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Kompresorji in kondenzacijske enote za hladilne naprave - Preskušanje lastnosti in preskusne metode - 1. del: Kompresorji za hladilne snovi

Compressors and condensing units for refrigeration - Performance testing and test methods - Part 1: Refrigerant compressors

Kältemittel-Verdichter und Verflüssigungssätze für die Kälteanwendung - Leistungsprüfung und Prüfverfahren - Teil 1: Kältemittel-Verdichter

Compresseurs pour fluides frigorigènes et unités de condensation pour la réfrigération - Essais de performances et méthodes d'essai - Partie 1: Compresseurs pour fluides frigogènes

Ta slovenski standard je istoveten z: EN 13771-1:2016

ICS:

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

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Compressors and condensing units for refrigeration - Performance testing and test methods - Part 1: Refrigerant compressors

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Kältemittel-Verdichter und Verflüssigungssätze für die Kälteanwendung - Leistungsprüfung und Prüfverfahren - Teil 1: Kältemittel-Verdichter

This European Standard was approved by CEN on 13 August 2016.

This European Standard was corrected and reissued by the CEN-CENELEC Management Centre on 23 November 2016.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 13771-1:2016) 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 May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

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.

This document supersedes EN 13771-1:2003.

The main changes with respect to the previous edition are listed below:

a) addition of the new Clause 4 “Uncertainty of measurement and test conditions”;

b) deletion of the list of measuring devices;

c) addition of two-stage and economized compressors;

d) addition of transcritical application;

e) addition of test requirements for inverter driven compressors;

f) addition of cyclic capacity control;

g) addition of the part load conditions according to mandate M/488.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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 specifies performance test methods for refrigerant compressors. These methods provide sufficiently accurate results for the determination of the refrigerating capacity, power absorbed, refrigerant mass flow, isentropic efficiency and the coefficient of performance.

This European Standard applies only to performance tests where the equipment for testing is available.

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

3 Terms, definitions and symbols

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

3.1 Terms and definitions

3.1.1
refrigerating capacity
Q
product of the mass flow of refrigerant at the compressor inlet port and the difference between the specific enthalpy of the refrigerant at the compressor inlet port and the specific enthalpy of fluid entering the evaporator expansion device

3.1.2
subcooling
difference between the bubble point temperature of the refrigerant corresponding to the compressor discharge pressure and the temperature of the liquid refrigerant below the bubble point

3.1.3
suction gas superheat
difference between the dew point temperature of the refrigerant corresponding to the compressor suction pressure and the suction gas temperature of the refrigerant at the compressor inlet

3.1.4
power absorbed
P
power demand to drive the compressor

Note 1 to entry: The determination of the power absorbed is specified under Clause 7.

3.1.5
coefficient of performance
COP_{R}
ratio of the refrigerating capacity to the power absorbed

Note 1 to entry: Both the above are at the specified test condition.

3.1.6
subcritical operation
operating condition with discharge pressure level below the critical pressure

3.1.7
transcritical operation
operating condition with discharge pressure level above the critical pressure

3.1.8
part load operation
for compressors with capacity control mechanism, part load is interpreted as operation with active capacity control at reduced capacity

Note 1 to entry: On/off cycling of the compressor motor is not considered as capacity control.

3.1.9
fluid
refrigerant liquid, gas or vapour including the state of appearance close to and above the critical pressure

3.1.10
evaporating temperature
dew temperature corresponding to the suction pressure of the compressor

3.1.11
condensing temperature
dew temperature corresponding to the discharge pressure of the compressor

3.1.12
refrigerant mass flow (m)
refrigerant mass flow at compressor port

3.1.13
volumetric efficiency (η_v)
ratio of the actual volume rate of flow under compressor inlet conditions, at the requirements specified in 4.3, to the displacement of the compressor

Note 1 to entry: Ports, see Table 2, index 1, 2 and 7.

3.1.14
isentropic efficiency (η_i)
ratio of total isentropic compression power to the power absorbed

Note 1 to entry: Total isentropic compression power is the sum of individual product of mass flow times the isentropic change in enthalpy across the corresponding compression stage.

3.1.15
oil circulation rate (x_{oil})
ratio of the measured oil mass flow to the mass flow of the circulating oil/refrigerant mixture at the inlet of the compressor

Note 1 to entry: Oil circulation rate may differ at other compressor ports.

3.2 Symbols

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

Table 1 — Symbols

Symbol	Designation	SI unit
A	Heat transfer surface	M^2
c	Specific heat capacity of heating and cooling liquid	J/(kg K)
f	Electrical frequency	Hz
F	Heat leakage factor	W/K
F_m	Mass flow ratio	-
h	Specific enthalpy	J/kg
h_{i1-2}	Specific enthalpy of refrigerant gas at the compressor outlet (2) having the same entropy as the refrigerant gas at the compressor inlet (1) for calculation of the isentropic efficiency (specified test conditions)	J/kg
h_{i7-2}	Specific enthalpy of refrigerant gas at the compressor outlet (2) having the same entropy as the refrigerant gas at the compressor intermediate pressure port (7) for calculation of the isentropic efficiency (specified test conditions)	J/kg
n	Compressor speed	s^{-1}
P	Power absorbed	W
p	Absolute pressure	Pa
m_a	Refrigerant mass flow as determined by the test	kg/s
m	Refrigerant mass flow at the specified test conditions	kg/s
m_f	Mass flow of heating or cooling liquid	kg/s
m_{oil}	Oil mass flow	kg/s
m_x	Mass flow of liquid refrigerant oil mixture	kg/s
V	Refrigerant volume flow	m^3/s
V_x	Volume flow of refrigerant oil mixture	m^3/s
T	Absolute temperature	K
ΔT_{eco}	Difference between fluid outlet of economizer and bubble temperature corresponding to intermediate pressure	K
t	Temperature	°C
t_{cal}	Mean surface temperature of the calorimeter	°C
t_b	Bubble point temperature of the refrigerant	°C
t_{bs}	Bubble point temperature of the secondary fluid	°C

Symbol	Designation	SI unit
t_x	Reference temperature	°C
t_{s1}	Inlet temperature of heating or cooling liquid	°C
t_{s2}	Outlet temperature of heating or cooling liquid	°C
u	Coefficient of heat transmission	W/(m^2·K)
U	Electrical voltage	V
V_{sw}	Theoretical compressor displacement at declared speed	m^3/s
x_{oil}	Oil circulation in the refrigerating system, expressed in mass of oil per mass of mixture	kg/kg
COP_R	Coefficient of performance	—
η_i	Isentropic efficiency	—
η_v	Volumetric efficiency	—
v	Specific volume	m^3/kg
ρ_a	Density of refrigerant corresponding to pressure and temperature at which the flow rate is measured	kg/m^3
Q_ι	Heat input to the calorimeter	W
Q_n	Electrical input to the heater	W
Q	Refrigerating capacity of the compressor at the specified test conditions	W

Table 2 — Indexes

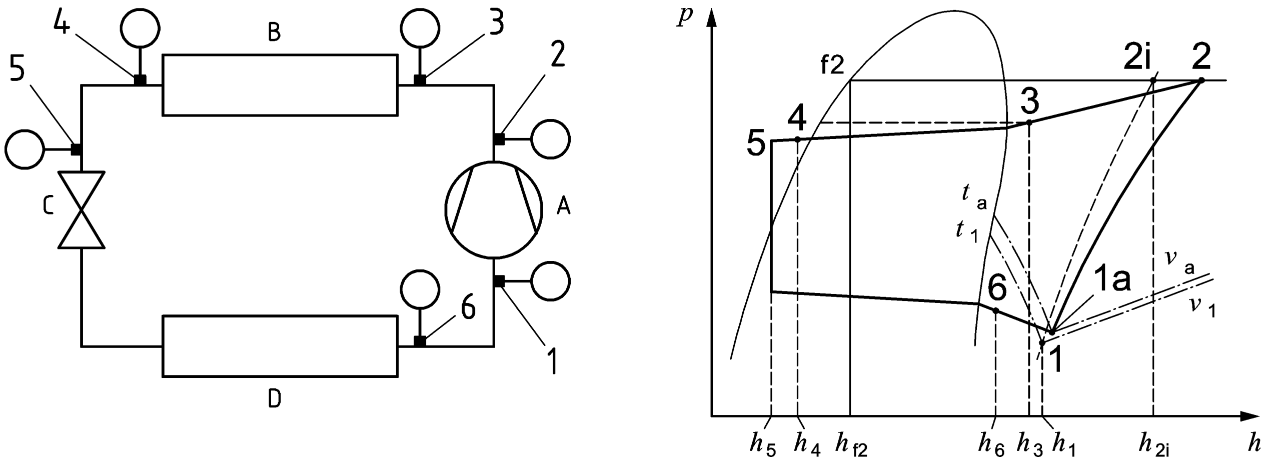
Index	Designation
a	Actual
amb	Ambient
1	Refrigerant at the compressor inlet
2	Refrigerant at the compressor outlet
3	Refrigerant at the inlet of the condenser/gas cooler
4	Refrigerant at the outlet of the condenser/gas cooler
5	Refrigerant at the inlet of the expansion device
6	Refrigerant at the outlet of the evaporator
7	Refrigerant at the intermediate pressure port (connection to the compressor)
8	Refrigerant at the inlet to flow meter
9	Refrigerant at the inlet of expansion device C7
10	Liquid outlet of refrigerant at the economizer HX
f2	Liquid refrigerant at bubble point corresponding to the pressure at the compressor outlet

Index	Designation
	according to the specified test conditions, for subcritical application or fluid refrigerant at the compressor outlet pressure and the temperature of the gas cooler outlet at the specified test condition
f7	Liquid refrigerant at bubble point corresponding to the pressure at the compressor intermediate pressure port according to the specified test conditions, for subcritical application
f_{10}	Liquid refrigerant at bubble point corresponding to the pressure at the compressor intermediate pressure port plus the temperature difference of the economizer HX
b	Bubble
d	Dew
i	Isentropic
cal	Calorimeter surface
crit	Critical point of refrigerant
f	Fluid
oil	Oil
s	Secondary fluid
x	Refrigerant/oil mixture

3.3 Refrigerant circuit state points

Figure 1 illustrates the state of the refrigerant as it passes through the system.

This is a general illustration showing conditions occurring in typical single stage systems, which are not all relevant for compressors performances (e.g. the shown pressure drops), but still important for inherent calculation. p-h diagrams relating to specific test methods will not show the various pressure drops in order to keep diagrams as clear as possible.



a) Circuit diagram   b) Pressure vs enthalpy diagram

Key

1 refrigerant gas at the compressor inlet

2 refrigerant gas at the compressor outlet

3 refrigerant gas at the inlet of the condenser/gas cooler

4 refrigerant at the outlet of the condenser or gas cooler

5 refrigerant fluid at the inlet of the expansion device

6 refrigerant gas at the outlet of the calorimeter

A compressor

B condenser

C expansion device

D evaporator

Figure 1 — Refrigerant circuit

4 Uncertainty of measurement and test conditions

4.1 Uncertainty of performance data

Measuring instruments shall be selected and calibrated so that the final result is within the maximum uncertainties of the measured value as indicated:

— refrigerating capacity: ± 2,5 %;

— electrical power absorbed: ± 1 % and

— mechanical power absorbed: ± 2,5 %.

4.2 Uncertainty of measurement

Uncertainty values are considered to cover a 95 % confidence interval, i.e. ± 2 times the standard deviation. Except where otherwise stated in the particular clauses, measurements shall be carried out within the maximum uncertainty of the measured value as indicated:

— Absolute pressure: ± 1 %;

— Electrical:

- Current ± 1 %;
- Frequency: ± 1 %;
- Power ± 1 %;
- Voltage ± 1 %;

— Refrigerant flow: ± 1 %;

— Rotary speed: ± 0,07 %;

— Mass: ± 0,2 %;

— Temperatures:

- Temperature for differences: ± 0,05 K;
- Temperature differences: ± 1 %;
- other temperatures: ± 0,3 K;

— Time: ± 0,1 %;

— Torque: ± 1 %.

— Water flow: ± 1 %.

Adherence to the limits listed above does not ensure the requirements of 4.1 are obtained automatically.

4.3 Test conditions

The specified test conditions under which the test is to be performed and their allowable deviations are given in Table 3.