SLOVENSKI STANDARD
SIST EN 13771-2:2008

01-april-2008

Kompresorji in kondenzacijske enote za hlajenje - Preskušanje lastnosti in preskusne metode - 2. del: Kondenzacijske enote

Compressors and condensing units for refrigeration - Performance testing and test methods - Part 2: Condensing units

Kältemittel-Verdichter und Verflüssigungssätze für die Kälteanwendung - Leistungsprüfung und Prüfverfahren - Teil 2: Verflüssigungssätze

Compresseurs et unités de condensation pour la réfrigération - Essais de performance et méthodes d'essais - Partie 2: Unités de condensation

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ICS:

23.140	Kompresorji in pnevmatični stroji	Compressors and pneumatic machines
27.200	Hladilna tehnologija	Refrigerating technology

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Compressors and condensing units for refrigeration - Performance testing and test methods - Part 2: Condensing units

Compresseurs et unités de condensation pour la réfrigération - Essais de performance et méthodes d'essai - Partie 2: Unités de condensation

Kältemittel-Verdichter und Verflüssigungssätze für die Kälteanwendung - Leistungsprüfung und Prüfverfahren - Teil 2: Verflüssigungssätze

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

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Foreword

This document (EN 13771-2:2007) has been prepared by Technical Committee CEN/TC 113 "Heat pumps and air conditioning units", the secretariat of which is held by AENOR.

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of an identical text or by endorsement, at the latest by February 2008 , and conflicting national standards shall be withdrawn at the latest by February 2008.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.

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1 Scope

This part of EN 13771 applies only to condensing units for refrigeration and describes a number of selected performance test methods. These methods provide sufficiently accurate results for the determination of the refrigerating capacity, power absorbed, refrigerant mass flow and the coefficient of performance.

This European Standard applies only to performance tests conducted at the manufacturer's works or wherever the instrumentation and load stability for testing to the accuracy required is available.

The type of measuring instrument and the allowable uncertainties within which measurements shall be made are listed in Table 2.

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 378-1:2000, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Basic requirements, definitions, classification and selection criteria*

EN 378-2, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

EN ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements (ISO 5167-1:2003)*

ISO 817, *Refrigerants - Designation system*

ISO 5168, *Measurement of fluid flow - Procedures for the evaluation of uncertainties*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
refrigerating capacity
Φ_0
product of the refrigerant mass flow and the difference between the specific enthalpy of the refrigerant at the inlet of the condensing unit and that at the outlet of the condensing unit. The refrigerant at the unit inlet is superheated above the suction dew point temperature to the stated value. The liquid is at a pressure corresponding to the outlet of the condensing unit

3.1.2
power absorbed

3.1.2.1
power absorbed by the condensing unit where the motor is an integral part of the unit, P_{cm}
electrical power input at the compressor motor terminals plus the power to all other devices (e.g. fan motor) forming an integral part of the condensing unit

3.1.2.2
power absorbed by the condensing unit where the motor is not supplied as an integral part in the unit, P_{cs}
electrically power input at the compressor shaft plus the power to all other devices (e.g. fan motor) forming an integral part of the condensing unit

3.1.3
refrigerant mass flow
q_m
refrigerant mass flow at the condensing unit inlet

3.1.4
coefficient of performance

3.1.4.1 coefficient of performance
COP_{rm}
ratio of the refrigerating capacity to the power absorbed as defined in 3.1.1 and 3.1.2.1

3.1.4.2 coefficient of performance
COP_{rs}
ratio of the refrigerating capacity to the power absorbed as defined in 3.1.1 and 3.1.2.2

NOTE All the above are at the basic test condition.

3.1.5
oil circulation in the refrigerating system
x_{oil}
ratio of the measured oil mass flow to the mass flow of the circulating oil/refrigerant mixture

3.1.6
condensing unit
factory assembled unit comprised of refrigeration compressor and motor, condenser and any necessary associated ancillaries

3.2 Symbols

For the purposes of this document, the symbols found in Table 1 apply.

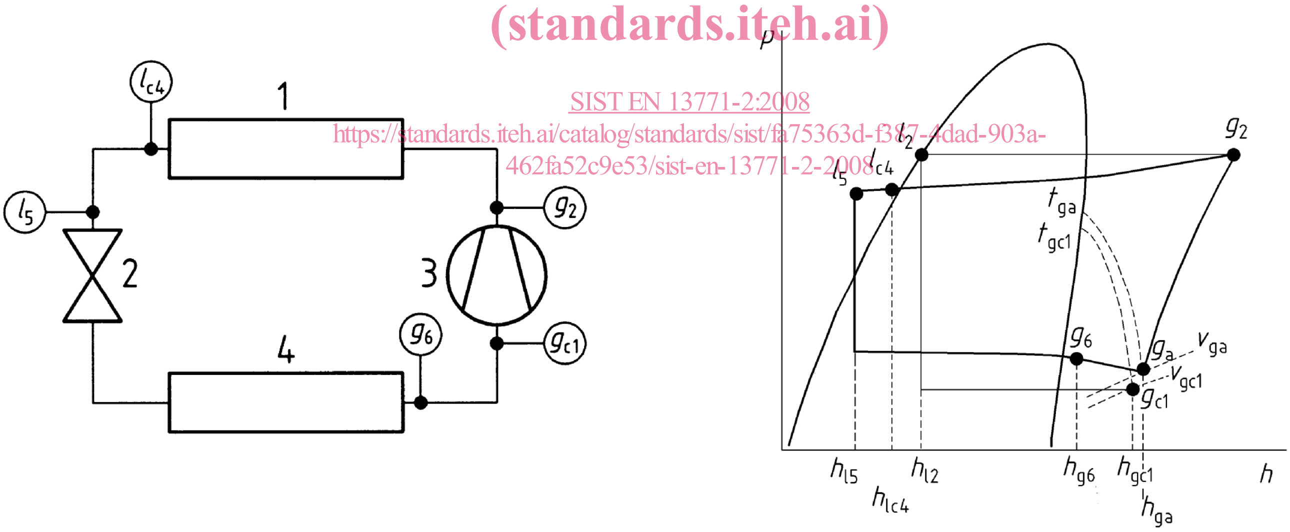
Table 1 — Symbols

Symbol	Designation	SI unit
c	Specific heat capacity of liquid	J/(kg K)
c_{oil}	Specific heat capacity of oil	J/(kg K)
COP_{rm}	Coefficient of performance as defined in 3.1.4.1	-
COP_{rs}	Coefficient of performance as defined in 3.1.4.2	-
f	Nominal electrical frequency	Hz
f_{a}	Actual electrical frequency	Hz
F	Heat leakage factor	W/K
$h_{\text{l 2}}$	Specific enthalpy of liquid refrigerant at bubble point corresponding to the pressure at the compressor outlet according to the basic test conditions	J/kg
h_{lc4}	Specific enthalpy of liquid refrigerant at the outlet of the condensing unit	J/kg
$h_{\text{l 5}}$	Specific enthalpy of liquid refrigerant at the inlet in the expansion device	J/kg
$h_{\text{g c 1}}$	Specific enthalpy of the refrigerant vapour at the condensing unit inlet at the basic test conditions	J/kg
$h_{\text{g 3}}$	Specific enthalpy of the refrigerant vapour at the inlet of the condenser	J/kg
$h_{\text{g 6}}$	Specific enthalpy of the refrigerant vapour at the outlet of the calorimeter	J/kg
n	Nominal compressor speed	1/min
n_{a}	Actual compressor speed	1/min
P_c	Power absorbed by the unit at the basic test conditions	W
P_{a}	Actual power absorbed by the compressor	W
P_{cm}	Power absorbed by the condensing unit (for motor compressors)	W
P_{cs}	Power absorbed by the condensing unit (for externally driven compressors)	W
P_F	Power absorbed by all other auxiliary components (fans, etc.)	W
$p_{gc\ 1}$	Absolute pressure, condensing unit inlet	MPa
$p_{g\ 2}$	Absolute pressure, compressor outlet	MPa
$p_{g\ 3}$	Pressure of the refrigerant vapour entering the condenser	MPa
$p_{g\ 6}$	Pressure of the refrigerant vapour of the evaporator outlet	MPa
p_{lc4}	Pressure of the refrigerant liquid leaving the condensing unit	MPa
$p_{l\ 5}$	Pressure of the refrigerant liquid entering the expansion device	MPa
p_s	Absolute pressure of the secondary fluid	MPa
q_m	Refrigerant mass flow as determined by the test	kg/s
$q_{m\ 0}$	Refrigerant mass flow at the basic test conditions	kg/s
q_{mf}	Fluid mass flow	kg/s
q_{mx}	Mass flow of liquid refrigerant/oil mixture	kg/s
q_v	Refrigerant volume flow	m3/s
q_{vx}	Volume flow of refrigerant/oil mixture	m3/s
t_a	Ambient temperature	°C
$t_{A\ in}$	Air inlet temperature at air-cooled condenser	°C
$t_{F\ in}$	Fluid inlet temperature at evaporator / water-cooled condenser	°C
$t_{F\ out}$	Fluid outlet temperature at evaporator / water-cooled condenser	°C
t_c	Mean surface temperature of the calorimeter at the basic test conditions	°C
t_{ga}	Actual temperature at the condensing unit inlet	°C
$t_{gc\ 1}$	Refrigerant vapour temperature at the condensing unit inlet at the basic test conditions	°C
$t_{g\ 3}$	Temperature of the refrigerant vapour entering condenser	°C
$t_{g\ 6}$	Temperature of the refrigerant vapour at the evaporator outlet	°C

$t_{l\,2}$	Saturation temperature of the liquid refrigerant corresponding to the pressure at the compressor outlet	°C
$t_{lc\,4}$	Temperature of the refrigerant liquid leaving the condensing unit	°C
$t_{l\,5}$	Temperature of the refrigerant liquid entering the expansion device	°C
t_r	The mean of the bubble and dew point temperature of the refrigerant	°C
t_s	Saturation temperature of the secondary fluid	°C
t_x	Reference temperature	°C
U	Nominal electrical voltage	V
x_{oil}	Oil circulation in the refrigerating system, expressed in kilogram per kilogram of mixture	kg/kg
v_{ga}	Actual specific volume of refrigerant vapour at the condensing unit inlet	m3/kg
$v_{g\,c1}$	Specific volume of refrigerant vapour at the condensing unit inlet at the basic test conditions	m3/kg
ρ_m	Density of refrigerant corresponding to pressure and temperature at which the flow rate is measured	kg/m3
Φ_i	Heat flow to the calorimeter	W
Φ_n	Electrical power for the heater	W
Φ_0	Refrigerating capacity of the condensing unit at the basic test conditions	W

3.3 Refrigerant circuit state points

Figure 1b) shows the state of the refrigerant as it flows through the refrigerating circuit shown in Figure 1a).



a) Circuit diagram **b) Pressure vs enthalpy diagram**

Key

1 Condenser (including any receiver and/or sub-cooler forming an integral part of the unit)
2 Expansion device
3 Compressor
4 Evaporator

Figure 1 — Refrigerant circuit

4 General requirements

4.1 Test equipment

All equipment shall comply with the requirements of EN 378-2.

4.2 Calculation methods

4.2.1 Principle

The determination of the refrigerating capacity of a condensing unit at the basic test conditions comprises:

— evaluation of the actual mass flow of refrigerant at the condensing unit inlet (q_m) when operating within the limits allowed to the basic test conditions in Table 3;

— correction of this mass flow to that, at the basic test conditions using the ratio of the actual specific volume (v_{ga}) of the refrigerant vapour at the condensing unit inlet to the specific volume of the vapour at the basic test conditions ($v_{gc\,1}$);

— product of the corrected mass flow and the difference between the specific enthalpies at the basic test conditions of the refrigerant vapour at the condensing unit inlet ($h_{g\,c1}$), and the liquid refrigerant at the condensing unit outlet ($h_{lc\,4}$).

NOTE For the purpose of this standard it is assumed that the volume flow rate is constant when the condensing unit is operating within the limits allowed in Table 3.

4.2.2 Specific enthalpy

The value of the specific enthalpy is listed in the recognised data of the thermodynamic properties of the refrigerant used.

4.2.3 Refrigerant mass flow

The refrigerant mass flow is either measured directly or calculated from measured values.

4.2.4 Power absorbed

Within a superheat range of ± 5 K it is assumed that the power consumption will stay constant.

4.2.5 Basic equations

The refrigerant mass flow q_m determined by measurement is converted to that at the basic test conditions using the following equation:

$$q_{m\,0} = q_m \frac{v_{ga}}{v_{gc\,1}} \cdot \frac{n}{n_a} \quad (1)$$

The refrigerating capacity as defined in 3.1.1 for condensing units is calculated using the following equation:

$$\Phi_0 = q_{m\,0} \cdot (h_{gc\,1} - h_{lc\,4}) \quad (2)$$

The power absorbed by the condensing unit as defined in 3.1.2 is converted from the measured power absorbed to that at the basic test conditions using the following equation: