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Air to water heat pumps — Testing and rating at part load conditions and calculation of seasonal coefficient of performance for space heating

Chauffe-eau à pompe à chaleur — Essais et détermination des caractéristiques à charge partielle et calcul de performance saisonnière

FDIS stage

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC- Directives, Part- 1. In particular, the different approval criteria needed for the different types of ISO documents document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC- Directives, Part- 2 (see www.iso.org/directives).

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Field Code Changed

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*.

This second edition cancels and replaces the first edition (ISO 21978:2021), which has been technically revised.

The main changes are as follows:

— — Valuesvalues of Uncertaintiesuncertainties have been corrected.;

— — Descriptivedescriptive terms or names have been revised following ISO/IEC Directives.;

— — Errorserrors in Appendix A hasAnnex A have been corrected.;

— — Typostypos have been corrected.

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Introduction

Air to water heat pumps are, at present, selected and compared at a rated condition. This condition does not represent the usual operating conditions of the equipment over a season. This operating condition can be better assessed by comparing equipment at representative reduced capacities and determining the ~~Seasonal Coefficient of Performance~~seasonal coefficient of performance.

This ~~standard~~document provides part load conditions and calculation methods for calculating the ~~Seasonal Coefficient~~seasonal coefficient of ~~Performance~~performance ($S_{COP,on}$ and $S_{COP,net}$) of such units when they are used to fulfil the heating demands.

Other energy consumptions can occur when the unit is not used to fulfil the heating demands such as those from a crankcase heater or when the unit is on standby. These consumptions are considered in the calculation methods for reference S_{COP}.

Reference S_{COP}/$S_{COP,on}$/$S_{COP,net}$ calculations may be based on calculated or tested values. For the purpose of S_{COP}/$S_{COP,on}$/$S_{COP,net}$, three design conditions average (A), colder (C) and warmer (W) are considered, as well as three temperature applications. In case of tested values, this ~~standard~~document gives the methods for testing air to water heat pumps at part load conditions.

Air to water heat pumps — Testing and rating at part load conditions and calculation of seasonal coefficient of performance for space heating

1 Scope

This document specifies test conditions for determining the seasonal performance characteristics of air to water heat pumps for space heating with electrically driven compressors with or without supplementary heater. In the case of air to water heat pumps 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.

The seasonal coefficient of performance depends, inter alia, on the climate conditions and temperature regime of the space heating distribution network.

This document specifies:

— three design conditions, each of them being characterized by a design temperature which represents the lowest temperature that can occur in that design condition;

— three water temperature distribution regimes, namely "temperature application" in the text.

This document also provides a full description of three heating seasons that can be used with the associated design conditions.

2 Normative references

There are no normative references in this document.

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For updated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-30-1, Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors (IE code)

53 Terms and definitions

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

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

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

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

3.1
35 °C application
temperature application where the indoor heat exchanger water(brine) outlet temperature of 35 °C is met at design temperature

3.2
45 °C application
temperature application where the indoor heat exchanger water(brine) outlet temperature of 45 °C is met at design temperature

3.3
55 °C application
temperature application where the indoor heat exchanger water(brine) outlet temperature of 55 °C is met at design temperature

3.4
active mode
mode corresponding to the hours with a heating load of the building and whereby the heating function of the unit is activated

Note 1 to entry: This condition can involve on/off-cycling of the unit in order to reach or maintain a required indoor air temperature.

3.5
active mode seasonal coefficient of performance
$S_{COP,on}$
average coefficient of performance of the unit in *active mode* ~~(3.4)~~(3.4) for the designated design condition, determined from the part load, supplementary heating capacity (where required) and *bin-specific coefficients of performance* ~~(3.12)~~(3.12) and weighted by the *bin hours* ~~(3.11)~~(3.11) where the bin condition occurs

Note 1 to entry: For calculation of $S_{COP,on}$, the energy consumption during *thermostat-off mode* ~~(3.47),~~(3.47), *standby mode* ~~(3.44),~~(3.44), *off mode* ~~(3.36)~~(3.36) and *crankcase heater mode* ~~(3.22)~~(3.22) are excluded. The energy consumption of a supplementary heater is added for the part load conditions where the declared capacity of the unit is lower than the heating load, regardless whether this supplementary heater is included in the unit or not included in the unit.

Note 2 to entry: Expressed in kWh/kWh.

3.6
air to water heat pump
~~Heat~~heat pump which consists of one or more factory-made assemblies which includes at space side refrigerant to water heat exchanger (load side), electrically driven compressor(s), and outdoor-side air-to refrigerant heat exchanger(s) (source side), including means to provide space heating and/or space cooling functions.

Note 1 to entry: It can include supplementary heater for space heating.

Note 2 to entry: This is also referred to as heat pump in this document.

3.7
annual energy consumption for heating
Q_{HE}
energy consumption required to meet the reference annual heating demand for a designated design condition and set of bin hours and calculated as the reference annual heating demand divided by the *active mode seasonal coefficient of performance* ~~(3.5)~~(3.5) and the energy consumption of the unit for thermostat-off-, standby-, off- and crankcase heater-mode during the heating season

Note 1 to entry: Expressed in kWh.

3.8
annual heating demand
Q_H
heating demand for a designated design condition and set of bin hours, to be used as basis for calculation of *seasonal coefficient of performance* ~~(3.43)~~(3.43) and calculated as the product of the ~~*design load* (3.26)~~*designload* (3.26) for heating and the *equivalent active mode hours* ~~*for heating* (3.32)~~*forheating* (3.32)

Note 1 to entry: Expressed in kWh.

3.9
available external static pressure difference
Δp_e
positive pressure difference measured between the air (or water) outlet section and the air (or water) inlet section of the unit, which is available for overcoming the pressure drop of any additional ducted air (or water) circuit

3.10
bin
outdoor temperature interval of 1 K

3.11
bin hours
***h*j**
hours per heating season for which an outdoor temperature occurs for each *bin* ~~(3.10)~~ (3.10)*j*

3.12
bin-specific coefficient of performance
$C_{Pb,T,j}$
coefficient of performance specific for every *bin* ~~(3.10)~~ (3.10)*j* with outdoor temperature T_j in a heating season

3.13
bin temperature
T_j
outdoor air dry bulb temperature

Note 1 to entry: Expressed in °C.

Note 2 to entry: The relative humidity can be indicated by a corresponding wet bulb temperature.

3.14
bivalent temperature
T_{biv}
lowest outdoor temperature point at which the unit is declared to have a capacity able to meet 100 % of the heating load without supplementary heater, whether it is integrated in the unit or not

Note 1 to entry: Below this point, the unit can still provide capacity, but additional supplementary heating is necessary to fulfil the heating load.

3.15
capacity control
ability of the unit to change its capacity by changing the volumetric flow rate of the refrigerant

Note 1 to entry: Units are indicated as '*fixed*' if the unit cannot change its volumetric flow rate, '*two-staged*' if the volumetric flow rate is changed or varied in series of not more than two steps, '*multi-stage*' if the volumetric flow rate is changed or varied in series of three or four steps or '*variable*' if the volumetric flow rate is changed or varied in series of five or more steps to represent continuously variable capacity.

Note 2 to entry: Multi-stage capacity units are considered as variable capacity units in this document.

3.16
capacity ratio
C_R
heating part load or full load divided by the declared heating capacity of the unit at the same temperature conditions

3.17
coefficient of performance at the declared capacity
C_{Pd}
declared heating capacity of the unit divided by the effective power input of the unit at specific temperature conditions, A, B, C, D, E, F and G, where applicable

Note 1 to entry: Expressed in kW/kW.

3.18
coefficient of performance at part load
C_{Pb}
coefficient of performance at the declared capacity, (3.17), corrected with the degradation coefficient, where applicable

Note 1 to entry: When the declared capacity of the unit is higher than the heating load, the coefficient of performance includes degradation losses. When the declared capacity of the unit is lower than the heating load (i.e. below the *bivalent temperature* ~~(3.14)~~(3.14) condition), the coefficient of performance of the declared capacity is used.

Note 2 to entry: Expressed in kW/kW.

3.19
compressor-off state
condition where the compressor is not running while the unit is operating in *active mode* ~~(3.4)~~(3.4)

Note 1 to entry: This is the "off" phase in on/off cycling.

3.20
crankcase heater mode operating hours
H_{CK}
annual number of hours the unit is considered to be in crankcase heater mode, the value of which depends on the designated design condition and set of bin hours

Note 1 to entry: Three examples of crankcase heater mode hours are given in ~~Annex C~~ Annex C.

Note 2 to entry: Expressed in h.

3.21
crankcase heater mode power input
P_{CK}
power input of the unit due to crankcase heater operation mode

