SLOVENSKI STANDARD
SIST EN 16147:2017+A1:2023

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Toplotne črpalke z električnimi kompresorji - Preskušanje, vrednotenje lastnosti in zahteve za označevanje naprav za pripravo tople sanitarne vode (vključuje dopolnilo A1)

Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units

Wärmepumpen mit elektrisch angetriebenen Verdichtern - Prüfungen, Leistungsbemessung und Anforderungen an die Kennzeichnung von Geräten zum Erwärmen von Brauchwarmwasser

Pompes à chaleur avec compresseur entraîné par moteur électrique - Essais, détermination des performances et exigences pour le marquage des appareils pour eau chaude sanitaire

Ta slovenski standard je istoveten z: EN 16147:2017+A1:2022

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23.140	Kompresorji in pnevmatični stroji	Compressors and pneumatic machines
27.080	Toplotne črpalke	Heat pumps
91.140.65	Oprema za ogrevanje vode	Water heating equipment

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EUROPEAN STANDARD

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EN 16147:2017+A1

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English Version

Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 16147:2017+A1:2022) 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of an identical text or by endorsement, at the latest by June 2023, and conflicting national standards shall be withdrawn at the latest by June 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes [A1] EN 16147:2017 [/A1].

[A1] The main changes with respect to the previous edition are listed below:

a) correction of the calculation of η_{wh} for heat pump water heaters and heat pump combination water heaters;

b) correction of the calculation of the annual consumption of electric energy;

c) completion of Annexes ZA, ZB, ZC and ZD in line with the standardization requests M/534 (water heaters) and M/535 (space heaters). [/A1]

This document includes Amendment 1 approved by CEN on 23 May 2021.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [/A1].

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annexes ZA, ZB, ZC and ZD, which are an integral part of this document.

Note that the following provides details of significant technical changes between this document and the previous edition:

d) re-structuring of the standard into the Clause 5 “Installation requirements”, Clause 6 “Settings and test conditions”, Clause 7 “Performance tests”, Clause 8 „Other tests“ and Clause 9 „Test results and test report“;

e) update of Table 1 “Uncertainties of measurement for indicated values” in terms of units;

f) update of the performance test regarding the stages (i.e. A. to F.) and the order of the tests (see 7.2);

g) introduction of 7.11 “Calculation of the smart control factor SCF” and 7.12 „Determination of the ambient correction term Q_{cor} “ on the basis of the European Standard EN 50440:2015;

h) introduction of 7.13.3 “Calculation of the Annual Consumption of electric energy”;

i) re-allocation and revision of the former “tapping cycles“ into the new annex “Load profiles” (see Tables A.1 to A.3);

j) introduction of 7.14 “Other performances” regarding rated heat output and seasonal coefficient of performance;

k) addition of the Annex ZA and Annex ZB for the relationship between this European Standard and the requirements of Commission Regulation (EU) No 814/2013 and (EU) No 812/2013;

l) addition of the Annex ZC and Annex ZD for the relationship between this European Standard and the requirements of Commission Regulation (EU) No 813/2013 and (EU) No 811/2013.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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1 Scope

This document specifies methods for testing, rating of performance and calculation of water heating energy efficiency of air/water, brine/water, water/water and direct exchange/water heat pump water heaters and heat pump combination heaters with electrically driven compressors and connected to or including a domestic hot water storage tank for domestic hot water production.

This document comprises only the testing procedure for the domestic hot water production of the heat pump system.

NOTE 1 Testing procedures for simultaneous operation for domestic hot water production and space heating are not treated in this standard. Simultaneous means that domestic hot water production and space heating generation occur at the same time and may interact.

NOTE 2 For heat pump combination heaters the seasonal efficiency of space heating is determined according to EN 14825.

This document only applies to water heaters which are supplied in a package of heat pump and storage tank. In the case of water heaters consisting of several parts with refrigerant connections, this European Standard applies only to those designed and supplied as a complete package.

This document does not specify requirements of the quality of the used water.

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.

〈A1〉 EN 14511-1:2018, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 1: Terms and definitions*

EN 14511-2:2018, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 2: Test conditions*

EN 14511-3:2018, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 3: Test methods*

EN 60204-1:2018, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

prEN IEC 60335-2-40:2020, *Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (IEC 60335-2-40:2018)*

EN 61000-3-11:2019, *Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection (IEC 61000-3-11:2017)* A1

3 Terms and definitions

For the purposes of this document, the terms and definitions given in A1 EN 14511-1:2018 A1 and the following apply.

3.1
heat pump water heater
water heater that uses ambient heat from air source, water source or ground source, and/or waste heat for heat generation

3.2
heat pump combination heater
heat pump space heater that is designed to also provide heat to deliver hot drinking or sanitary water at given temperature levels, quantities and flow rates during given intervals, and is connected to an external supply of drinking or sanitary water

3.3
domestic hot water
water heated for household or similar purposes

3.4
storage volume
V_m
measured volume of the tank

3.5
non heated space air
heat source for a heat pump which absorbs heat by an air heat exchanger in direct contact with the air inside a non-heated space within a building

3.6
indoor air
heat source for a heat pump which absorbs heat by an air heat exchanger in direct contact with the air inside a heated space within a building

3.7
coefficient of performance for domestic hot water
COP_{DHW}
coefficient of performance which is determined by the use of a reference load profile and which includes the heat losses of the storage tank

3.8
reference hot water temperature
θ'_{WH}
temperature determined as the mean temperature value of the average temperatures during one single draw-off which ends when the hot water temperature is below 40 °C

3.9
mixed water at 40 °C
V_{40}
quantity of water at 40 °C, which has the same heat content (enthalpy) as the hot water which is delivered above 40 °C at the output of the water heater

3.10
off-peak product
water heater that is energised for a maximum period of 8 consecutive hours between 22:00 and 07:00 of the 24 hour tapping pattern

3.11
water heating energy efficiency
η_{wh}
ratio between the useful energy (in domestic hot water) provided by a water heater and the energy required for its generation

3.12
load profile
given sequence of water draw-offs

3.13
water draw-off
given combination of useful water flow rate, useful water temperature, useful energy content and peak temperature

3.14
useful water flow rate
f
minimum flow rate for which hot water is contributing to the reference energy

3.15
useful water temperature
T_m
water temperature at which hot water starts contributing to the reference energy

3.16
useful energy content
Q_{tap}
energy content of hot water provided at a temperature equal to, or above, the useful water temperature, and at water flow rates equal to, or above, the useful water flow rate

3.17
peak temperature
T_p
minimum water temperature to be achieved during water draw-off calculated as the mean value over the water draw-off

3.18
reference energy of the load profile
Q_{ref}
sum of the useful energy content of water draw-offs in a particular load profile

3.19
daily electrical energy consumption
Q_{elec}
consumption of electrical energy for water heating over 24 consecutive hours under a specific load profile

3.20
smart control
device that automatically adapts the water heating process to individual usage conditions with the aim of reducing energy consumption

3.21
smart control factor
SCF
water heating energy efficiency gain due to smart control

3.22
primary standby heat loss
P_{stby}
primary power input of a heat pump water heater in operating modes without heat demand

3.23
standby power input
P_{es}
total power input of the unit during the standby test, including the power input of the unit to overcome heat losses of the tank and the power input of any auxiliary device

3.24
ambient correction term
Q_{cor}
energy correction term which takes into account the fact that the place where the water heater is installed is not an isothermal place

3.25
conversion coefficient
CC
coefficient reflecting the power generation efficiency

Note 1 to entry: According to Directive 2012/27/EU the *CC* value is equal to 2,5.

4 Symbols and abbreviations

Symbol	Description	Units
AEC	Annual electrical energy consumption	kWh/a
CC	conversion coefficient, equal to 2,5	—
SCF	smart control factor	—
COP_{DHW}	coefficient of performance for domestic hot water	—
c_p	specific heat capacity of water	kJ/(kgK)
ESP	external static pressure	Pa
f	useful water flow rate	l/min
f_{max}	maximum flow rate of considered load profile	l/min
$f_{max}(t)$	maximum flow rate of hot water during draw-off	l/min
$f(t)$	useful water flow rate	l/min
i	index for the draw-off	—
k	coefficient for the determination of ambient correction term, which value is given in Table 7	—
m_{act}	difference of the two weights (filled/empty) of the storage water heater	kg
P_{es}	standby power input	kW
P_{rated}	rated heat output	kW
P_S	measured average power input for off-peak products	kW
P_{stby}	primary standby heat loss	kW
Q_{cor}	ambient correction term	kWh
Q_{elec}	daily electrical energy consumption	kWh
$Q_{EL\text{-}LP}$	calculated heat energy produced by electrical resistance heater during the whole load profile	kWh
$Q_{EL\text{-}tap}$	Calculated heat energy produced by electrical resistance heater to reach the required tapping temperature	kWh
$Q_{HP\text{-}tap}$	useful energy during one single draw-off	kWh
Q_{LP}	total useful energy content during the whole load profile	kWh
Q_{elec}^{smart}	total electrical energy consumption during the smart period of the smart cycle	kWh

Symbol	Description	Units
Q_{LP}^{smart}	total useful energy content during the smart period of the smart cycle	kWh
Q_{elec}^{ref}	Total electrical energy consumption during the reference period of the smart cycle	kWh
Q_{LP}^{ref}	total useful energy content during the reference period of the smart cycle	kWh
Q_{ref}	reference energy of the load profile	kWh
Q_{tap}	energy content of hot water provided at a temperature equal to, or above, the useful water temperature, and at water flow rates equal to, or above, the useful water flow rate	kWh
smart	indicator of the smart control compliance of the product	
$SCOP_{DHW}$	Seasonal Coefficient of Performance for domestic hot water	
t_d	test phase duration	s
t_{es}	duration of the last on-off-cycle of the heat pump	s
t_h	heating up time	s
t_{40}	time from starting the draw-off until θ_{WH} is less than 40 °C	s
t_{tap}	duration of a draw-off of useful water	s
t_{TTC}	load profile time	h
T_{DB}	dry bulb temperature	°C
T_m	useful water temperature	°C
T_p	peak temperature	°C
T_{WB}	wet bulb temperature	°C
$\dot{V}_{air}$	nominal air volume flow rate	m^3/s
$\dot{V}_{fluid}$	measured liquid volume flow rate	m^3/s
V_m	storage volume	l
V_{40}	mixed water at 40 °C	l
$W_{eh\text{-}HP}$	total electrical energy consumption during the test duration t_h	kWh
$W_{eh\text{-}M}$	measured electrical energy consumption during the test duration t_h	kWh
$W_{EL\text{-}Corr}$	correction due to electrical energy consumption of fan/liquid pump	kWh

Symbol	Description	Units
$W_{EL\text{-}LP}$	total electrical energy consumption during the whole load profile	kWh
$W_{EL\text{-}M\text{-}LP}$	total measured electrical energy consumption	kWh
$W_{EL\text{-}OFF}$	calculated electrical energy consumption for off-peak products	kWh
$W_{es\text{-}HP}$	total electrical energy consumption during the last on-off-cycle	kWh
$W_{es\text{-}M}$	measured electrical energy consumption during the last on-off cycle	kWh
Δp_e	measured external static pressure difference	Pa
Δp_i	measured internal static pressure difference	Pa
η	efficiency of the fan or the pump according to EN 14511–3	—
η_{wh}	water heating energy efficiency	%
n_{tap}	number of draw-offs during the load profile	—
θ_{WC}	incoming cold water temperature	°C
$\theta_{WC}(t)$	incoming cold water temperature during draw-off	°C
θ_{WH}	outgoing hot water temperature	°C
$\theta_{WH}(t)$	hot water temperature during draw-off	°C
θ'_{WH}	reference hot water temperature	°C
$\rho(T)$	density of water at temperature T	kg/m^3

5 Installation requirements

5.1 Test apparatus and uncertainties of measurement

The test apparatus shall be designed in such a way that all requirements for adjustment of set values, stability criteria and uncertainties of measurement according to this European Standard can be fulfilled.

Water systems or other heat transfer liquid systems shall be sufficiently free of entrained gas as to ensure that the measured results are not significantly influenced.

The inlet and outlet temperatures of the domestic water are measured in the centre of the flow and as close as possible to the appliance. The response time of the temperature sensor and the sampling interval have to be chosen to maintain the uncertainties in Table 1.

Ducted air systems shall be sufficiently airtight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

The uncertainties of measurement shall not exceed the values specified in Table 1.

Table 1 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty
Domestic Hot Water		
Temperature	°C	±0,2 K
Temperature difference	K	±0,2 K
Volume	L	±2 %
Volume flow	l/min	±2 %
Thermal energy	kWh	±5 %
Liquid (heat source)		
Temperature inlet/outlet	°C	±0,15 K
Volume flow	m^3/s	±1 %
Static pressure difference	Pa	±1 kPa ($\Delta P \leq 20$ kPa) ± 5 % ($\Delta P \geq 20$ kPa)
Brine concentration	% vol.	±2 % vol.
Air (heat source)		
Dry bulb temperature	°C	±0,2 K
Wet bulb temperature	°C	±0,4 K
Volume flow	m^3/h	±5 %
Static pressure difference	Pa	±5 Pa ($\Delta P \leq 100$ Pa) ±5 % ($\Delta P \geq 100$ Pa)
Electrical quantities		
Electric power	W	±0,1 W (≤10 W) ±1 % (≥10 W)
Electrical energy	kWh	±1 %
Voltage	V	±0,5 %
current	A	±0,5 %
Ambient		
Ambient temperature indoors	°C	±0,5 K

5.2 Test room for the outdoor heat exchanger of air source heat pumps

The size of the test room shall be selected to avoid any resistance to air flow at the air inlet and air outlet orifices of the test object. The air flow through the room shall not be capable of initiating any short circuit between the two orifices, and therefore the velocity of air flow at these two locations shall not exceed 1,5 m/s when the test object is switched off.

Unless otherwise stated by the manufacturer, the air inlet and air outlet orifices shall not be less than 1 m from the surfaces of the test room; this also applies to any measuring ducts.

Any direct heat radiation (e.g. solar radiation) onto heating units in the test room onto the heat pump or onto the temperature measuring points shall be avoided.

5.3 Installation and connection of the heat pump

The heat pump shall be installed and connected for the test as recommended by the manufacturer in his installation and operation manual. The accessories provided by option (for example heating element) are not included in the test.

Temperature and pressure measuring points shall be arranged in order to obtain significant mean values.

5.4 Installation of heat pumps consisting of several parts

In the case of heat pumps consisting of several refrigeration parts (split heat pumps) the following installation conditions shall be complied with for the tests:

a) each refrigerant line shall be installed in accordance with the manufacturer's instructions; the length of each line shall be between 5 m and 7,5 m;

b) the lines shall be installed so that the difference in elevation does not exceed 2,5 m;

c) thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions;

d) unless constrained by the design at least half of the interconnecting lines shall be exposed to the outdoor conditions with the rest of the lines exposed to the indoor conditions.

For the test of direct exchange ground coupled heat pumps requirement d) is not valid.

For indirect systems where the heat pump is separated from the tank, water or brine connections to the tank shall be installed in accordance with the manufacturer’s instructions to the maximum stated length or 5 m, whichever is shorter. Piping shall be installed according to d) and with as few bends as possible and insulated according to c).