SLOVENSKI STANDARD
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Toplotna črpalka s plinsko gnanim motorjem z notranjim zgorevanjem - 4. del: Preskusne metode

Gas-fired endothermic engine driven heat pumps - Part 4: Test methods

Gasbefeuerte endothermische Motor-Wärmepumpen - Teil 4: Prüfverfahren

Pompes à chaleur à moteur endothermique alimenté au gaz - Partie 4 : Méthodes d'essai

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 16905-4:2017) has been prepared by Technical Committee CEN/TC 299 "Gas-fired sorption appliances, indirect fired sorption appliances, gas-fired endothermic engine heat pumps and domestic gas-fired washing and drying appliances", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by September 2017, and conflicting national standards shall be withdrawn at the latest by September 2017.

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 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 Annex ZA and Annex ZB, which is an integral part of this document.

This standard comprises the following parts under the general title, *Gas-fired endothermic engine driven heat pumps:*

— *Part 1: Terms and definitions*;

— *Part 2: Safety* (WI 00299025; currently in preparation);

— *Part 3: Test conditions*;

— *Part 4: Test methods*;

— *Part 5: Calculation of seasonal performances in heating and cooling mode*.

EN 16905-1, prEN 16905-2, EN 16905-3, EN 16905-4 and EN 16905-5 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see prEN 16905-2:201X, Annex ZA for safety aspects and EN 16905-5:2017, Annex ZA for rational use of energy aspects).

These documents are linked to the Energy Related Products Directive (2009/125/EC) in terms of tests conditions, tests methods and seasonal performances calculation methods under Mandate M/535; (see EN 16905-3:2017, Annex ZA, EN 16905-4:2017, Annex ZA, EN 16905-5:2017, Annex ZA and prEN 16905-2:201X, Annex ZB).

These documents will be reviewed whenever new mandates could apply.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

1.1 Scope of EN 16905 series

This European Standard specifies the requirements, test methods and test conditions for the rating and performance calculation of air conditioners and heat pumps using either air, water or brine as heat transfer media, with gas-fired endothermic engine driven compressors when used for space heating, cooling and refrigeration, hereafter referred to as "GEHP appliance".

This European Standard only applies to appliances with a maximum heat input (based on net calorific value) not exceeding 70 kW at standard rating conditions.

This European Standard only applies to appliances under categories I_{2H}, I_{2E}, I_{2Er}, I_{2R}, $I_{2E(S)B}$, I_{2L}, I_{2LL}, I_{2ELL}, $I_{2E(R)B}$, I_{2ESi}, $I_{2E(R)}$, I_{3P}, I_{3B}, $I_{3B/P}$, II_{2H3}+, II_{2Er3}+, $II_{2H3B/P}$, $II_{2L3B/P}$, $II_{2E3B/P}$, $II_{2ELL3B/P}$, II_{2L3P}, II_{2H3P}, II_{2E3P} and II_{2Er3P} according to EN 437.

This European Standard only applies to appliances having:

a) gas fired endothermic engines under the control of fully automatic control systems;

b) closed system refrigerant circuits in which the refrigerant does not come into direct contact with the fluid to be cooled or heated;

c) where the temperature of the heat transfer fluid of the heating system (heating water circuit) does not exceed 105 °C during normal operation;

d) where the maximum operating pressure in the:

   1) heating water circuit (if installed) does not exceed 6 bar;

   2) domestic hot water circuit (if installed) does not exceed 10 bar.

This European Standard applies to appliances only when used for space heating or space cooling or for refrigeration, with or without heat recovery.

The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by this European Standard.

Packaged units, single split and multisplit systems are covered by this European Standard. Single duct and double duct units are covered by this European Standard.

The above appliances can have one or more primary or secondary functions.

This European Standard is applicable to appliances that are intended to be type tested. Requirements for appliances that are not type tested would need to be subject to further consideration.

In the case of packaged units (consisting of several parts), this European Standard applies only to those designed and supplied as a complete package.

NOTE All the symbols given in this text are used regardless of the language used.

1.2 Scope of EN 16905-4

This part of the EN 16905 series specifies the test methods for gas-fired endothermic engine driven heat pumps for heating and/or cooling mode including the engine heat recovery.

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.

EN 437, *Test gases — Test pressures — Appliance categories*

EN 12102, *Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power level*

EN 16905-1, *Gas-fired endothermic engine driven heat pumps — Part 1: Terms and definitions*

prEN 16905-2[1)], *Gas-fired endothermic engine driven heat pumps — Part 2: Safety*

EN 16905-3:2017, *Gas-fired endothermic engine driven heat pumps — Part 3: Test conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16905-1 apply.

4 Test methods

4.1 General

A steady-state or transient or cyclical operation test could be applied for 100 % load tests or for reduced load tests.

The sound power level is measured in the standard rating conditions as given in EN 16905-3 with the corresponding test methods according to EN 12102 considering that this standard, dedicated to determination of the sound power level could be used with appliances covered in the scope of the EN 16905 series.

4.2 Basic principles method of calculation for the determination of capacities

4.2.1 Capacity

4.2.1.1 Measured capacity

The measured heating or cooling capacity of air-to-air or water (brine)-to-air GEHP shall be determined by measurements in a calorimeter room (see Annex A) or by the air enthalpy method (see Annex B).

The measured heating or cooling capacity of air-to-water (brine) or water (brine)-to-water (brine) GEHP shall be determined in accordance with the water enthalpy method (see Annex D).

The measured heat recovery capacity of all GEHP shall be determined in accordance with the water enthalpy method (see Annex D).

1) Currently in preparation.

4.2.1.2 Effective capacity

4.2.1.2.1 Effective heating capacity

The effective heating capacity is the measured heating capacity corrected for the heat from the device (pump(s) or fan(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger:

a) if the fan(s) or pump(s) is (are) an integral part of the appliance, the capacity correction due to the device, C_{device_indoor}, calculated according to 4.2.4.3.3.1 or 4.2.4.4.2.1, which is excluded from the total electrical power input shall also be subtracted from the heating capacity (the correction is negative). The effective heating capacity shall be determined using the following formula:

$$Q_{Eh} = Q_h - Abs\left(C_{device\_indoor}\right) \quad (1)$$

b) if the fan(s) or pump(s) is (are) not an integral part of the appliance, the capacity correction due to the device, C_{device_indoor}, calculated according to 4.2.4.3.3.2 or 4.2.4.4.2.2, which is added to the total electrical power input shall be also added to the heating capacity (the correction is positive). The effective heating capacity shall be determined using the following formula:

$$Q_{Eh} = Q_h + Abs\left(C_{device\_indoor}\right) \quad (2)$$

where

Q_{Eh} is the effective heating capacity, in kilowatt;

Q_h is the measured heating capacity, in kilowatt;

C_{device_indoor} is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

4.2.1.2.2 Effective cooling capacity

The effective cooling capacity is the measured cooling capacity corrected for the heat from the device (pump(s) or fan(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger:

a) if the fan(s) or pump(s) is (are) an integral part of the appliance, the capacity correction due to the device, $C_{device\text{-}indoor}$, calculated according to 4.2.4.3.3.1 or 4.2.4.4.2.1, which is excluded from the total power input shall be added to the cooling capacity (the correction is positive). The effective heating capacity shall be determined using the following formula:

$$Q_{Ec} = Q_c + Abs\left(C_{device\_indoor}\right) \quad (3)$$

b) if the fan(s) or pump(s) is (are) not an integral part of the appliance, the capacity correction due to the device, $C_{device\text{-}indoor}$, calculated according to 4.2.4.3.3.2 or 4.2.4.4.2.2, which is added to the total electrical power input shall be subtracted from the cooling capacity (the correction is negative).The effective cooling capacity shall be determined using the following formula:

$$Q_{Ec} = Q_c - Abs\left(C_{device\_indoor}\right) \quad (4)$$

where:

Q_{EC} is the effective cooling capacity, in kilowatt;

Q_c	is the measured cooling capacity, in kilowatt;
C_{device_indoor}	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

4.2.1.3 Rating capacity

4.2.1.3.1 Rating heating capacity

The rating heating capacity shall be determined using the following formula:

$$Q_{Rh} = Q_h \times \frac{Q_{grh}}{Q_{gmh}} \pm Abs\left(C_{device\_indoor}\right) \quad (5)$$

where

Q_{Rh}	is the rating heating capacity, in kilowatt;
Q_h	is the measured heating capacity, in kilowatt;
Q_{grh}	is the rating gas heat input in heating mode, in kilowatt;
Q_{gmh}	is the measured gas heat input in heating mode, in kilowatt;
C_{device_indoor}	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the device responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.1.2.1.

4.2.1.3.2 Rating cooling capacity

The rating cooling capacity shall be determined using the following formula:

$$Q_{Rc} = Q_c \times \frac{Q_{grc}}{Q_{gmc}} \pm Abs\left(C_{device\_indoor}\right) \quad (6)$$

where

Q_{Rc}	is the rating cooling capacity, in kilowatt;
Q_c	is the measured cooling capacity, in kilowatt;
Q_{grc}	is the rating gas heat input in cooling mode, in kilowatt;
Q_{gmc}	is the measured gas heat input in cooling mode, in kilowatt;
C_{device_indoor}	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the device responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.1.2.2.

4.2.2 Engine heat recovery capacity

4.2.2.1 Effective engine heat recovery capacity

The effective engine heat recovery capacity is the measured engine heat recovery capacity corrected for the heat from the device (pump(s)) of the engine heat recovery circuit (measured in any condition):

a) if this (these) pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), c_{device_hr}, calculated according to 4.2.4.4.2.1 which is excluded from the total electrical power input shall be also subtracted from the engine heat recovery capacity (the correction is negative).

b) if this(these) pump(s) is (are) not an integral part of the appliance, capacity correction due to the pump(s), c_{device_hr}, calculated according to 4.2.4.4.2.2, which is added to the total electrical power input shall be also added to the engine heat recovery capacity (the correction is positive).

The effective engine heat recovery capacity shall be determined using the following formula, which is applicable to either heating or cooling mode:

$$Q_{Ehr} = Q_{hr} \pm Abs\left(C_{device\_hr}\right) \tag{7}$$

where

Q_{Ehr} is the effective engine heat recovery capacity, in kilowatt;

Q_{hr} is the measured engine heat recovery capacity, in kilowatt;

C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery exchanger, in kilowatt.

4.2.2.2 Rating engine heat recovery capacity in heating mode

The rating engine heat recovery capacity shall be determined using the following formula:

$$Q_{Rhrh} = Q_{hr} \times \frac{Q_{grhrh}}{Q_{gmhr}} \pm Abs\left(C_{device\_hr}\right) \tag{8}$$

where

Q_{Rhrh} is the rating engine heat recovery capacity in heating mode, in kilowatt;

Q_{hr} is the measured engine heat recovery capacity, in kilowatt;

Q_{grhrh} is the rating engine heat recovery gas heat input in heating mode, in kilowatt;

Q_{gmhr} is the measured engine heat recovery gas heat input, in kilowatt;

C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, see 4.2.2.1.

4.2.2.3 Rating engine heat recovery capacity in cooling mode

The rating engine heat recovery capacity shall be determined using the following formula:

$$Q_{Rhrc} = Q_{hr} \times \frac{Q_{grhrc}}{Q_{gmhr}} \pm Abs\left(C_{device\_hr}\right) \tag{9}$$

where

Q_{Rhrc} is the rating engine heat recovery capacity in cooling mode, in kilowatt;

Q_{hr} is the measured engine heat recovery capacity, in kilowatt;

Q_{grhrc} is the rating engine heat recovery gas heat input in cooling mode, in kilowatt;

Q_{gmhr} is the measured engine heat recovery gas heat input, in kilowatt;

C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE 1 For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, see 4.2.2.1.

NOTE 2 The rating heat recovery heat input in cooling mode is equal to the rating heat recovery heat input in heating mode.

4.2.3 Heat input

4.2.3.1 General conditions for operation of the gas-fired part of the appliance

Tests are carried out with the appropriate reference gas(es) for the category to which the appliance belongs (see EN 437), supplied at the corresponding normal pressure indicated in EN 437.

4.2.3.2 Measurement of heat inputs under test conditions

The appliance is installed as described in prEN 16905-2 and adjusted as described in 4.2.4.1 and then operated at the heat input imposed by control system of the appliance. The heat input measurement is carried out when thermal "equilibrium" conditions have been achieved under the particular test conditions.

NOTE 1 It is important to note that the rating heating, cooling or heat recovery heat input is determined in accordance with the method given in prEN 16905–2, but that the measured heat input achieved under particular test conditions is different and determined in a different way. This is described below.

Air pressure at inlet and outlet of the gas engine shall be balanced to avoid under/over pressure of the gas engine.

The heat input under the test conditions (Q_{gm}) in kilowatt is given by the formula:

$$Q_{gm} = 0,278 \cdot \frac{\sum_{j=1}^{n} \left(Mc_j * H_{iM(T)j} \right)}{n} \quad (10)$$

or

$$Q_{gm} = 0,278 \cdot \frac{\sum_{j=1}^{n} \left(Vc_j * H_{iV(T)j} \right)}{n} \quad (11)$$

where

- j is the scan number;
- n is the number of scan of the data collection period;
- Q_{gm} is the measured heat input, in kilowatt;
- $H_{iM(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoule per kilogram;
- Mc_j is the mass flow rate of dry test gas at the considered scan, in kilogram per hour;
- $H_{iV(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoule per cubic meter (dry gas, 15 °C, 1 013,25 mbar);
- Vc_j is the volumetric flow rate of dry test gas corrected to 1013,25 mbar and 15 °C at the considered scan, in cubic meter per hour and derived from the following formula:

$$Vc_j = V_{mj} \cdot \frac{p_{aj} + pj - p_{wj}}{1\,013,25} \cdot \frac{288,15}{273,15 + t_{gj}} \quad (12)$$

where

V_{mj} is the measured gas flow rate at the considered scan, in cubic meter per hour;

p_{aj} is the atmospheric pressure at the considered scan, in millibar;

pj is the gas supply pressure at the gas meter at the considered scan, in millibar;

p_{wj} is the partial (water) vapour pressure in the gas used at the considered scan, in millibar;

t_{gj} is the gas temperature at the gas meter at the considered scan, in degrees Celsius.

NOTE 2 It is important to note that gas supply pressure at the gas meter is different from gas supply pressure of the appliance.

NOTE 3 Alternative expression of heat inputs.

In recognition that in several European markets and in recent European Norms and Regulations, the use of the gross calorific value is becoming increasingly diffused, the alternative calculation and publication of heat input (Q_g) on the basis of the gross calorific value is allowed only when the reference GCV is explicitly stated beside the value.

EXAMPLE Q_g: 23 kW_{GCV}.

Elsewhere, the heat input (Q_g) is always to be understood as based on net calorific value (NCV) as per 4.2.3.2.

4.2.4 Electrical power input

4.2.4.1 General condition for operation of the electrical part of the appliance

Tests are carried out with the nominal voltage.

The “global” electrical power input correction depends on the design of each appliance. Its “global” correction is the sum of appropriate “individual” corrections (see Annex G).

4.2.4.2 Effective electrical power input

The effective electrical power input shall be determined using the following formula:

$$P_E = \frac{\sum_{j=1}^{n}\left(P_{Tj}\right)}{n} \pm Abs\left(C_{device\_indoor}\right) \pm Abs\left(C_{device\_outdoor}\right) \pm Abs\left(C_{device\_hr}\right) \quad (13)$$

where

j is the scan number;

n is the number of scan of the data collection period;

P_E is the effective electrical power input, in kilowatt;

P_{Tj} is measured (total) electrical power input at the considered scan, in kilowatt;

C_{device_indoor} is the electrical power input correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device\_outdoor}$ is the electrical power input correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE The effective electrical power input is not corrected to heat recovery pump contribution as long as the heat recovery is not taken into account in calculation procedure of the Energy Related Products Directive (2009/125/EC).

4.2.4.3 Electrical power input correction of fan(s)

4.2.4.3.1 General

The following corrections of the electrical power input of fan(s) shall be made for fan(s) responsible for circulating the heat transfer medium through the indoor or outdoor heat exchanger, where applicable.

4.2.4.3.2 Electrical power input correction of fan(s) for appliances without duct connection

4.2.4.3.2.1 Electrical power input correction for appliances with at least one internal fan

In the case of appliances which are not designed for duct connection, i.e. which do not permit any external pressure differences, and which are equipped with integral fan(s), the electrical power absorbed by the fan(s) shall be included in the effective electrical power absorbed by the appliance (no correction).

4.2.4.3.2.2 Electrical power input correction for appliances without internal fan

If no fan is provided with the appliance, the part of the electrical power input which is to be included in the effective electrical power absorbed by the appliance shall be calculated using the following formula (the correction is positive):

$$C_{device\_indoor} \; or \; C_{device\_outdoor} = \frac{q \times (-\Delta pi)}{\eta * 1\,000} \qquad (14)$$

where

C_{device_indoor} is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device\_outdoor}$ is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

η is the efficiency of the fan(s);

Δpi is the measured internal static pressure difference, expressed in Pascal;

q is the measured air flow rate at standard air conditions, in cubic meters per second.

NOTE The efficiency of the fan(s) given in a report edited by an accredited laboratory is used. Otherwise, the efficiency of the fan(s) is equal to 0,3 by convention.