SLOVENSKI STANDARD
SIST EN 327:2002

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Prenosniki toplote ï Kondenzatorji s prisilno konvekcijo ï Postopki preskuġanja za ugotavljanje tehniļ nih karakteristik

Heat exchangers - Forced convection air cooled refrigerant condensors - Test procedure for establishing performance

Wärmeaustauscher - Ventilatorbelüftete Verflüssiger - Prüfverfahren zur Leistungsfeststellung

Echangeurs thermiques - Aérocondenseurs à convection forcée - Procédure d'essai pour la détermination de la performance

Ta slovenski standard je istoveten z: EN 327:2000

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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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English version

Heat exchangers - Forced convection air cooled refrigerant condensors - Test procedure for establishing performance

Echangeurs thermiques - Aérocondenseurs à convection forcée - Procédure d'essai pour la détermination de la performance ée

Wärmeaustauscher - Ventilatorbelüftete Verflüssiger - Prüfverfahren zur Leistungsfeststellung

This European Standard was approved by CEN on 12 May 2000.

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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 Central Secretariat has the same status as the official versions.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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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 EN ENV 327:1990.

The document was implemented previously as a European Prestandard (ENV) in 1990.

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of an identical text or by endorsement, at the latest by December 2000, and conflicting national standards shall be withdrawn at the latest by December 2000.

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.

Introduction

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

1 Scope

1.1 This European Standard applies to non ducted forced convection air cooled refrigerant condensers with dry air side surface within which the refrigerant changes phases. Its purpose is to establish uniform methods of performance assessment. It does not deal with evaluation of conformity.

This European Standard does not apply to air cooled condensers, designed primarily for installation within the machinery compartment of packaged products or in factory-assembled condensing units.

This European Standard does not apply to condensers with an integral subcooling part.

1.2 This European Standard specifies methods to test and ascertain the following:

- product identification;
- standard capacity;
- nominal air flow rate;
- nominal fan power.

1.3 This standard does not cover technical safety aspects.

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 the publication referred to applies.

ISO 5801	Industrial fans - Performance testing using standardized airways
EN 45001	General criteria for the operation of testing laboratories
IEC 34-1	Rotating Electrical Machines - Part 1 Rating and Performance

3 Definitions

For the purposes of this standard the following definitions apply.

3.1 forced convection air cooled refrigerant condenser: A refrigeration system component that condenses refrigerant vapour by rejecting heat to air, which is mechanically circulated over its dry heat transfer surface by integral fans and fan drives. The heat transfer coil includes distributing and collecting headers.

In the following "forced convection air cooled refrigerant condenser" is referred to as "condenser".

3.2 refrigerant: Fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and a low pressure and rejects heat at a higher temperature and a higher pressure usually involving changes of the state of the fluid.

3.3 capacity: The total heat flow, rejected by the refrigerant. This total heat flow of rejection being equal to the product of the mass flow rate of the refrigerant and the difference between the enthalpies of the refrigerant at the condenser inlet and outlet connections.

3.4 pressures

NOTE All pressures are average values ascertained over the test duration, and are absolute pressures.

3.4.1 ***condensing pressure:*** The pressure of the refrigerant at the inlet connection of the condenser.

3.4.2 ***evaporating pressure:*** The pressure of the refrigerant at the outlet connection of the calorimeter (applicable only to low pressure calorimeter method).

3.4.3 ***calorimeter pressure:*** The pressure in the secondary fluid side of the calorimeter vessel (applicable only to low pressure calorimeter method and high pressure calorimeter with indirect heat inducement).

3.5 temperatures

NOTE All temperatures are average values ascertained over the test duration.

3.5.1 ***air temperatures***

All air temperatures are dry bulb temperatures.

3.5.1.1 *air inlet temperature:* The average dry bulb temperature of the air at the inlet of the condenser taking into consideration the local air velocities.

3.5.1.2 *ambient air temperature:* The average temperature of the air surrounding the calorimeter, responsible for the heat exchange with the ambient.

3.5.1.3 *inside air temperature:* The average temperature of the air inside the calorimeter, responsible for the heat exchange with the ambient.

3.5.2 ***refrigerant temperatures***

3.5.2.1 *condensing temperature:* The dew point temperature of the refrigerant corresponding to the condensing pressure.

3.5.2.2 *superheated vapour temperature:* The temperature of the refrigerant vapour at the condenser inlet connection.

3.5.2.3 *subcooled refrigerant temperature:* The temperature of the liquified refrigerant at the outlet connection of the condenser.

3.5.2.4 *evaporating temperature:* The dew point temperature of the refrigerant corresponding to the evaporating pressure (applicable only to low pressure calorimeter method).

3.5.2.5 *vapour temperature:* The temperature of the refrigerant at the calorimeter outlet connection.

3.5.3 ***water temperatures***
(applicable only to air side calorimeter method)

3.5.3.1 *water inlet temperature:* The temperature of the water as it enters the calorimeter.

3.5.3.2 *water outlet temperature:* The temperature of the water as it leaves the calorimeter.

3.6 temperature differences

3.6.1 ***inlet temperature difference:*** The difference between the condensing temperature and the air inlet temperature.

3.6.2 ***superheating:*** The difference between the superheated vapour temperature and the condensing temperature.

3.6.3 ***subcooling:*** The difference between the bubble point temperature corresponding to the absolute pressure of the refrigerant at the outlet connection of the condenser and the subcooled refrigerant temperature.

3.7 fan power: The electric power, absorbed by the fan motors measured at the electrical terminals of the motor(s).

3.8 nominal fan power: The fan power measured during the air flow test and corrected to the nominal atmospheric pressure of 1013 hPa.

> NOTE The fan power will also differ with the temperature at which the fan runs. As the fan power is only a small proportion of the total cooling load, the deviations are considered to be negligible.

3.9 nominal air flow: The air volume flow rate, flowing through the condenser when the condenser's air side is dry and clean.

3.10 internal volume: The internal volume is the volume of the refrigerant containing parts of the condenser between its two connections.

3.11 fouling resistance: The thermal resistance due to unwanted deposit on the heat exchanger surface reducing its heat transfer performance.

The fouling resistance for a clean surface is zero.

Clean, in this context, means that all production residues have been removed from the heat transfer surface and the fan(s) by the factory's cleaning process.

3.12 oil content: The proportion of oil by mass in the pure refrigerant circulating in the heat exchanger.

4 Symbols

For the purposes of this standard the following symbols apply:

E	energy supply to the calorimeter (refrigerant side calorimeters)	kWh
HLF	heat loss factor from calorimeter	kW/K
h_{sup}	spec. enthalpy of superheated vapour at condenser inlet connection	kJ/kg
h_{sub}	spec. enthalpy of subcooled liquid refrigerant at condenser outlet connection	kJ/kg
h_{R4}	specific enthalpy of the refrigerant at inlet connection of the calorimeter	kJ/kg
h_{R5}	specific enthalpy of the superheated refrigerant at outlet connection of the calorimeter	kJ/kg
h_{W1}	specific enthalpy of water entering the calorimeter	kJ/kg
h_{W2}	specific enthalpy of water leaving the calorimeter	kJ/kg
n	rotational speed of the fans	1/min
P_{fan}	fan power	kW
p_{atm}	atmospheric pressure	hPa
p_c	condensing pressure	bar *
p_e	evaporating pressure	bar *
p_i	pressure of the secondary fluid in the calorimeter	bar *
q_{mR}	mass flow rate of refrigerant	kg/s
q_{mW}	mass flow rate of water	kg/s
q_{va}	volumetric flow rate of the air	m^3/s
t_{A1}	air inlet temperature	°C
t_R	refrigerant temperatures	°C
t_{RM}	refrigerant temperature at flow meter	°C
t_{sup}	superheated vapour temperature	°C
t_{sub}	subcooled refrigerant temperature	°C
t_W	water temperatures	°C
t_{WM}	water temperature at flow meter	°C
t_{amb}	ambient temperature	°C
t_i	temperature inside calorimeter	°C
Δt_1	inlet temperature difference	K

* NOTE 1 bar = 100 kPa

Δt_{sup}	superheating	K
Δt_{sub}	subcooling	K
τ	test duration	s

Subscripts

m	mass
v	volume
W	water
R	refrigerant

Numbers

Position as defined in the annexes.

5 Standard capacity

5.1 Basis for standard capacity data

The influence of the refrigerant mass flow, the heat flux and the condensing temperature on the overall heat transfer of an air cooled condenser is low. As a result, in the range of temperature differences between 10K and 20K, the capacity is almost proportional to the temperature difference. The influence of superheat on the capacity is also very low; it is below + 0,2 % per K superheat. Therefore only one set of conditions is necessary to specify the performance of a condenser.

The airflow through a condenser has great influence on its capacity. Because of the complicated relations a simple conversion to other air flows is not possible with sufficient accuracy. Therefore the electrical values which influence the fan speed (voltage and frequency) shall correspond with the standard supply conditions.

5.2 Standard capacity conditions

The standard capacity shall be based on tests performed on a clean and dry condenser under the following operating conditions.

t_{A1}	25°C
Δt_1	15K
Δt_{sub}	$\leq$ 3K

nominal voltage and frequency

Δt_{sup} for common refrigerants this shall be determined according to:

R134a	25K
R22	45K
NH_3	50K

For other refrigerants this shall be the value that results when the refrigerant is subjected to isentropic compression from -10 °C evaporating and +10 °C vapour to +40 °C condensing temperatures.

5.3 Conditions for the nominal air flow rate

The nominal air volume flow rate refers to an air temperature of + 20 °C and an atmospheric pressure of 1013 hPa.

5.4 Conditions for nominal fan power

The nominal fan power refers to an air temperature of + 20 °C and to an atmospheric pressure of 1013 hPa.

6 Manufacturer's data

To identify the condenser and allow traceability, the manufacturer or supplier shall supply the following minimum information for every condenser.

a) type (designation);

b) rating of the fan motor(s) according to IEC 34-1;

c) the standard capacity, stating the refrigerant used;

d) nominal air flow;

e) nominal fan power;

f) nominal voltage and frequency;

g) fin shape, spacing and thickness;

h) tube nominal bore and internal form;

i) tube geometry;

j) circuit arrangement;

k) condenser coil internal volume including headers;

l) installation instructions.

7 Measurements

7.1 Uncertainty of measurements

The permissible uncertainty of significant measurements is given in table 1.

Table 1 - Uncertainty of measurements

Measurements	Uncertainty of measurements
Air inlet temperature	± 0,2 °C
All other air temperatures	± 0,5 °C
Refrigerant temperature (general)	± 0,3 °C
Refrigerant pressure	Shall be small enough for the measurement of the condensing temperature to be obtained within ± 0,2 °C
Water temperature difference	± 0,5% of the measured value
Refrigerant flow rate	± 2 % of the measured value
Water flow rate	± 1 % of the measured value
Electrical energy	± 1 % of the measured value
Current, voltage, cycles	± 0,5 % of the measured value
Time interval	± 0,2 % of the measured value or ± 2 s (smaller value applies)
Oil content in the refrigerant	± 20 % of the measured value
Mass	± 0,5% of the measured value
Atmospheric pressure	± 5 hPa
Fan speed	± 1 % of the measured value

7.2 Measurement criteria

7.2.1 *Pipe side temperature measurement*

7.2.1.1 *General*

Temperatures shall be measured using one of the following methods:

a) Method A.

When the temperature is measured on the outside of the connecting pipe it shall be measured at two opposite points of the same cross-section and, if the pipe is horizontal, there shall be one point above and one below.

The pipe shall be insulated on each side of the temperature measuring point for a length of at least ten times of its outside diameter. It shall be ensured, that good thermal contact exists between the sensor and the pipe at the measuring point.

This method is only applicable if the active temperature difference is small and the internal heat transfer is much higher than the external one.

The measured value is the arithmetic mean of both individual values.

b) Method B

When the temperature is measured by a sensor immersed in the pipe, care shall be taken that temperature stratifications and flow patterns do not influence the accuracy of the measurements.