θ_w=0,5·(θ_{w1}+θ_{w2})]	°C
λ	Thermal conductivity	$Wm^{-1}K^{-1}$

4 Test method

4.1 Principle

The cooling capacity of the test object shall be determined from measurements of the cooling water flow rate, and the cooling water temperature rise, under steady state conditions. The cooling capacity shall be presented as a function of the temperature difference between the reference room temperature and the mean cooling water temperature.

The measurements shall be performed in an airtight room, to the requirements of 4.2, with controlled temperatures on the inside surfaces and with negligible heat flow through the perimeters of the room. To balance the cooling capacity of the test object, heating is supplied in the test room by means of a number of electric heated dummies placed on the floor within the test room. In order to obtain reproducible results, the dummies shall be placed in pre-determined positions as described in 4.4.

4.2 Test room

The floor area of the test room shall be between 10,0 m^2 and 21,0 m^2.

The ratio of width to length of the test room shall be not less than 0,5 and the inside height shall be between 2,7 m and 3,0 m.

The recommended inside dimensions are a length of 4 m, a width of 4 m and a height of 3 m.

NOTE The test room specification enables the use of test rooms in accordance with EN 442 for the testing of chilled surfaces. The dimensions of the test room are given as a recommendation. It is permitted for the test room dimensions to deviate from the recommended dimensions.

The test room shall be sufficiently tight to minimise flow from the ambient air outside which shall not exceed 0.8 $ls^{-1}m^2$ of the perimeter surface at a pressure difference of 50 Pa (note includes floor walls and ceiling). The air within the test room shall not be influenced by any forced air flow.

The inner wall and floor temperature can be controlled by different methods, for instance:

a) water panels covering all the outside surfaces with circulating temperature controlled water;

b) forced air flow circulation, temperature controlled with electric heaters, in an external room.

The walls, floor and ceiling of the test room shall be insulated in such a way, that during the test the average heat flow through these surfaces is less than 0,40 Wm^{-2}. This heat flow shall be determined by means of preliminary calibration tests of the room, or by calculation.

The radiation emission rate of the inner surfaces of the room shall be at least 0,9.

It is recommended that fixed temperature sensors should be installed at least in the centre of each room surface.

NOTE It is assumed that the insulation is placed inside, however if placed outside, the position of the temperature sensor should be in the outer surface of the insulating layer and covered locally with required insulation to ensure accurate measurement of the surface temperature.

4.3 Instrumentation

The heating of the test room is provided by means of a number of electrically heated dummies (see Figure 5) placed on the floor inside the test room.

The power to each dummy shall not exceed 180 W and shall be continuously adjustable, for instance with a variable voltage transformer or with thyristor.

The number of dummies shall be even and chosen so that each dummy covers an average floor area of 0,9 m^2 to 1,35 m^2 (i.e. the maximum heat load is 200 Wm^{-2}).

The casing of the dummies consists of lacquered steel sheet. The emission rate of the inner and outer surface should be at least 0,9. The real electric power to the dummies shall be measured with a wattmeter of quality class 1,0 % or better.

Air temperatures shall be measured by radiant shielded sensors with an accuracy of measurement equal to, or better than, ± 0,1 K.

Surface temperatures shall be measured by sensors fixed to the surface, which have an accuracy of measurement equal to, or better than, ± 0,1 K.

Globe temperature shall be measured with a sensor with accuracy of measurement equal to, or better than, ± 0,1 K placed in the centre of a black globe with diameter 60 mm - 150 mm, according to ISO 7726.

The temperature of the water into and out of the test object shall be measured by sensors, placed in the water flow immediately before and after the test object, with an accuracy of measurement equal to, or better than, ± 0,1 K. These sensors shall be calibrated to provide an accuracy of measurement of the cooling water temperature rise within ± 0,02 K. The sensor placed in the globe shall be calibrated together with the water temperature probes to give an accuracy of measurement of the temperature difference between the reference room temperature and the inlet and outlet water temperatures equal to, or better than, ± 0,05 K.

The water flow rate shall be measured with a flow meter calibrated by a weighing method to an accuracy equal to, or better than, ± 0,5 %.

The dew point temperature of the test room air shall be measured using an instrument with sufficient accuracy to ensure that the dew point is at least 2 K lower than the water inlet temperature.

4.4 Test procedure

4.4.1 Test set up

The test object shall be installed in the test room in accordance with the manufacturer's instructions (see Figure 1). Where the test ceiling is smaller than the test room then the infill panels between the test ceiling and the test room perimeter should be suitably air tight and thermally insulated to the requirements give in 4.2. The projection area of the test object shall be at least 70 % of the area of the test room surface, which can be expressed as follows:

$$R_i = \frac{A_i}{A_t} > 0{,}7 \qquad (1)$$

where

R_i is the installation area ratio;

A_i is the installation area;

and A_t is the test room area.

The active area ratio can also be calculated as follows:

$$R_a = \frac{A_s}{A_i} \tag{2}$$

where

R_a is the active area ratio;

A_s is the active area;

and A_i is the installation area.

Where the installation details do not define the location of the test object on the total surface then the test object shall be centralised on the total surface, and if relevant the longest side of the test object shall be parallel to the longest side of the total surface. The void behind the surface containing the test object shall not exceed 300 mm.

Where water header pipework is not part of the standard installation and is particular to the test installation then this pipework shall be insulated with a maximum thermal conductivity of the surface of 4 W/m^2·K

The dummies are located in two rows, symmetrically along the longest centre-line of the room. The distance between the rows shall be half of the room width.

The distance between the centres of the dummies in each row shall be calculated from the following:

$$b = \frac{l_r}{n_r} \tag{3}$$

where

b is the distance between the centres of the dummies in each row;

l_r is the room length;

and n_r is the number of dummies in the row.

The distance from the end walls to the centre of the nearest dummy shall be half the distance between dummies.

Typical examples are shown in Figures 3 and 4.

The properties of the dummies are specified in Figure 5.

NOTE In the case of a chilled floor the dummies are suitable for standing directly on the floor.