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Heat pump water heaters — Testing and rating for performance —

Part 2: Heat pump water heaters for space heating

Chauffe-eau à pompe à chaleur — Essais et classification des performances —
Partie 2: Chauffe-eau à pompe à chaleur pour le chauffage des locaux

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Foreword

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Heat pump water heaters — Testing and rating for performance —

Part 2: Heat pump water heaters for space heating

1 Scope

This document specifies test conditions and test procedures for determining the performance characteristics of air source heat pump water heaters for space heating with electrically driven compressors with or without supplementary heater. The purpose of this document is to rate the performance of the heat pump water heaters for space heating with no operation of any supplementary heater. In the case of heat pump water heaters for space heating consisting of several parts with refrigerant or water connections, this document applies only to those designed and supplied as a complete package.

NOTE Testing procedures for simultaneous operation for hot water supply and space heating are not treated in this document. Simultaneous means that hot water supply and space heating generation occur at the same time and can interact.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
heat pump water heater for space heating
heat pump
air source heat pump water heater with electrically driven compressors with or without supplementary heater for space heating purposes

3.2
heating capacity
heat given off by the unit to the heat transfer medium per unit of time

Note 1 to entry: Heating capacity is expressed in watts.

Note 2 to entry: If heat is removed by the indoor heat exchanger for defrosting, it is taken into account.

3.3
standard heating capacity
rated heating capacity under standard rating conditions as defined in Tables 5, 6 and 7

3.4
effective power input
average electrical power input of the unit within the defined interval of time obtained from:

— power input for operation of the compressor and any power input for defrosting;

— power input for all control and safety devices of the unit;

— proportional power input of the conveying devices (e.g. fans, pumps) for ensuring the transport of the heat transfer media inside the unit

Note 1 to entry: Effective power input is expressed in watts.

3.5
outdoor air
air from the outdoor environment

3.6
operating range
working range for the heat pump as specified by the manufacturer

3.7
outdoor heat exchanger
heat exchanger which is designed to remove heat from the outdoor ambient environment, or any other available heat source, or to transfer heat to it

4 Symbols and abbreviated terms

Symbol	Definition	Units
C_p	Specific heat capacity of water	kJ/(kg*K)
C_{20}	A scaling factor equal to 0,49	—
EEI	The Energy Efficiency Index equal to 0,23	—
IE	The motor efficiency level	—
P_H	Heating capacity	W
P_{hyd}	The hydraulic power of the pump	W
q	Volume flow rate	m^3/s
t	Time	s
ρ	Density of the hot water depending on the temperature at the flow meter	kg/m^3
Δp_e	The measured available external static pressure difference	Pa
Δp_i	The measured internal static pressure difference	Pa
Δt	Difference between inlet and outlet temperatures	K
η	0,3 by convention	—

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 document are 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 water temperatures of the heat pump are measured in the centre of the flow and as close as possible to the unit. The response time of the temperature sensor and the sampling interval shall 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.

When performing measurements, set the highest room temperature on the unit/system control device. If in the instructions, the manufacturer indicates a value for the temperature set on the control device for a given rating condition, then this value shall be used.

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

For free air intake temperature measurements, it is required either:

— to have at least one sensor per square meter, with not less than four measuring points and by restricting to 20 the number of sensors equally distributed on the free air surface; or

— to use a sampling device. It shall be completed by four sensors for checking uniformity if the surface area is greater than 1 m^2.

Air temperature sensors shall be placed at a maximum distance of 0,25 m from the free air surface.

For units consisting of a heat pump and a storage tank as a factory made unit, water inlet and outlet temperature measurements shall be taken at the inlet and outlet of this unit.

For water and brine, the density and specific heat in Formulae (1), (2) and (3) shall be determined in the temperature conditions measured near the volume flow measuring device.

For inverter type control units, the setting of the frequency shall be done for each rating condition. The manufacturer shall provide in the documentation information instructions on how to obtain the necessary data to set the required frequencies. If skilled personnel with knowledge of control software is required for the start of the system, the manufacturer or the nominated agent should be in attendance when the system is being installed and prepared for tests.

The uncertainties of measurement shall not exceed the values specified in Table 1. Additionally, the heat capacity measured on the liquid side shall be determined within a maximum uncertainty of 5 % independently of the individual uncertainties of measurements including the uncertainties on the properties of the fluid.

Table 1 — Uncertainties of measurement

Measured quantity	Unit	Uncertainty
Liquid		
Temperature	°C	±0,15 K
Temperature difference	K	±0,15 K
Volume flow	l/min	±1 %
Static pressure difference	kPa	±1 kPa (≤20 kPa) ±5 % (>20 kPa)
Concentration (for brine)	%	2 %
Air		
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 (ΔP ≤ 100 Pa) ±5 % (ΔP ≥ 100 Pa)

Table 1 *(continued)*

Measured quantity	Unit	Uncertainty
Electrical quantities		
Electric power	W	±1 %
Electrical energy	kWh	±1 %
Voltage	V	±0,5 %
current	A	±0,5 %

5.2 Test room for the airside and remote condenser

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.

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 the installation and operation manual. If a back-up heater is provided in option or not, it shall be switched off or disconnected to be excluded from the testing. Temperature and pressure measuring points shall be arranged in order to obtain representative 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.

6 Setting and test conditions

6.1 General

Set points for internal control equipment of the unit, i.e. thermostats, pressure switches or mixing valves, shall be set to the values as stated in the installation and operating instructions.

If several set points or a range are stated, the manufacturer shall indicate the one to be used for the tests.

6.2 Settings for non-ducted units

For non-ducted units, the adjustable settings, i.e. louvers and fan speed, shall be set according to the installations and operating instructions.

Without information from the manufacturer, louvers and fan speed shall be set for maximum air flow rate.

6.3 Setting the external static pressure difference for ducted units

The volume flow and the pressure difference shall be related to standard air and with dry heat exchanger. If the air flow rate is given by the manufacturer with no atmospheric pressure, temperature and humidity conditions, it shall be considered as given for standard air conditions.

The air flow rate as stated in the installation and operating instructions shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

The rated air flow rate as stated in the installation and operating instructions shall be set and the resulting external static pressure (ESP) measured.

If the ESP is lower than 30 Pa, the air flow rate is decreased to reach this minimum value. The apparatus used for setting the ESP shall be maintained in the same position during all the tests.

If the installation and operating instructions state that the maximum allowable duct length is for inlet and outlet together less than 2 m, then the unit shall be tested with the duct length and the ESP is considered to be 0.

6.4 Setting of units with integral pumps

For units with integral water or brine pumps, the external static pressure shall be set at the same time as the temperature difference.

When the liquid pump has one or several fixed speeds, the speed of the pump shall be set in order to provide the minimum external static pressure.

In case of variable speed liquid pump, the manufacturer shall provide information to set the pump in order to reach a maximal external static pressure of 10 kPa.

Deviations from set values shall not exceed values indicated in Table 2. Variations from specified conditions shall not exceed values indicated in Table 3.

Table 2 — Permissible deviations from set values

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviations of individual measured values from set values
Liquid		
— inlet temperature	±0,2 K	±0,5 K
— outlet temperature	±0,3 K	±0,6 K
— volume flow[a]	±1 %	±2,5 %
— static pressure difference	—	±10 %
Air		
— inlet temperature		
— dry bulb	±0,3 K	±1 K
— wet bulb	±0,4 K	±1 K
— volume flow	±5 %	±10 %
— static pressure difference	—	±10 %
Voltage	±4 %	±4 %
[a] Frosting period excluded.		

Table 3 — Variations allowed for the test conditions when the heat pump is running

Readings	Variations of arithmetical mean values from specified test conditions		Variation of individual readings from specified test conditions	
	Interval H[a]	Interval D[b]	Interval H[a]	Interval D[b]
Air				
— dry-bulb temperature[c]	±0,6 K	±1,5 K	±1,0 K	±5,0 K
— wet-bulb temperature	±0,4 K	±1,0 K	±0,6 K	—
Liquid				
— inlet temperature	±0,2 K	—	±0,5 K	-5 K
— outlet temperature	±0,5 K	—	±1 K	+2 K

[a] Interval H applies when the heat pump is in the heating mode, except for the first 10 min after termination of a defrost cycle, and the first 10 min after a restart of the heat pump.

[b] Interval D applies during a defrost cycle and during the first 10 min after the termination of a defrost cycle when the heat pump is operating in the heating mode.

[c] For units with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

6.5 Test conditions

The space heating tests shall be carried out under the environmental conditions specified in Table 4 depending on the location of the unit. For all units, electrical power voltage and frequency shall be given by the manufacturer.

For the rating tests, the appropriate test conditions shall be applied in accordance with Tables 5, 6 and 7.

The airflow rate shall be set to nominal, as indicated by the manufacturer. When only a range is given, tests are to be carried out at the maximum value.

Table 4 — Environmental conditions

Type	Measured quantities	Environmental temperature
Air-to-water units installed indoors	Dry bulb temperature	15 °C to 30 °C
Air-to-water units installed outdoors	Dry bulb temperature Wet bulb temperature	Air inlet temperatures (see Tables 5 6 and 7)

Table 5 — Test conditions for space heating (Low temperature)

	Outdoor heat exchanger		Indoor heat exchanger Low temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	30	35
Application Rating conditions	2	1	[a]	35
	–7	–8	[a]	35
	–15	—	[a]	35
	12	11	[a]	35

[a] The test is performed at the flow rate obtained during the test at the standard rating conditions.

Table 6 — Test conditions for space heating (Medium temperature)

	Outdoor heat exchanger		Indoor heat exchanger Medium temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	40	45
Application Rating conditions	2	1	[a]	45
	–7	–8	[a]	45
	–15	—	[a]	45
	12	11	[a]	45

[a] The test is performed at the flow rate obtained during the test at the standard rating conditions.

Table 7 — Test conditions for space heating (High temperature)

	Outdoor heat exchanger		Indoor heat exchanger High temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	47	55
Application Rating conditions	2	1	[a]	55
	–7	–8	[a]	55
	–15	—	[a]	55
	12	11	[a]	55

[a] The test is performed at the flow rate obtained during the test at the standard rating conditions.

7 Space heating test

7.1 Heating capacity test

The heating capacity of heat pumps shall be determined in accordance with the direct method at the water or brine heat exchanger at test conditions of Tables 5, 6 and 7, by determination of the volume flow of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density of the heat transfer medium.

For steady state operation, the heating capacity shall be determined using the following formula:

$$P_H = q \times \rho \times C_p \times \Delta t \quad (1)$$

where

P_H is the heating capacity in watts;

q is the volume flow rate, expressed in cubic meters per second;

ρ is the density, measured at the flow meter location, expressed in kilograms per cubic meter;

C_p is the specific heat, measured at the flow meter location, at constant pressure, expressed in joules per kilogram and kelvin;

Δt is the difference between inlet and outlet temperatures, expressed in kelvin;

NOTE 1 The mass flow rate can be determined directly instead of the term ($q \times \rho$).

NOTE 2 The enthalpy change ΔH can be directly measured instead of the item ($C_p \times \Delta t$).

7.2 Heating capacity correction

7.2.1 General

The capacity shall include the correction due to the heat output of indoor and/or outdoor fans and/or pumps, integrated into the unit or not as follows.

7.2.2 Capacity correction of fans for units without duct connection

In the case of units which are not designed for duct connection, i.e. which do not permit any external pressure difference, and which are equipped with an integral fan, no capacity correction due to heat provide by the fan shall apply.

7.2.3 Capacity correction due to indoor fan for ducted units

7.2.3.1 Units with integrated indoor fan

If the fan at the indoor heat exchanger is an integral part of the unit, the power input correction of the fan, as calculated with Formula (6) (see 7.2.5.3.1) shall be:

— subtracted from the measured heating capacity.

7.2.3.2 Units with non-integrated indoor fan

If the fan at the indoor heat exchanger is not an integral part of the unit, the power input correction as calculated with Formula (7) (see 7.2.5.3.2) shall be:

— added to the measured heating capacity.

7.2.4 Capacity correction due to indoor liquid pump

7.2.4.1 Units with integrated liquid pump

If the liquid pump is an integrated part of the unit, the capacity correction as defined in 7.2.4.3 or 7.2.4.4 shall be:

— subtracted from the measured heating capacity.

7.2.4.2 Units with non-integrated liquid pump

If the liquid pump is not an integral part of the unit, the capacity correction as defined in 7.2.4.5 shall be:

— added to the measured heating capacity.

