SLOVENSKI STANDARD
SIST EN 1048:1999

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Prenosniki toplote ï Hladilniki tekoļ in s prisilno konvekcijo ï Postopki preskuģanja za ugotavljanje tehniļ nih karakteristik

Heat exchangers - Air-cooled liquid coolers "dry coolers" - Test procedure for establishing the performance

Wärmeaustauscher - Luftgekühlte Flüssigkeitskühler "Trockenkühltürme" - Prüfverfahren zur Leistungsfeststellung

Echangeurs thermiques - Refroidisseurs de liquide à convection forcée - Procédures d'essai pour la détermination des performances

Ta slovenski standard je istoveten z: **EN 1048:1998**

ICS:

27.060.30	Grelniki vode in prenosniki toplote	Boilers and heat exchangers
27.200	Hladilna tehnologija	Refrigerating technology

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Descriptors: heat transfer, heat exchangers, coolers, air cooling, liquid cooling, definitions, tests, characteristics, calorific power, measurements, testing conditions

English version

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This European Standard was approved by CEN on 3 September 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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 supersedes ENV 1048:1993.

The document was implemented previously as a European Standard (ENV) in 1993 and no technical changes have been made.

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 March 1999, and conflicting national standards shall be withdrawn at the latest by March 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.

Introduction

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

1 Scope

This European Standard applies to remote forced convection air cooled liquid coolers, within which no change in the liquid phase occurs.

This European Standard does not apply to liquid coolers, designed primarily for installation within the machinery compartment of packaged products.

Its purpose is to establish uniform methods to test and ascertain the following:

- Product identification
- Capacity
- Air flow rate
- Liquid side pressure drop
- Energy requirements.

This European 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.

EN 45001:1989 General criteria for the operation of testing laboratories

3 Definitions

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

3.1 forced convection air cooled liquid cooler; "dry cooler": A self contained system, that cools a single phase liquid by rejecting sensible heat via a heat exchanger to air that is mechanically circulated by integral fan(s).

In the following, "forced convection air cooled liquid cooler" is referred to as "dry cooler".

3.2 liquid: The working fluid circulated through the refrigeration system, which remains in liquid phase during the absorption and rejection of heat during the test. The liquid can be any fluid which can be defined and that has known physical properties.

3.3 capacity: The cooling effect on the liquid passing through the dry cooler. It is defined as the product of the liquid mass flow rate and the difference between the enthalpies at the inlet and outlet connections of the dry cooler.

3.4 temperatures:

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

3.4.1 air inlet temperature: Dry bulb temperature of the air at the inlet of the dry cooler, taking into consideration the local air velocities.

3.4.2 liquid inlet temperature: Temperature of the liquid at the inlet connection of the dry cooler, taking into consideration the local liquid velocities.

3.4.3 liquid outlet temperature: Temperature of the liquid at the outlet connection of the dry cooler, taking into consideration the local liquid velocities.

3.5 temperature differences

3.5.1 inlet temperature difference: Difference between the liquid inlet temperature and air inlet temperature of the dry cooler.

3.5.2 liquid temperature difference: Difference between the liquid inlet and liquid outlet temperatures of the dry cooler.

3.6 liquid pressure

3.6.1 liquid inlet pressure: Average static pressure of the liquid at the inlet connection of the dry cooler.

3.6.2 liquid outlet pressure: Average static pressure of the liquid at the outlet connection of the dry cooler.

3.7 liquid pressure difference: Difference between the liquid inlet pressure and the liquid outlet pressure.

3.8 rotational speed of the fans: Average rotational speed of all the fans installed within the dry cooler.

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

4 Symbols

For the purpose of this European Standard the following apply.

4.1 Letters

cp_A	Specific heat capacity of the air	kJ/(kg · K)
cp_L	Specific heat capacity of the liquid, at the mean temperature within the dry cooler	kJ/(kg · K)
n_1	Rotational speed of the fans, measured during the capacity test	1/min
n_2	Rotational speed of the fans, measured during the air volume flow test	1/min
P	Capacity	kW
P_{fan}	Power input to fan motor(s)	kW
p_{L1}	Liquid inlet pressure	bar
p_{L2}	Liquid outlet pressure	bar
P_{atm}	Atmospheric pressure	h Pa
Δp_L	Liquid pressure difference	bar
q_{mL}	Mass flow rate of the liquid	kg/s
q_{vA}	Volumetric flow rate of the air	m^3/s
q_{vL}	Volumetric flow rate of the liquid	m^3/s
ro_A	Density of the air	kg/m^3
ro_L	Density of the liquid at temperature t_{L3}	kg/m^3
t_{A1}	Air inlet temperature	°C
t_{L1}	Liquid inlet temperature	°C
t_{L2}	Liquid outlet temperature	°C

t_{L3}	Liquid temperature at flow meter	°C
Δt_I	Inlet temperature difference	K
Δt_L	Liquid temperature difference	K
Z	Test duration	s

4.2 Superscripts –

(a,b) refers to the test sequence, (a) above and (b) below the standard conditions.

(st) refers to standard conditions.

5 Standard capacity

5.1 Basis for standard capacity data

5.1.1 The capacity of the dry cooler is dependent on:

a) Inlet and liquid temperature difference.

b) Mass flow of air and liquid.

c) Type of liquid and its temperature.

d) Mounting of unit.

The complex relationship that exists between these items and the capacity, means that it is not possible, with sufficient accuracy, to generalise this relationship over widely varying operating conditions.

5.1.2 As dry coolers are usually designed to meet specific sets of operating conditions, this standard specifies:

a) an acceptable test method which can be applied to any prescribed set of operating conditions;

b) a standard capacity operating condition, which can be used for comparison purposes.

5.2 Standard conditions for dry cooler capacity

Standard capacity shall be based on tests performed on a clean dry cooler under the following operating conditions:

Liquid type	Water
$t_{A1}^{(st)}$	25 °C
$\Delta t_I^{(st)}$	15 K

$\Delta t_L^{(st)}$	5 K
$p_{atm}^{(st)}$	1013 h Pa

The nominal electrical voltage, frequency and phase shall be as specified by the manufacturer.

5.3 Operating conditions for the nominal air flow

The air volume flow is not influenced by atmospheric pressure and temperature changes when the fan speed is constant.

The air volume flow measured during the air flow test shall be corrected to allow for the variation in fan speeds between the capacity test, n_1 and the air flow test n_2.

6 Manufacturer's data

To identify the dry cooler and allow its traceability, the manufacturer or supplier shall supply the test house with the following minimum information for every dry cooler:

a) manufacturer's identification;
b) type, model and size (designation);
c) rating of the fan motor(s) according to CENELEC standard;
d) test conditions and liquid to be used, if other than the standard conditions;
e) capacity;
f) electrical power input of the fan motor(s) at test conditions;
g) heat exchanger liquid side internal volume;
h) installation instructions;
i) air flow;
j) total heat transfer surface (air flow side);
k) fin spacing;
l) tube nominal bore;
m) tube/fin geometry;
n) circuiting arrangement;
o) liquid pressure drop.

7 Measurements

7.1 Uncertainty of measurements

The permissible uncertainty for various measurements is given in table 1.

Table 1: Uncertainty of measurements

Measurements	Uncertainty of measurements
Temperatures: Air and liquid Liquid temperature difference	 ± 0,2 K ± 0,1 K
Pressures: Atmospheric Liquid, differential pressure	 ± 5 hPa ± 1 % of the reading or ± 0,02 bar, the higher value applies
Liquid flow rate	± 1 % of the reading
Electrical energy, power	± 1 %
Current, voltage, frequency	± 0,5 %
Time interval	± 0,2 % of the reading or ± 2 s; the smaller value applies
Number of revolutions	± 1 % of the reading

7.2 Measurement criteria

7.2.1 *Temperature measuring points, liquid side*

a) Where the temperatures are measured by sensors immersed in the connecting pipes, it shall be ensured temperature stratification and flow patterns do not influence the accuracy of the measurements.

b) Where the temperatures are measured on the outside of the connecting pipes, they 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 connecting pipes shall be insulated from the dry cooler for a distance of at least ten times the outside diameter beyond the temperature measuring points. Good thermal contact between the sensor and the pipe at the measuring point shall be ensured. a) is the preferred method.

The liquid temperatures shall be measured as close as possible to the dry cooler connections and in any case within fifteen times the outside diameter of the connecting pipe.