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Water-source heat pumps — Testing and rating for performance —

Part 1: Water-to-air and brine-to-air heat pumps

Pompes à chaleur à eau — Essais et détermination des caractéristiques de performance —

Partie 1: Pompes à chaleur eau-air et eau glycolée-air

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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 13256-1:1998), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Significant updates to the formatting, symbols, and terms and definitions, have been included to more closely align with other pertinent ISO standards and the latest ISO requirements.

— The original water loop heat pump (WLHP), ground water heat pump (GWHP) and ground loop heat pump (GLHP) application rating designations, specifying entering liquid source rating test conditions, have been replaced with High, Medium, and Low source temperature range conditions to represent a wider operating map at both standard and partially loaded application rating conditions. It is now possible, when all three (High, Medium and Low) temperature ranges are specified by the manufacturer for energy modelling programs to interpolate performance at other entering water temperatures than those used in the standard.

— Specific antifreeze solution composition requirements have been removed to eliminate prescriptive language and promote industry innovation of novel and improved antifreeze solutions.

— Airflow testing requirements have been updated to align with the complexities of testing more sophisticated constant airflow electronically commutated fan motors.

— Testing tolerances and uncertainties have been harmonized with other pertinent ISO standards.

— Annexes have been added and/or significantly updated that harmonize with other pertinent ISO standards.

A list of all parts in the ISO 13256 series can be found on the ISO website.

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.

Introduction

This document covers heating and cooling systems which are generally referred to as “water-source heat pumps.” These systems generally include an indoor coil with air-moving means, a compressor, and a refrigerant-to-water or refrigerant-to-brine heat exchanger. A system may provide both heating and cooling, cooling-only, or heating-only functions.

Water-source heat pumps — Testing and rating for performance —

Part 1: Water-to-air and brine-to-air heat pumps

1 Scope

1.1 This document establishes performance testing and rating criteria for factory-made residential, commercial and industrial, electrically-driven, mechanical- compression type, water-to-air and brine-to-air heat pumps. The requirements for testing and rating contained in this document are based on the use of matched assemblies.

1.2 Equipment designed for rating at one liquid temperature range under this document may not be suitable at all liquid temperature ranges covered in this document.

1.3 This document does not apply to the testing and rating of individual assemblies for separate use, nor to the testing and rating of heat pumps covered in ISO 5151, ISO 13253 or ISO 13256-2.

2 Normative references

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 undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 817, *Refrigerants — Designation and safety classification*

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
water-to-air heat pump
brine-to-air heat pump
heat pump which consists of one or more factory-made assemblies which normally include an indoor conditioning coil with air-moving means, compressor(s), and refrigerant-to-water or refrigerant-to-brine heat exchanger(s), including means to provide both cooling and heating, cooling-only, or heating-only functions

Note 1 to entry: When such equipment is provided in more than one assembly, the separated assemblies should be designed to be used together.

Note 2 to entry: Such equipment may also provide functions of sanitary water heating, air cleaning, dehumidifying, and humidifying.

3.2
water-loop heat pump
water-to-air heat pump using liquid circulating in a common piping loop functioning as a heat source in `heating mode and/or heat sink in cooling mode

Note 1 to entry: The temperature of the liquid loop is usually within a range of 10 °C to 30 °C.

3.3
ground-water heat pump
water-to-air heat pump using water pumped from a well, lake, or stream functioning as a heat source in heating mode and/or heat sink in cooling mode

Note 1 to entry: The temperature of the water is related to the climatic conditions and is generally constant within the range from 5 °C to 25 °C for deep wells.

3.4
ground-loop heat pump
brine-to-air heat pump using a brine solution circulating through a subsurface piping loop functioning as a heat source in heating mode and/or heat sink in cooling mode

Note 1 to entry: The heat exchange loop may be placed in horizontal trenches or vertical bores, or be submerged in a body of surface water.

Note 2 to entry: The temperature of the brine is related to the heat exchange load and climatic conditions and is generally within a range from −5 °C to 40 °C.

3.5
total cooling capacity
amount of sensible and latent heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Expressed in units of watts.

3.6
net total cooling capacity
total cooling capacity with fan power adjustment

Note 1 to entry: Expressed in units of watts.

3.7
heating capacity
amount of heat that the equipment can add to the conditioned space in a defined interval of time

Note 1 to entry: Expressed in units of watts.

3.8
net heating capacity
heating capacity with fan power adjustment

Note 1 to entry: Expressed in units of watts.

3.9
rated voltage
voltage shown on the nameplate of the equipment

Note 1 to entry: Expressed in units of volts.

3.10
rated frequency
frequency shown on the nameplate of the equipment

Note 1 to entry: Expressed in units of Hz.

3.11
energy efficiency ratio
EER
ratio of the net total cooling capacity to the effective power input at any given set of rating conditions

Note 1 to entry: Expressed in units of watt per watt.

3.12
coefficient of performance
COP
ratio of the net heating capacity to the effective power input of the equipment at any given set of rating conditions

Note 1 to entry: Expressed in units of watt per watt.

3.13
standard air
dry air at 20,0 °C and at a standard barometric pressure of 101,325 kPa, having a mass density of 1,204 kg/m^3

3.14
effective power input
average electrical power input to the equipment within a defined interval of time; i.e. the sum of:

— the power input for operation of the compressor excluding additional electrical heating devices,

— the power input of all control and safety devices of the equipment, and

— the proportional power input of the conveying devices for the transport of the heat transfer media through the heat pump only (e.g. fans, pumps, whether internal or external, whether provided with the equipment or not)

Note 1 to entry: Expressed in units of watts.

3.15
latent cooling capacity
amount of latent heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Expressed in units of watts.

3.16
sensible cooling capacity
amount of sensible heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Expressed in units of watts.

3.17
brine
heat transfer liquid that has a freezing point lower than the freezing point of water

3.18
external static pressure difference
Δ_{pe}
pressure difference measured between the air (or water/brine) outlet section and the air (or water/brine) inlet section of the unit, which is available for overcoming the pressure drop of any additional ducted air (or water/brine) circuit

Note 1 to entry: Expressed in units of pascals.

3.19
internal static pressure difference
Δ_{pi}
pressure difference measured between the air (or water/brine) outlet section and the air (or water/brine) inlet section of the unit, which corresponds to the total pressure drop of all components on the air (or water/brine) side of the unit.

Note 1 to entry: Expressed in units of pascals.

3.20
fixed capacity heat pump
equipment which does not have possibility to change its capacity

Note 1 to entry: This definition applies to each cooling and heating operation individually.

3.21
two-stage capacity heat pump
equipment where the capacity is varied by two steps

Note 1 to entry: This definition applies to each cooling and heating operation individually.

3.22
multi-stage capacity heat pump
equipment where the capacity is varied by three or four steps

Note 1 to entry: This definition applies to each cooling and heating operation individually.

3.23
variable capacity heat pump
equipment where the capacity is varied by five or more steps to represent continuously variable capacity

Note 1 to entry: This definition applies to each cooling and heating operation individually.

3.24
standard rating conditions
operating conditions while establishing the standard rating net cooling and/or heating capacities

Note 1 to entry: These conditions correspond to an operation of the heat pump at full capacity, in relation to the source side.

3.25
application rating conditions
operating conditions while establishing additional cooling and/or heating capacities

Note 1 to entry: These conditions correspond to an operation of the heat pump at reduced capacity, in relation to the source side.

3.26
standard rating capacity
net cooling and/or heating capacity measured at standard rating conditions

4 Symbols

Symbol	Description and Units
A_n	nozzle area, m^2
α	pressure ratio
C_d	nozzle discharge coefficient
c_{pa1}	specific heat of dry air entering indoor side, J/kg·K

Symbol	Description and Units
c_{pa2}	specific heat of dry air leaving indoor side, J/kg·K
c_{pf}	specific heat of liquid, J/kg·K
D_n	nozzle throat diameter, mm
Δ_{pi}	measured internal static pressure difference, Pa
Δ_{pe}	measured external static pressure difference, Pa
h_{a1}	specific enthalpy of air entering indoor air-side, J/kg of dry air
h_{a2}	specific enthalpy of air leaving indoor air-side, J/kg of dry air
h_{r1}	specific enthalpy of refrigerant entering indoor side, J/kg
h_{r2}	specific enthalpy of refrigerant leaving indoor side, J/kg
K_1	latent heat of vaporization of water, J/kg (2,47 x 10^6, J/kg at 15 °C)
η	representative efficiency
P_i	power input to indoor-side compartment, W
p_n	pressure, at nozzle throat, kPa absolute
p_v	velocity pressure at nozzle throat or static pressure difference across nozzle, Pa
ϕ_c	total power input
ϕ_{fa}	fan power adjustment, W
ϕ_{lci}	latent cooling capacity, (indoor air-side data), W
ϕ_{nc}	net cooling capacity, W
ϕ_{nh}	net heating capacity, W
ϕ_{sci}	sensible cooling capacity, (air-side data), W
ϕ_{tci}	total cooling capacity, (airside data), W
ϕ_{tco}	total cooling capacity, (liquid side data), W
ϕ_{thi}	total heating capacity, (air-side data), W
ϕ_{tho}	total heating capacity, (liquid side data), W
q	measured volumetric flow rate, l/s
q_a	measured airflow rate at standard air conditions, m^3/s
q_m	air mass flow rate, kg/s
q_{ro}	refrigerant and oil mixture flow rate, m^3/s
q_s	air volume flow rate, standard air, m^3/s
q_V	air-volume flow rate, calculated, m^3/s
q_{Vi}	air volume flow rate, measured, m^3/s
q_{wc}	flow rate, liquid condensate (steam), kg/s
Re	Reynolds number
t_{a1}	temperature, air entering indoor side, dry bulb, °C
t_{a2}	temperature, air leaving indoor side, dry bulb, °C
t_{f3}	temperature, liquid entering equipment, °C
t_{f4}	temperature, liquid leaving equipment, °C
ν	kinematic viscosity of air
ν_n	specific volume of dry air at conditions existing at nozzle at standard barometric pressure, m^3/kg
v_n	specific volume of air at nozzle, m^3/kg of air-water vapour mixture
W_1	mass of cylinder and bleeder assembly, empty, g
W_3	mass of cylinder and bleeder assembly, with sample, g
W_5	mass of cylinder and bleeder assembly, with oil from sample, g
w_f	Liquid mass flow rate, kg/s
w_{i1}	specific humidity, air entering indoor side, kg/kg of dry air

Symbol	Description and Units
w_{i2}	specific humidity, air leaving indoor side, kg/kg of dry air
W_n	specific humidity at nozzle inlet, kg/kg of dry air
X_0	concentration of oil to refrigerant-oil mixture
X_r	mass ratio, refrigerant to refrigerant-oil mixture
Y	expansion factor

5 Rating and test conditions

5.1 Rating conditions for the determination of net capacities

5.1.1 Ratings

Ratings shall be established at the test conditions specified in 5.2, using the test procedures described in Clause 7. Ratings relating to cooling and heating capacities shall be net values (see 7.4.4 and 7.4.5), including the effects of circulating-fan heat (see 7.4.4 and 7.4.5), but excluding any supplementary heat. Energy efficiency ratios shall be based on the effective power input as defined in 3.11.

5.1.2 Power input of fans for heat pumps without duct connection

In the case of heat pumps which are not designed for duct connection and which are equipped with an integral fan, all power consumed by the fans shall be included in the effective power input to the heat pump.

5.1.3 Power input of fans for heat pumps with duct connection

5.1.3.1 If no fan is provided with the heat pump, a fan power adjustment is to be included in the effective power input to the heat pump, using Formula (1):

$$\phi_{fa} = \frac{q_a \times (\Delta_{pi})}{\eta} \qquad (1)$$

where

ϕ_{fa} is the fan power adjustment, in W;

η = 0,3 by convention;

Δ_{pi} is the absolute value of the measured internal static pressure difference, in Pa;

q_a is the airflow rate at standard air conditions, in m^3/s.

This value shall be added to the heating capacity and subtracted from the cooling capacity.

5.1.3.2 If a fan is an integral part of a heat pump, only the portion of the fan power required to overcome the internal resistance shall be included in the effective power input to the heat pump. The fraction which is to be excluded from the total power consumed by the fan shall be calculated using Formula (2):

$$\phi_{fa} = \frac{q_a \times \Delta_{pe}}{\eta} \qquad (2)$$

where

ϕ_{fa} is the fan power adjustment, in W;

η = 0,3 by convention;

Δ_{pe} is the measured external static pressure difference, in Pa;

q_a is the airflow rate at standard air conditions, in m^3/s.

This value shall be subtracted from the heating capacity and added to the cooling capacity.

5.1.4 Power input of liquid pumps

5.1.4.1 If no liquid pump is provided with the heat pump, a pump power adjustment is to be included in the effective power consumed by the heat pump, using Formula (3):

$$\phi_{pa} = \frac{q \times \left(\Delta_{pi}\right)}{\eta} \qquad (3)$$

where

ϕ_{pa} is the pump power adjustment, in W;

η = 0,3 by convention;

Δ_{pi} is the absolute value of the measured internal static pressure difference, in Pa;

q is the measured volumetric fluid flow rate, in m^3/s.

5.1.4.2 If a liquid pump is an integral part of the heat pump, only the portion of the pump power required to overcome the internal resistance shall be included in the effective power input to the heat pump. The fraction which is to be excluded from the total power consumed by the pump shall be calculated using Formula (4):

$$\phi_{pa} = \frac{q \times \Delta_{pe}}{\eta} \qquad (4)$$

where:

ϕ_{pa} is the pump power adjustment, in W;

η = 0,3 by convention;

Δ_{pe} is the measured external static pressure difference, in Pa;

q is the measured volumetric fluid flow rate, in m^3/s.

5.1.5 Airflow rates

5.1.5.1 All standard ratings shall be determined at airflow rates as described below. All airflow rates shall be expressed as cubic meters per second of standard air as defined in 3.10.

5.1.5.2 The manufacturer shall specify a single airflow rate for all tests required in this document unless automatic adjustment of airflow rate is provided by the equipment. A separate control signal output for each step of airflow rate shall be considered as an automatic adjustment.

5.1.5.3 For ducted heat pumps which have integral, non-constant airflow, single or multi-speed fans the airflow rate shall be set as specified by the manufacturer. The external static pressure shall not be less