SLOVENSKI STANDARD
SIST EN 1216:1999

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Prenosniki toplote – Hladilniki in grelniki zraka s prisilno konvekcijo – Postopki preskušanja za ugotavljanje tehničnih karakteristik

Heat exchangers - Forced circulation air-cooling and air-heating coils - Test procedures for establishing the performance

Wärmeaustauscher - Luftkühler und Lufterhitzer für erzwungene Konvektion - Prüfverfahren zur Leistungsfeststellung

Echangeurs thermiques - Batteries à ailettes à circulation forcée - Procédures d'essai pour la détermination des performances

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27.060.30	Grelniki vode in prenosniki toplote	Boilers and heat exchangers

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EUROPEAN STANDARD
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EN 1216

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Descriptors: heat exchangers, definitions, symbols, performance evaluation, calorific power, measurements, installation, tests, computation

English version

Heat exchangers - Forced circulation air-cooling and air-heating coils - Test procedures for establishing the performance

Echangeurs thermiques - Batteries à ailettes à circulation forcée - Procédures d'essai pour la détermination des performances

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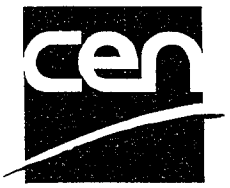

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 110 "Heat exchangers", the secretariat of which is held by BSI.

This European Standard replaces ENV 1216:1993.

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of an identical text or by endorsement, at the latest by June 1999, and conflicting national standards shall be withdrawn at the latest by June 1999.

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

0 Introduction

This European Standard is one of a series of European Standards dedicated to heat exchangers.

1 Scope

This European Standard applies to forced circulation air-cooling or air-heating coils operating:

a) with an evaporating or condensing refrigerant;

b) with a cooling or heating fluid;

c) without fans.

Operation with steam is not part of the standard.

This Standard specifies uniform methods of testing under non-frosting conditions conducted on test samples to test and ascertain the following:

- product identification;
- the capacity;
- air side pressure drop;
- fluid side pressure drop,

at standard conditions, unless otherwise stated by the user.

It is not the purpose of this Standard to specify the types of test used for production or field testing.

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 amendments 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 publication referred to applies:

EN 45001 General criteria for the operation of testing laboratories

3 Definitions

For the purposes of this Standard, the following definitions apply:

3.1 forced-circulation air-cooling or air-heating coil: A tubular heat exchanger, with or without extended surfaces, for use in an air flow, circulated by fans.

3.1.1 ***forced-circulation air-cooling coil:*** An air-cooling coil through which a cooling fluid is circulated for the purpose of the sensible cooling, or sensible cooling and dehumidification of a forced-circulation air flow, including all components necessary for the distribution and collection of the cooling fluid.

3.1.2 ***forced-circulation air-heating coil:*** An air-heating coil through which a heating fluid is circulated for the purpose of the sensible heating of a forced-circulation air flow, including all components necessary for the distribution and collection of the heating fluid.

3.1.3 ***cooling fluid:*** Either refrigerant or a liquid used for cooling.

3.1.4 ***heating fluid:*** Either refrigerant or a liquid used for heating.

3.1.5 ***(primary) refrigerant:*** The working fluid, in a refrigeration system, that absorbs heat by evaporation at a low temperature and rejects it by condensation at a higher temperature. In the following, the term refrigerant is used.

3.1.6 ***liquid:*** A working fluid circulated through a heating or cooling system which remains liquid during the absorption or rejection of heat.

3.2 coil dimensions

3.2.1 ***row:*** A bank of tubes that are located in a plane at right angle to the direction of the air flow.

3.2.2 ***coil inlet area:*** The internal cross sectional area of the duct containing the heat exchanger supplied by the manufacturer.

3.2.3 ***total heat transfer surface (air side):*** Whole external surface of the coil which is exposed to the air flow passing through the coil.

3.3 capacity

3.3.1 ***air-cooling capacity***

3.3.1.1 *sensible (dry) air-cooling capacity:* Heat flow which is rejected by the air by means of temperature drop.

3.3.1.2 *latent air-cooling capacity*: Latent heat flow which is rejected by the condensing water vapour of the air.

3.3.1.3 *total cooling capacity on air side:* Sum of the sensible and the latent capacities measured at the same time. It is equal to the enthalpy change of the air across the air cooling coil reduced by the enthalpy flow removed by the condensed water.

3.3.1.4 *total cooling capacity on fluid side:* Heat flow absorbed by the cooling fluid, expressed as the product of the mass flow of the cooling fluid and the difference between specific enthalpies at the outlet and inlet connections of the coil.

3.3.1.5 *enthalpy flow of condensate:* Difference between the total cooling capacities on air side and on fluid side which is equal to the specific enthalpy of the condensate multiplied by its flow rate.

3.3.2 ***air-heating capacity***

3.3.2.1 *heating capacity on air side:* Heat flow absorbed by the air passing through the coil.

3.3.2.2 *heating capacity on fluid side:* Heat flow rejected by the heating fluid, expressed as the product of the mass flow of the heating fluid and the difference between specific enthalpies at the inlet and outlet connections of the coil.

3.4 temperature

NOTE: All temperatures are average values ascertained over the measuring period.

3.4.1 ***air temperature***

3.4.1.1 *air inlet temperature:* Average dry bulb or wet bulb temperature of the air at the coil inlet, taking into consideration the local air velocities.

3.4.1.2 *air outlet temperature:* Average dry bulb temperature of the air at the coil outlet, taking into consideration the local air velocities.

3.4.2 ***liquid temperature***

3.4.2.1 *liquid inlet temperature:* Average temperature of the liquid at the inlet connection of the coil, taking into consideration the local liquid velocities.

3.4.2.2 *liquid outlet temperature:* Average temperature of the liquid at the outlet connection of the coil, taking into consideration the local liquid velocities.

3.4.3 ***refrigerant temperature***

3.4.3.1 *evaporating temperature:* Saturation temperature, corresponding to the absolute pressure of the refrigerant, at the suction outlet connection of the air cooling coil.

3.4.3.2 *condensing temperature:* Saturation temperature, corresponding to the absolute pressure of the refrigerant, at the inlet connection of the air-heating coil.

3.4.3.3 *superheated vapour temperature:* Actual temperature of the refrigerant vapour.

a) at the air-cooling coil suction outlet connection;

b) at the air-heating coil inlet connection.

3.4.3.4 *subcooled refrigerant temperature:* Temperature of the liquid refrigerant.

a) at the inlet of the expansion device (not part of the air-cooling coil);

b) at the outlet connection of the air-heating coil.

3.5 temperature difference

3.5.1 ***operation with refrigerant***

3.5.1.1 *inlet temperature difference:* Absolute value of the difference between the air inlet dry bulb temperature and:

a) for air-cooling coils the evaporating temperature;

b) for air-heating coils the condensing temperature.

3.5.1.2 *superheating:* Difference between:

a) for air-cooling coils the superheated vapour temperature and the evaporating temperature;

b) for air-heating coils the superheated vapour temperature and the condensing temperature.

3.5.1.3 *subcooling:* Difference between the saturation temperature corresponding to the absolute pressure and the subcooled liquid refrigerant temperature:

a) in the case of an air-cooling coil at the inlet of the expansion device;

b) in the case of an air-heating coil at the outlet connection of the coil.

3.5.2 ***operation with liquid***

3.5.2.1 *inlet temperature difference:* Absolute value of the difference between air inlet temperature and liquid inlet temperature.

3.5.2.2 *liquid temperature difference:* Absolute value of the difference between liquid inlet and outlet temperature.

3.5.3 ***air temperature difference:*** Absolute value of the difference between air inlet and outlet temperature.

3.6 air flow/velocity

3.6.1 ***air face velocity:*** Air volume flow rate through the coil divided by the coil face area.

3.6.2 ***air mass flux:*** Air mass flow through the coil divided by the coil face area.

3.7 pressure drop

3.7.1 ***air side pressure drop:*** Static pressure difference between the air inlet and outlet of the coil.

3.7.2 ***fluid side pressure drop:*** Static pressure difference of the fluid between the inlet and outlet connections of coil.

3.8 specific enthalpy

3.8.1 ***air specific enthalpy:*** Specific enthalpy corresponding to the dry bulb temperature and the dew point or wet bulb temperature.

3.8.2 ***liquid specific enthalpy:*** Product of the temperature and the specific heat capacity of the liquid.

3.8.3 ***refrigerant specific enthalpy***

3.8.3.1 *refrigerant inlet specific enthalpy:* Specific enthalpy is the specific enthalpy of the refrigerant at the inlet connection of the coil,

- for air heating coils defined as the specific enthalpy of the refrigerant corresponding to the condensing pressure and the superheated vapour temperature;
- for air cooling coils defined as the specific enthalpy of the saturated liquid refrigerant at the inlet of the expansion device corresponding to the subcooled refrigerant temperature.

3.8.3.2 *refrigerant outlet specific enthalpy*: Specific enthalpy is the specific enthalpy of the refrigerant at the outlet connection of the coil,

– for air heating coils defined as the specific enthalpy of the refrigerant corresponding to the subcooled refrigerant temperature;

– for air cooling coils defined as the specific enthalpy of the refrigerant corresponding to the evaporating pressure and the superheated vapour temperature.

3.9 specific enthalpy difference: Difference in the specific enthalpy at the inlet of the coil and the specific enthalpy at the outlet of the coil.

4 Symbols

For the purpose of this European Standard, the following apply:

4.1 Letters

c_{pA}	specific heat capacity of air under test conditions	kJ/(kgK)
c_{pW}	specific heat capacity of air side condensate	kJ/(kgK)
h_A	specific enthalpy of air	kJ/kg
h_F	specific enthalpy of fluid at coil connections	kJ/kg
h_L	specific enthalpy of liquid at coil connections	kJ/kg
h_{R0}	specific enthalpy of refrigerant at the inlet of the expansion device	kJ/kg
h_R	specific enthalpy of refrigerant at the coil connections	kJ/kg
h_W	vaporization heat of water at 0 °C (h_W = 2500,4)	kJ/kg
P_{lat}	measured latent cooling capacity	kW
P_{sens}	measured sensible cooling capacity	kW
P_{totA}	measured total cooling or heating capacity on the air side	kW
P_{totF}	measured total cooling or heating capacity on the fluid side	kW
P_{totL}	measured total cooling or heating capacity on the liquid side	kW
P_{totR}	measured total cooling or heating capacity on the refrigerant side	kW
P_{tot}	measured total cooling or heating capacity	kW
P_W	measured capacity on the air side condensates	kW
p_{atm}	atmospheric pressure	hPa
p_e	evaporating pressure	kPa
p_c	condensing pressure	kPa
p_L	liquid pressure at the coil connections	kPa
p_{R0}	refrigerant pressure at expansion device inlet (air cooling coils)	kPa
p_{R2}	refrigerant pressure at the coil outlet (for heating coils with refrigerant)	kPa
q_{mA}	mass flow rate of dry air	kg/s
q_{mF}	mass flow rate of fluid	kg/s
q_{mL}	mass flow rate of liquid	kg/s
q_{mR}	mass flow rate of refrigerant	kg/s
q_{mW}	mass flow rate of air side condensate	kg/s
t_A	air temperature (dry bulb)	°C
t_c	condensing temperature	°C
t_e	evaporating temperature	°C
t_L	liquid temperature	°C
t_{MR}	temperature of the refrigerant at the flow measuring point	°C
t_{ML}	temperature of the liquid at the flow measuring point	°C
t_{R0}	refrigerant temperature at the inlet of the expansion device (air cooling coils)	°C
t_{R1}	refrigerant inlet temperature (air heating coils)	°C
t_{R2}	refrigerant outlet temperature	°C
t_W	air side condensate temperature	°C
t_{dp}	air dewpoint temperature	°C
t_{Wb}	air wet bulb temperature	°C
V_A	air face velocity	m/s
V_{mA}	air mass flux	kg/(s.m^2)
X	mass of water vapour per kg of dry air (vapour content)	kg/kg

Z	test duration	s
p_A	air side pressure drop	Pa
p_L	liquid side pressure drop	Pa
p_F	fluid side pressure drop	Pa
Δt_1	inlet temperature difference	K
Δt_2	difference between air inlet wet bulb temperature and liquid inlet or evaporating temperature	K
Δt_L	liquid temperature difference	K
Δt_{sub}	subcooling	K
Δt_{sup}	superheating	K

4.2 Subscripts

1 refers to inlet
2 refers to outlet

4.3 Superscripts

(st) refers to standard conditions

5 Standard capacity

5.1 Basis for standard-capacity data

The capacity of a given forced-circulation air-cooling or air-heating coil is dependent on:

a) inlet temperature and the moisture content of the entering air;

b) mass flow of air and of the cooling or heating fluid;

c) inlet and outlet conditions of the cooling or heating fluid.

Therefore the capacities of a forced-circulation air-cooling or air-heating coil are to be given for specific operating conditions.

5.2 Standard conditions for coil capacity

As coils may be used in a wide range of applications, conditions shall be specified for each particular case with minimum values of

$\Delta t_L = 5$ K

$\Delta t_1 = 10$ K

$\Delta t_2 = 7$ K

Table 1 provides a set of standard conditions, which can be used for comparison purposes.