SLOVENSKI PREDSTANDARD

oSIST prEN 15116:2005

marec 2005

Ventilation in buildings - Chilled beams - Testing and rating of active chilled beams

ICS 91.140.30

Referenčna številka
oSIST prEN 15116:2005(en)

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 15116

December 2004

ICS

English version

Ventilation in buildings - Chilled beams - Testing and rating of active chilled beams

Ventilation dans les bâtiments - Poutres refroidies - Essais et évaluation des poutres refroidies actives

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Ref. No. prEN 15116:2004: E

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Foreword

This document (prEN 15116:2004) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

1 Scope

This European Standard specifies methods for measuring the cooling capacity of chilled beams with forced air flow. The evaluation of aerodynamic air performance should be based on the requirements of WI156080 and the requirements set out in this standard.

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

The test method applies to all types of convector cooling systems with forced air supply using any medium as energy transport medium. This standard only applies to situations where induced air only passes through the heat exchanger (primary air does not pass through the heat exchanger).

NOTE The result is valid only for the specified test set up. For other conditions, (i.e. different positions of heat loads, inactive ceiling elements around the test objects), the producer should give guidance based on full scale tests.

This standard refers to water as the main cooling medium , with the possibility of additional cooling from the primary air. Wherever water is written, any other cooling medium can also be used in the test.

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,*Ventilation for buildings — Symbols, and terminology*

EN ISO 7726, *Ergonomics of the thermal environment — Instruments for measuring physical quantities*

EN 13182, *Ventilation for buildings — Instrumentation requirements for air velocity measurements in ventilated spaces*

prEN 14240, *Ventilation for buildings — Chilled ceilings — Testing and rating*

prEN 14518, *Ventilation for buildings — Chilled beams — Testing and rating of passive chilled beams*

WI156080, *Air terminal devices- aerodynamic testing and rating for mixed flow applications for non-isothermal testing — Part 1: Cold jets*

3 Definitions and symbols

3.1 Definitions

For the purposes of this standard, the definitions in EN 12792 apply together with the following:

3.1.1
active chilled beam
convector with integrated air supply where the induced air or primary air plus induced air pass through the cooling coil(s). The cooling medium in the coil is water

3.1.2
test room
room in which the test object is mounted

3.1.3
primary air flow rate (q_p)
airflow supplied to the test object through a duct from outside of the test room

3.1.4
induced air flow rate (q_i)
secondary airflow from the test room induced into the test object by the primary air

3.1.5
exhaust air flow rate (q_e)
airflow discharged from the test room. The exhaust air flow rate is the same as the primary air flow rate

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

3.1.7
nominal cooling water flow rate (q_{wN})
flow rate that gives a cooling water temperature rise ($\theta_{w2} - \theta_{w1}$) of 2 K ± 0,2 K at nominal temperature difference ($\Delta\theta_N$ = 8 K) and at nominal air flow rate

3.1.8
room air temperature (θ_a)
average of air temperatures measured with radiation shielded sensors in 1,1 m height in positions out of the main air current from the test object

3.1.9
globe temperature (θ_g)
temperature measured with a temperature sensor placed in the centre of the globe. The globe is placed in 1,1 m height in a position out of the main air current from the test object

3.1.10
reference air temperature (θ_r)
reference air temperature equals average air temperature of the induced air on the inlet side of the cooling coil(s), measured with radiation shielded sensors in two positions along the induced air opening

3.1.11
cooling water inlet temperature (θ_{w1})
average of the measured water temperature into the test object during the test period

3.1.12
cooling water outlet temperature (θ_{w2})
average of the measured water temperature out of the test object during the test period

3.1.13
mean cooling water temperature (θ_w)
mean value of the cooling water inlet and outlet temperatures, [θ_w=0,5·(θ_{w1} + θ_{w2})]

3.1.14
primary air temperature (θ_p)
average of the primary air temperature during the test period

3.1.15
temperature difference ($\Delta\theta$)
difference between reference air temperature and mean cooling water temperature, $\Delta\theta = \theta_r - \theta_w$

3.1.16
nominal temperature difference ($\Delta\theta_N$)
nominal temperature difference (8 K) between the reference air temperature and the mean cooling water temperature ($\Delta\theta_N = \theta_r - \theta_w = 8$ K)

3.1.17
primary air temperature difference ($\Delta\theta_p$)
temperature difference between the reference air temperature and the primary air temperature

3.1.18
specific heat capacity (c_p)
heat required to raise the temperature of a unit mass of the cooling medium by 1K

NOTE c_p for water = 4,187 $kJ \cdot kg^{-1} \cdot K^{-1}$ and c_p for air = 1,005 $kJ \cdot kg^{-1} \cdot K^{-1}$, at 15 °C.

3.1.19
cooling length (L)
active length of the cooling section

3.1.20
total length (L_t)
total installed length of the cooling section including casing

3.1.21
water side cooling capacity (P_w)
cooling capacity of the test object calculated from the measured cooling water flow rate and the cooling water temperature rise $P_w = c_p\, q_m\, (\theta_{w2} - \theta_{w1})$

3.1.22
air side cooling capacity (P_a)
cooling capacity calculated from the primary air flow rate and primary air temperature difference. $P_a = c_p\, q_p\, \rho_p\, (\theta_r - \theta_p)$

3.1.23
specific cooling capacity per unit length (P_L)
water side cooling capacity divided by the (active) cooling section length

3.1.24
specific cooling capacity (P_K)
cooling capacity divided by the difference between reference air temperature and mean cooling water temperature, $\Delta\theta = \theta_r - \theta_w$ raised to the exponent m i.e. $P_K = P/\Delta\theta^m$

3.1.25
nominal cooling capacity (P_N) or nominal specific cooling capacity (P_{LN})
water side cooling capacity calculated from the curve of best fit for the nominal cooling water flow rate at nominal temperature difference ($\Delta\theta_N$ = 8 K) and at nominal air flow rate

3.2 Symbols and units

For the purposes of this standard the symbols in EN 12792 apply together with those given in Table 1.

Table 1 — Symbols and units

Symbol	Quantity	Unit
A	Constant in $P_K = Aq\ p^n$	
k_1	Constant in $P = k1\ \ \Delta\theta^m$	
k_2	Constant in $P = k2\ \ qp^n$	
n	Exponent used in $P_K = Aq\ p^n$	
m	Exponent used in $P_K = P/\Delta\theta^m$	
L	Cooling length (active length)	M
L_t	Total length of a chilled beam, including casing	M
c_p	Specific heat capacity	$kJ \cdot kg^{-1} \cdot K^{-1}$
h	Height from floor to underside of active chilled beam	M
P	Total cooling capacity	W
P_L	Specific cooling capacity per unit active length	$W\ m^{-1}$
P_N	Nominal cooling capacity (at $\Delta\theta_N$ = 8 K)	W
P_{LN}	Nominal specific cooling capacity per unit active length	$W \cdot m^{-1}$
P_K	Specific cooling capacity ($P_K = P/\Delta\theta^m$)	$W\ K^{-m}$
P_a	Air cooling capacity	W
q_w	Cooling medium flow rate	$l(litre) \cdot s^{-1}$
q_{wN}	Nominal cooling water flow rate	$l(litre) \cdot s^{-1}$
q_m	Cooling medium mass flow rate ($q_m = \rho_w\ q_w$)	$kg \cdot s^{-1}$
q_{pN}	Nominal primary air flow rate	$l(litre) \cdot \cdot s^{-1}$
q_p	Primary air flow rate	$l(litre) \cdot \cdot s^{-1}$
q_i	Induced air flow rate	$l(litre) \cdot \cdot s^{-1}$
q_e	Exhaust air flow rate	$l(litre) \cdot \cdot s^{-1}$
θ_a	Room air temperature	°C
θ_g	Globe temperature	°C
θ_r	Reference air temperature	°C
θ_{sw}	Surface wall temperature	°C
θ_p	Primary air temperature	°C
θ_{w1}	Cooling water inlet temperature	°C
θ_{w2}	Cooling water outlet temperature	°C
θ_w	Mean cooling water temperature	°C
ρ_p	Density of primary air at θ_p	$kg \cdot m^{-3}$
ρ_w	Density of cooling medium at θ_w	$kg \cdot l^{-1}$(litre)
$\Delta\theta$	Temperature difference reference air temperature-water mean	K
$\Delta\theta_N$	Nominal temperature difference (=8K)	K
$\Delta\theta p$	Temperature difference reference air temperature-primary air temperature	K

4 Test method

4.1 Principle

4.1.1 General

The water side cooling capacity of the test object shall be determined from measurements of the cooling water flow rate and cooling water temperature rise under steady state condition. The water side cooling capacity shall be presented as a function of the primary air flow rate and the temperature difference between the reference air 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. Two alternative methods are allowed:

4.1.2 The internal heat supply method

The perimeter of the room shall be insulated and have negligible heat flow through it. The perimeters shall be insulated in such a way that during the test the average heat flow through these surfaces is less than 0,40 $W \cdot m^{-2}$

To balance the cooling capacity of the test object, heating is supplied in the test room by means of a number of electric heated person simulators, dummies, as described in 4.3 of prEN 14240. The dummies are placed on the floor inside the test room. To get reproducible results the dummies must be placed in determined positions as described in 4.4.1 of prEN 14240. For location of beam(s) relative to the dummies, see 4.4.1 of this standard.

NOTE This method use the same test room and heating supply to the room as specified in EN 14240 for testing and rating of chilled ceilings.

4.1.3 The external heat supply method.

To balance the cooling capacity of the test object, heating is supplied to the test room evenly distributed through the walls and the floor. The ceiling shall be insulated in such a way that during the test the heat flow through the ceiling is less than 0,40 $W \cdot m^{-2}$. The temperature of the inner walls and floor of the test room must be controlled and maintained uniform at any level necessary to keep the desired room temperature. The maximum temperature difference between any point of the inner walls and floor during the test shall be less than 1,0 K.

4.2 Test room

The floor area of the test room shall be between 10,0 m2 and 21,0 m2.

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).