BS EN 12309-4:2014

BSI Standards Publication

Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW

Part 4: Test methods

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National foreword

This British Standard is the UK implementation of EN 12309-4:2014. Together with BS EN 12309-1:2014, BS EN 12309-3:2014, BS EN 12309-5:2014, BS EN 12309-6:2014 and BS EN 12309-7:2014, it supersedes BS EN 12309-2:2000, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/37, Gas fired sorption and laundering appliances.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods

Appareils à sorption fonctionnant au gaz pour le chauffage et/ou le refroidissement de débit calorifique sur PCI inférieur ou égal à 70 kW - Partie 4 : Méthodes d'essai

Gasbefeuerte Sorptions-Geräte für Heizung und/oder Kühlung mit einer Nennwärmebelastung nicht über 70 kW - Teil 4: Prüfverfahren

This European Standard was approved by CEN on 18 October 2014.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Contents

Page

Foreword

This document (EN 12309-4:2014) 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of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

This document supersedes EN 12309-2:2000.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] 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 are integral parts of this document.

This European Standard comprises the following parts under the general title, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW*:

— *Part 1: Terms and definitions*;

— *Part 2: Safety*;

— *Part 3: Test conditions*;

— *Part 4: Test methods*;

— *Part 5: Requirements*;

— *Part 6: Calculation of seasonal performances*;

— *Part 7: Specific provisions for hybrid appliances*;

— *Part 8: Environmental aspects*.

EN 12309-1 and EN 12309-2 supersede EN 12309-1:1999, whereas EN 12309-1, EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6, and EN 12309-7 supersede EN 12309-2:2000.

EN 12309-1, EN 12309-2, EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6, and EN 12309-7 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see Annex ZA of prEN 12309-2:2013 for safety aspects and Annex ZA of EN 12309-5:2014 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/495 (see EN 12309-3:2014, Annex ZA; EN 12309-4:2014, Annex ZA; EN 12309-6:2014, Annex ZA and EN 12309-7:2014, Annex ZA and prEN 12309-2:2013, Annex ZB and EN 12309-5:2014, Annex ZB).

These documents will be reviewed whenever new mandates could apply.

EN 12309-8 (“Environmental aspects”) deals with the incorporation of the Resolution BT 27/2008 regarding CEN approach on addressing environmental issues in product and service standards.

According to the CEN-CENELEC Internal Regulations, the national standards organizations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

1.1 Scope of EN 12309

Appliances covered by this European Standard include one or a combination of the following:

— gas-fired sorption chiller;

— gas-fired sorption chiller/heater;

— gas-fired sorption heat pump.

This European Standard applies to appliances designed to be used for space heating or cooling or refrigeration with or without heat recovery.

This European Standard applies to appliances having flue gas systems of type B and type C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having:

— integral burners under the control of fully automatic burner control systems,

— closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated,

— mechanical means to assist transportation of the combustion air and/or the flue gas.

The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in EN 12309-1:2014).

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

The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by EN 12309.

Installations used for heating and/or cooling of industrial processes are not within the scope of EN 12309.

All the symbols given in this text should be used regardless of the language used.

1.2 Scope of this Part 4 of EN 12309

This part of EN 12309 specifies the test methods for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW.

This part of EN 12309 deals particularly with test protocols and tools to calculate the capacity, the gas utilization efficiency and the electrical power input of the appliance. This data can be used in particular to calculate the seasonal efficiency of the appliance.

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 12309-1:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 1: Terms and definitions*

prEN 12309-2:2013, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW —Part 2: Safety*

EN 12309-3:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 3: Test conditions*

EN 12309-7:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 7: Specific provisions for hybrid appliances*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12309-1:2014 apply.

4 Test methods

4.1 General

A steady-state, transient or cyclical operation test could be applied for full capacity tests or for reduced capacity tests.

The sound power level is measured in the standard rating conditions as given in EN 12309-3:2014 for monovalent and EN 12309-7:2014 for hybrids and bivalent with the corresponding test methods according to EN 12102. It is considered that this European Standard, dedicated to determination of the sound power level could be used with appliances covered in the scope of EN 12309.

4.2 Basic principles

4.2.1 Heating capacity

4.2.1.1 General

The heating capacity of air-to-water(brine), water(brine)-to-water(brine) chiller/heater or heat pumps shall be determined in accordance with the direct method at the water or brine (indoor) heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change, of the heat transfer medium (see 4.2.1.2, 4.2.1.3, 4.2.1.4).

4.2.1.2 Measured heating capacity

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

$$Q_{\mathrm{h}} = \frac{\sum_{j=1}^{n} (Vm_{\mathrm{j}} \times \delta_{\mathrm{j}} \times Cp_{\mathrm{j}} \times \Delta t_{\mathrm{j}})}{n} \tag{1}$$

where

j is the scan number;

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

Q_{h} is the measured heating capacity, in kilowatts;

Vm_{j} is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;

δ_{j} is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;

Cp_{j} is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;

Δt_{j} is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term $(Vm_{\mathrm{j}} * \delta_{\mathrm{j}})$.

NOTE 2 The enthalpy change ΔH_{j} can be determined directly instead of the term $(Cp_{\mathrm{j}} * \Delta t_{\mathrm{j}})$.

4.2.1.3 Effective heating capacity

The effective heating capacity is the measured heating capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.2, which is excluded from the total electrical power input shall also be subtracted from the heating capacity (the correction is negative);

b) if the pump(s) is (are) not an integral part of the appliance, the capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.3, 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:

$$Q_{\mathrm{Eh}} = Q_{\mathrm{h}} + c_{\mathrm{pump}} \tag{2}$$

where

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

Q_{h} is the measured heating capacity, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

4.2.1.4 Rated and nominal heating capacities

The rated heating capacity (at full load) shall be determined using the following formula:

$$Q_{\text{Rh}} = Q_{\text{h}} \times \frac{Q_{\text{grh}}}{Q_{\text{gmh}}} + c_{\text{pump}} \tag{3}$$

where

Q_{Rh} is the rated heating capacity, in kilowatts;

Q_{h} is the measured heating capacity, in kilowatts;

Q_{grh} is the rated heating heat input, in kilowatts;

Q_{gmh} is the measured heating heat input, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

NOTE 1 The rated heating heat input and the rated cooling heat input could be equal.

The nominal heating capacity (at full load) is an unique rated heating capacity (at full load) and shall be determined using the following formula:

$$Q_{\text{Nh}} = Q_{\text{h}} \times \frac{Q_{\text{gNh}}}{Q_{\text{gmh}}} + c_{\text{pump}} \tag{4}$$

where

Q_{Nh} is the nominal heating capacity, in kilowatts;

Q_{h} is the measured heating capacity, in kilowatts;

Q_{gNh} is the nominal heating heat input, in kilowatts;

Q_{gmh} is the measured heating heat input, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

NOTE 2 For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.1.3.

4.2.2 Cooling capacity

4.2.2.1 General

The cooling capacity of air-to-water(brine), water(brine)-to-water(brine) reversible heat pumps, chillers and chillers/heaters shall be determined in accordance with the direct method at the water or brine indoor heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change of the heat transfer medium (see 4.2.2.2, 4.2.2.3, 4.2.2.4).

4.2.2.2 Measured cooling capacity

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

$$Q_c = \frac{\sum_{j=1}^{n} (Vm_j \times \delta_j \times Cp_j \times \Delta t_j)}{n} \quad (5)$$

where

j *is the scan number;*

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

Q_c is the measured cooling capacity, in kilowatts;

Vm_j is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;

δ_j is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;

Cp_j is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;

Δt_j is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term $(Vm_j * \delta j)$.

NOTE 2 The enthalpy change ΔH_j can be determined directly instead of the term $(Cp_j * \Delta t_j)$.

4.2.2.3 Effective cooling capacity

The effective cooling capacity is the measured cooling capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.2, which is excluded from the total power input shall be added to the cooling capacity (the correction is positive).

b) if the pump(s) is (are) not an integral part of the appliance, the capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.3, 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:

$$Q_{Ec} = Q_c + c_{pump} \quad (6)$$

where

Q_{Ec} is the effective cooling capacity, in kilowatts;

Q_c is the measured cooling capacity, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

4.2.2.4 Rated and nominal cooling capacities

The rated cooling capacity (at full load) shall be determined using the following formula:

$$Q_{\mathrm{Rc}} = Q_{\mathrm{c}} \times \frac{Q_{\mathrm{grc}}}{Q_{\mathrm{gmc}}} + c_{\mathrm{pump}} \tag{7}$$

where

Q_{Rc} is the rated cooling capacity, in kilowatts;

Q_{c} is the measured cooling capacity, in kilowatts;

Q_{grc} is the rated cooling heat input, in kilowatts;

Q_{gmc} is the measured heat input, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

NOTE 1 The rated cooling heat input and the rated heating heat input could be equal.

NOTE 2 The nominal cooling heat input and the nominal cooling heat input could be equal.

The nominal cooling capacity (at full load) is an unique rated cooling capacity (at full load) and shall be determined using the following formula:

$$Q_{\mathrm{Nc}} = Q_{\mathrm{c}} \times \frac{Q_{\mathrm{gNc}}}{Q_{\mathrm{gmc}}} + c_{\mathrm{pump}} \tag{8}$$

where

Q_{Nc} is the nominal cooling capacity, in kilowatts;

Q_{c} is the measured cooling capacity, in kilowatts;

Q_{gNc} is the nominal cooling heat input, in kilowatts;

Q_{gmc} is the measured cooling heat input, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

NOTE 3 For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.2.3.

4.2.3 Heat recovery capacity

4.2.3.1 General

The heat recovery capacity of air-to-water(brine) and water(brine)-to-water(brine) chillers or chillers/heaters shall be determined in accordance with the direct method at the water or brine heat recovery heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change of the heat transfer medium (see 4.2.3.2, 4.2.3.3, 4.2.3.4).

4.2.3.2 Measured heat recovery capacity

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

$$Q_{\mathrm{hr}} = \frac{\sum_{j=1}^{n} (Vm_{\mathrm{j}} \times \delta_{\mathrm{j}} \times Cp_{\mathrm{j}} \times \Delta t_{\mathrm{j}})}{n} \qquad (9)$$

where

j is the scan number;

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

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

Vm_{j} is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;

δ_{j} is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;

Cp_{j} is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;

Δt_{j} is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term ($Vm_{\mathrm{j}} \cdot \delta_{\mathrm{j}}$).

NOTE 2 The enthalpy change ΔHj can be determined directly instead of the term ($Cp_{\mathrm{j}} \cdot \Delta t_{\mathrm{j}}$).

4.2.3.3 Effective heat recovery capacity

The effective heat recovery capacity is the measured heat recovery capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.2 which is excluded from the total electrical power input shall be also subtracted from the heat recovery capacity (the correction is negative).

b) if the pump(s) is (are) not an integral part of the appliance, capacity correction due to the pump(s), c_{pump}, calculated according to 4.2.5.4.3, which is added to the total electrical power input shall be also added to the heat recovery capacity (the correction is positive).

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

$$Q_{\mathrm{Ehr}} = Q_{\mathrm{hr}} + c_{\mathrm{pump}} \qquad (10)$$

where

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

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

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

4.2.3.4 Rated and nominal heat recovery capacities

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

$$Q_{\text{Rhr}} = Q_{\text{hr}} \times \frac{Q_{\text{grhr}}}{Q_{\text{gmhr}}} + c_{\text{pump}} \tag{11}$$

where

Q_{Rhr} is the rated heat recovery capacity, in kilowatts;

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

Q_{grhr} is the rated heat recovery heat input, in kilowatts;

Q_{gmhr} is the measured heat input, in kilowatts;

c_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

NOTE 1 Normally, the rated heat recovery heat input is the rated cooling heat input.

The nominal heat recovery capacity is an unique rated cooling capacity (at full load) and shall be determined using the following formula:

$$Q_{\text{Nhr}} = Q_{\text{hr}} \times \frac{Q_{\text{gNhr}}}{Q_{\text{gmhr}}} + c_{\text{pump}} \tag{12}$$

where

Q_{Nhr} is the nominal heat recovery capacity, in kilowatts;

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

Q_{gNhr} is the nominal heat recovery heat input, in kilowatts;

Q_{gmhr} is the measured heat recovery heat input, in kilowatts;

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

NOTE 2 Normally, the nominal heat recovery heat input is the nominal cooling heat input.

NOTE 3 For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.3.3.

4.2.4 Heat input

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

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

Prior to carrying out any tests, the heat input of the burner(s) at full capacity is adjusted, if this is necessary, in order that it is within ± 5 % of the nominal heat input. This nominal heat input is determined when the appliance is operating at the appropriate standard rating conditions given in EN 12309-3:2014.

4.2.4.2 Measurement of heat inputs under test conditions

The appliance is installed as describe in prEN 12309-2:2013, 7.1.6, and adjusted as described in 4.2.4.1 and then operated at the heat input imposed by the 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 nominal or rated heating, cooling or heat recovery heat input is determined in accordance with the method given in prEN 12309-2:2013, but that the measured heat input achieved under particular test conditions is different and determined in a different way. This is described below.

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

$$Q_{gm} = 0,278 \times \frac{\sum_{j=1}^{n} (Mc_j \times H_{iM(T)j})}{n} \quad (13)$$

or

$$Q_{gm} = 0,278 \times \frac{\sum_{j=1}^{n} (Vc_j \times H_{iV(T)j})}{n} \quad (14)$$

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 kilowatts;
- $H_{iM(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoules per kilogram;
- Mc_j is the mass flow rate of dry test gas at the considered scan, in kilograms per hour;
- $H_{iV(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoules per cubic meter (dry gas, 15 °C, 1013,25 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 meters per hour and derived from the following formula:

$$Vc_j = V_{mj} \times \frac{p_{aj} + p_j - p_{wj}}{1013,25} \times \frac{288,15}{273,15 + t_{gj}} \quad (15)$$

where

- V_{mj} is the measured gas flow rate at the considered scan, in cubic meters per hour;
- p_{aj} is the atmospheric pressure at the considered scan, in millibars;
- p_j is the gas static pressure at the gas meter at the considered scan, in millibars;
- p_{wj} is the saturated (water) vapour pressure in the gas used at the considered scan, in millibars;
- 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 static pressure at the gas meter could be different from gas static pressure of the appliance.

NOTE 3 p_{wj} covers the use of wet gas meters (equal zero if dry gas meter is used).

NOTE 4 Alternative expression of heat inputs: the use of the gross calorific value is becoming increasingly common. 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 4.2.4.2.

4.2.5 Electrical power input

4.2.5.1 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 B).

4.2.5.2 Effective electrical power input

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

$$P_E = \frac{\sum_{j=1}^{n}(P_{Tj})}{n} + c_{pump} + c_{outdoor} \tag{16}$$

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 kilowatts;
- P_{Tj} is measured (total) electrical power input at the considered scan, in kilowatts;
- C_{pump} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and/or heat recovery heat exchanger, in kilowatts;
- $C_{outdoor}$ is the electrical power input correction due to the fan(s) or pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts.

4.2.5.3 Electrical power input of fans

4.2.5.3.1 General

The following corrections of the electrical power input of fan(s) shall be made for fan(s) providing the air to the outdoor heat exchanger, where applicable.

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

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).

4.2.5.3.3 Electrical power input of fan(s) for appliances with duct connection

4.2.5.3.3.1 If the fan(s) is (are) an integral part of the appliance, only a part of the electrical power input of the fan motor(s) shall be included in the effective electrical power absorbed by the appliance. The part that is to be excluded (subtracted) from the total electrical power absorbed by the appliance shall be calculated using the following formula (the correction is negative):

$$c_{\text{outdoor}} = \frac{q \times \Delta p_{\text{e}}}{\eta \times 1000} \tag{17}$$

where

c_{outdoor}	is the electrical correction due to fan(s), in kilowatts;
η	is equal to η target; as declared according to the Ecodesign regulation n°327/2011 for fans driven by motors between 125 W and 500 kW;
η	is 0,3 by convention for fans driven by motors below 125 W;
Δp_{e}	is the measured external static pressure difference, in pascals;
q	is the measured air flow rate at standard air conditions, in cubic meters per second.

4.2.5.3.3.2 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):

$$c_{\text{outdoor}} = \frac{q \times (-\Delta p_{\text{i}})}{\eta \times 1000} \tag{18}$$

where

c_{outdoor}	is the electrical correction due to fan(s), in kilowatts;
η	is equal to η target; as declared according to the Ecodesign regulation n° 327/2011 for fans driven by motors between 125 W and 500 kW;
η	is 0,3 by convention for fans driven by motors below 125 W;
Δp_{i}	is the measured internal static pressure difference, in pascals;
q	is the measured air flow rate at standard air conditions, in cubic meters per second.

4.2.5.4 Electrical power input of pumps

4.2.5.4.1 General

The following correction of the electrical power input of pump(s) shall be made to both the pump responsible for circulating the heat transfer medium through the indoor heat exchanger (c_{pump}) and circulating the heat transfer medium through the outdoor heat exchanger (c_{outdoor}) where applicable. When the pump is integrated, it shall be connected for operation; when the pump is delivered separately, it shall be connected for operation according to the appliance's instructions and be considered as an integral part of the appliance.

4.2.5.4.2 Electrical power input for appliances with at least one internal pump

If the pump(s) is (are) an integral part of the appliance, only a part of the electrical power input to the pump motor(s) shall be included in the effective electrical power absorbed by the appliance. The part which is to be excluded (subtracted) from the total electrical power absorbed by the appliance shall be calculated using the following formula (the correction is negative):

$$c_{pump} \text{ or } c_{outdoor} = \frac{q \times \Delta p_e}{\eta \times 1000} \tag{19}$$

where

c_{pump} is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts;

$c_{outdoor}$ is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts;

η is the efficiency of the pump calculated according to Annex A in kilowatts per kilowatt;

Δp_e is the measured external static pressure difference, in pascals;

q is the measured water flow rate, in cubic meters per second.

If the pump presents negative external static pressure due to a mismatch with the appliance, correction shall be calculated according to 4.2.5.4.3.

4.2.5.4.3 Electrical power input for appliances without internal pump

If no pump 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):

$$c_{pump} \text{ or } c_{outdoor} = \frac{q \times (-\Delta p_i)}{\eta \times 1000} \tag{20}$$

where

c_{pump} is the electrical correction due to no pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts;

$c_{outdoor}$ is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts;

η is the efficiency of the pump calculated according to Annex A in kilowatts per kilowatt;

Δp_i is the measured internal static pressure difference, in pascals;

Q is the measured water flow rate, in cubic meters per second.

4.2.5.4.4 Specific cases

In the case of appliances designed especially to operate on a distributing network of heating/cooling water without water-pump, no correction is to be applied to the electrical power input.

4.2.6 Gas utilization efficiency

4.2.6.1 Heating mode

The gas utilization efficiency in heating mode shall be determined using the following formula:

$$GUEh = \frac{Q_{\text{Eh}}}{Q_{\text{gmh}}} \tag{21}$$

where

GUEh is the heating gas utilization efficiency, in kilowatts per kilowatt;

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

Q_{gmh} is the measured heating heat input, in kilowatts.

4.2.6.2 Cooling mode

The gas utilization efficiency in cooling mode shall be determined using the following formula:

$$GUEc = \frac{Q_{\text{Ec}}}{Q_{\text{gmc}}} \tag{22}$$

where

GUEc is the cooling gas utilization efficiency, in kilowatts per kilowatt;

Q_{Ec} is the effective cooling capacity, in kilowatts;

Q_{gmc} is the measured cooling heat input, in kilowatts.

4.2.7 Auxiliary energy factor

4.2.7.1 Heating mode

The auxiliary energy factor in the heating mode is determined using the following formula:

$$AEFh = \frac{Q_{\text{Eh}}}{P_{\text{Eh}}} \tag{23}$$

where

AEFh is the heating auxiliary energy factor, in kilowatts per kilowatt;

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

P_{Eh} is the effective heating electrical power input, in kilowatts.

4.2.7.2 Cooling mode

The auxiliary energy factor in heating mode is determined using the following formula:

$$AEFc = \frac{Q_{\mathrm{Ec}}}{P_{\mathrm{Ec}}} \tag{24}$$

where

$AEF\mathrm{c}$ is the cooling auxiliary energy factor, in kilowatts per kilowatt;

Q_{Ec} is the effective cooling capacity, in kilowatts;

P_{Ec} is the effective cooling electrical power input, in kilowatts.

4.3 Test apparatus

4.3.1 Arrangement of the test apparatus

4.3.1.1 General requirements

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

In cooling mode, permissible deviations are given for one test method, named fixed delta T method, where the inlet and the outlet temperatures shall match the target values.

In heating mode, permissible deviations are given for three different types of test methods (Table 2, Table 3, Table 4 and Table 5):

— the outlet temperature method, which is the reference method for monovalent appliances, where the outlet temperature shall match the target value which is specified in EN 12309-3:2014;

— the inlet temperature method, which is the reference method for hybrid appliances and monovalent appliances which operate in ON/OFF cycling, where the inlet temperature shall match the target value;

— the mean temperature method where the mean of outlet and inlet temperatures shall match the target value.

4.3.1.2 Test room for the air side

The size of the test room shall be selected such that any resistance to air flow at the air inlet and air outlet orifices of the appliance is avoided. The air flow through the room shall not be capable of initiating any short circuit between these two orifices, and therefore the velocity of the air flow through the room at these two locations shall not exceed 1,5 m/s when the appliance is switched off. Unless otherwise stated in the appliance’s instructions, the air inlet or air outlet orifices shall be at least 1 m from the surfaces of the test room.

Any direct heat radiation by heating device (appliance, equipment...) in the test room onto the appliance or onto the temperature measuring points shall be avoided.

4.3.1.3 Appliances with duct connection

The connections of a ducted air appliance to the test facility shall be sufficiently air tight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

4.3.1.4 Appliances with integral pumps

For appliances with integral and adjustable water or brine pump(s), the pump(s) shall be set to obtain an external static pressure as close as possible to 0 Pa.

4.3.2 Installation and connection of the appliance

4.3.2.1 General

The appliance shall be installed and connected for the test as recommended by the appliance’s installation manual. It shall be connected to a compensation system that allows setting of the required full or reduced capacity. Examples of such compensation systems in heating and cooling mode are given in Annex E.

For single duct appliances, in case the appliance's instructions do not specify how to install the discharge duct, the discharge duct shall be as short and straight as possible compatibly with minimum distance between the appliance and the wall for correct air inlet but not less than 0,5 m. Accessories shall not be connected to the discharge end of the duct.

For double duct appliances, the same requirements apply to both suction and discharge ducts, unless the appliance is designed to be installed directly on the wall.

4.3.2.2 Measuring points

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 and not less than four measuring points and by restricting to 20 the number of sensor equally distributed on the 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 water and brine, the density in formula of 4.2.1.2, 4.2.2.2 and 4.2.3.2 shall be determine in the temperature conditions measured near the flow measuring device.

4.4 Uncertainties of measurement

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

Table 1 — Uncertainties of measurement for indicated individual values

Measured quantity	Unit	Uncertainty of measurement
Water or brine		
- temperature inlet/outlet	°C	± 0,15 K
- temperature difference	K	± 0,21 K
- flow rate (volume or mass	m^3/s or kg/s	± 1 %
- static pressure difference	Pa	±5 Pa ($P \leq$ 100 Pa) or ± 5 % (P > 100 Pa)
Air		
- dry bulb temperature	°C	± 0,2 K
- wet bulb temperature	°C	± 0,4 K
- flow rate (volume)	m^3/s	± 5 %
- static pressure difference	Pa	± 5 Pa ($P \leq$ 100 Pa) or ± 5 % (P > 100 Pa)
Concentration		
- heat transfer medium	%	± 2 %
Heat input		
- atmospheric pressure	mbar	±5 mbar
- gas pressure	mbar	± 2 % full scale without exceeding 0,5 mbar
- gas flow rate	m^3/h or kg/h	± 1 %
- gas temperature	°C	± 0,5 K
- calorific value	MJ/m^3	± 1 %
Electrical inpu		
- electrical power	kW	± 2 %
Time	s	± 0,2 s up to 1 h ± 0,1 % beyond 1 h

The specification range of the measuring apparatus is chosen to be suitable between minimum part load and full load according to the uncertainties in Table 1.

The measurement uncertainties indicated concern individual measurements. For measurements requiring a combination of individual measurements (e.g. efficiency measurements), the lower uncertainties associated with individual measurements may be necessary to limit the overall uncertainty.

The heating, cooling or recovery capacities measured shall be determined within a maximum overall uncertainty of ($20,5 \times \Delta T^{-0,89}$)%, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

The gas input shall be determined within a maximum overall uncertainty of 2 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of the gas.

If the water (brine) flow stops during, for example, a transient test or during a cyclical operation test, no maximum overall uncertainty is required for the capacity.

The same principle applies for electrical power input and for gas input when relevant.

4.5 Test procedure

4.5.1 General

4.5.1.1 Introduction

The test procedures describe below are valid for full capacity and reduced capacity tests.

For the measurement of inputs and heating/cooling/heat recovery capacity, it is necessary to record all the data mentioned in 4.7 continuously. Except the following; gas density, Wobbe index and calorific value when the gas comes from a tank and this tank has not been changed during the tests. For heat recovery and inputs measurements, the sampling (intervals and frequencies) shall be the same as for corresponding heating or cooling capacity.

For any type of operation, the sequence shall be adjusted such that a complete recording is effected at least once every 10 s.

For water (brine) to water (brine) appliances, informative Annex F can be used to detect a possible measurement error due to an incorrect operation of a measuring device.

The laboratory can use the test protocol with any test bench on condition that it respects the required permissible deviations given in this standard and it lets the controls of the appliance operate.

In case of hybrid appliances, no ON/OFF cycles shall be generated by the laboratory itself.

In case of monovalent appliances which operate in ON/OFF cycles measurements can be alternatively done in compliance with normative Annex G.

4.5.1.2 All appliances

The test conditions are given in EN 12309-3:2014 for monovalent appliances and in EN 12309-7:2014 for hybrid appliances. However, test conditions coming from other standards, regulations or certification procedures can be used.

If liquid heat transfer medium other than water is used, the specific heat capacity and density of such heat transfer media shall be determined and taken into consideration in the evaluation (results and uncertainty).

For full capacity tests, when performing measurements in heating mode, set the highest room temperature on the appliance /system control device. When performing measurements in cooling mode, set the lowest room temperature on the appliance/system control device.

4.5.1.3 Non ducted appliances

For non-ducted appliances, the adjustable settings such as louvers and fan speed shall be set for maximum steady-state operation air flow.

After that setting, the air flow rate is set under control of the appliance.

When the appliance is modulating, no disturbance of air flow should be perceived by the appliance as a consequence of the operation of test room apparatus.

4.5.1.4 Ducted appliances

The air flow rate and the pressure difference shall be related to standard air dry heat exchanger.

If the air flow rate is stated with no atmospheric pressure, temperature and humidity conditions, it shall be considered as stated for standard rating conditions. The air flow rate stated shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

The nominal air flow rate stated shall be set and the resulting external static pressure (ESP) measured.

If the ESP is lower than 30 Pa, the air flow rate is adjusted 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 instructions data state that the maximum allowable length of the discharge duct is less than 1 m, then the appliance can be tested as a non-ducted appliance with an ESP of 0 Pa.

After that setting, the air flow rate is set under control of the appliance.

4.5.1.5 Air to water (brine) and water (brine) to water (brine) appliances

The nominal water (brine) flow rate stated shall be set at corresponding standard rating conditions and the resulting pressure drops measured. After that setting, the water flow rate is set under control of the appliance.

In the case of brine, if it is not mentioned in the technical instructions for installation and adjustment, the nature and the concentration of the product to use for the tests shall be stated. The minimum brine concentration shall be chosen to provide proper operation at minimum outlet temperature stated.

4.5.2 Non-cyclical operation

4.5.2.1 Output measurement for water (brine) to water (brine) appliances

4.5.2.1.1 Steady-state operation conditions

Data collection shall take place when steady-state operating conditions are fulfilled. These conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of 30 min, with respect to the tolerances given in Table 2, Table 3 or Table 4. Periodic fluctuations of measured quantities caused by the operation of control devices are permissible on condition the mean value of such fluctuations does not exceed the permissible deviations listed in Table 2, Table 3 or Table 4. The data collection period follows this period of 30 min. All these requirements also apply for a test at reduced capacity when the burner operates at least at its minimal heat input.

Table 2 — Permissible deviations on the set values during steady-state operation tests for fixed delta *T* method (reference method in cooling mode)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,3 K ± 0,3 K ± 0,4 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,6 K ± 0,8 K ± 1,0 K
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,3 K ± 0,3 K ± 0,4 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,6 K ± 0,8 K ± 1,0 K
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Electrical input				
- voltage	± 4 %		± 4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 3 — Permissible deviations on the set values during steady-state operation tests for outlet temperature method (reference method in heating mode) and mean temperature method

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % >load ≥ 40 % load < 40 %	± 0,3 K ± 0,3 K ± 0,4 K	/	/
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Indoor water or brine				
- inlet temperature leading to the target outlet or to the mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature or mean temperature	maximum > load ≥ 70 % 70 % >load ≥ 40 % load < 40 %	± 0,3 K ± 0,3 K ± 0,4 K	/	/
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Electrical input				
- voltage	± 4 %		± 4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 4 — Permissible deviations on the set values during steady-state operation tests for inlet temperature method

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,3 K ± 0,3 K ± 0,4 K	/	/
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
- outlet temperature	/	/	/	/
- flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Electrical input				
- voltage	± 4 %		± 4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

4.5.2.1.2 Measurement of heating capacity, cooling capacity, heat recovery capacity, gas input and electrical power input

The heating capacity, cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is 40 min. All data shall be collected during the same period at the same frequency.

4.5.2.1.3 Measurement of *GUE*

The duration of the data collection is divided in to four 10 min parts. A *GUE* is calculated for each part. The fluctuations of the *GUE* of the four different parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual *GUE* from mean value does not exceed 3,0 %.

4.5.2.2 Measurement in cooling mode for air-to-water (brine) appliances

4.5.2.2.1 Steady-state operation conditions

Data collection shall take place when steady-state operating conditions are fulfilled. These conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of 30 min, with respect to the tolerances given in Table 2 and Table 5. Periodic fluctuations of measured quantities caused by the operation of control devices are permissible, on condition the value of such fluctuations does not exceed the permissible deviations listed in Table 2 and Table 5. The data collection period follows this period of 30 min. All the requirements also apply for a test at reduced capacity when the burner operates at least at the minimal heat input.

Table 5 — Permissible deviations on the set values for steady-state operation tests (Supplement table for air to water appliance)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air - inlet temperature (dry bulb/wet bulb) [a] - flow rate (volume) - static pressure drop	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 % rated capacities others capacities rated capacities others capacities	± 0,3 K ± 0,5 K ± 0,6 K / / / /	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 % rated capacities others capacities rated capacities others capacities	± 1,0 K ± 1,2 K ± 1,4 K ± 10 % / ± 10 % /
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.				

4.5.2.2.2 Measurement of cooling capacity, heat recovery capacity, gas input and electrical power input

The cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is 40 min. All data shall be collected during the same period at the same frequency.

4.5.2.2.3 Measurement of *GUE*

The duration of the data collection is divided in to four 10 min parts. A *GUE* is calculated for each part. The fluctuations of the *GUE* of the four different parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual *GUE* from mean value does not exceed 3,0 %.

4.5.2.3 Measurement in heating mode for air-to-water appliances

4.5.2.3.1 General

The test procedure consists of three periods: a preconditioning period, an equilibrium period, and a data collection period. The duration of the data collection period differs depending upon whether the heat pump's operation is in steady-state operation or transient operation.

Annex D gives a flow chart of the procedure and pictorially represents most of the different test sequences that are possible when conducting a heating capacity test.

All the requirements also apply at reduced capacity when the burner operates at least at the minimal heat input.

4.5.2.3.2 Preconditioning period

The test room preconditioning apparatus and the appliance under test shall be operated until the appropriate test tolerances specified in Table 2, Table 3, Table 4 and Table 5 are attained for at least 10 min.

A defrost cycle may end a preconditioning period. If a defrost cycle does end a preconditioning period, the appliance shall operate in the heating mode for at least 10 min after defrost termination prior to beginning the equilibrium period. It is recommended that the preconditioning period ends with manually-induced defrost cycle for all the conditions for which an automatic defrost cycle is expected.

4.5.2.3.3 Equilibrium period

The equilibrium period immediately follows either the preconditioning period or a “recovery” period of 10 min after the defrost cycle that ends the preconditioning period.

A complete equilibrium period is 30 min in duration.

The appliance shall operate while meeting the appropriate test tolerances specified in Table 2, Table 3, Table 4 and Table 5, except as specified in 4.5.2.3.7 (Test procedure for transient operation).

4.5.2.3.4 Data collection period

The data collection period immediately follows the equilibrium period.

The difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger shall be measured. For each interval of 5 min during the data collection period, an average temperature difference shall be calculated, ΔTi (τ). The average temperature difference for the first 5 min of the data collection period, ΔTi (τ = 0), shall be saved for the purpose of calculating the following parameter:

$$\%\Delta T = \frac{\left(\Delta Ti(\tau = 0) - \Delta Ti(\tau)\right)}{\Delta Ti(\tau = 0)} \times 100 \qquad (25)$$

where

$\%\Delta T$	is the coefficient of change, in %;
$\Delta Ti(\tau = 0)$	is the average difference between the outlet and inlet temperatures for the first 5 min period; in Kelvin;
$\Delta Ti(\tau)$	is the average difference between the outlet and inlet temperatures for other 5 min period than the first 5 min, in Kelvin.

If the coefficient of change ($\%\Delta T$) remains within 2,5 % during the first 40 min of the data collection period, and the appropriate test tolerances specified in Table 2, Table 3 or Table 4 and Table 5 are satisfied during both the equilibrium period and the first 40 min of the data collection period, then the test shall be designated a steady-state operation test. Steady-state operation tests shall be terminated after 40 min of data collection.

4.5.2.3.5 Test procedure when a defrost cycle ends the preconditioning period

When a defrost cycle ends the preconditioning period, if the appliance initiates a defrost cycle during the equilibrium period or during the first 40 min of the data collection period, the test shall be designated a transient operation test (see 4.5.2.3.7).

4.5.2.3.6 Test procedure when a defrost cycle does not end the preconditioning period

4.5.2.3.6.1 General

When a defrost does not end the preconditioning period, either 4.5.2.3.6.2 or 4.5.2.3.6.3 or 4.5.2.3.6.4 applies.

4.5.2.3.6.2 If the appliance initiates a defrost cycle during the equilibrium period or during the first 70 min of the data collection period, the test shall be restarted as specified 4.5.2.3.6.4.

4.5.2.3.6.3 If the coefficient of change (%ΔT) exceeds 2,5 % any time during the first 70 min of the data collection period, then the test procedure shall be restarted as specified in 4.5.2.3.6.4. Prior to the restart, defrost cycle shall occur. This defrost cycle may be manually initiated or delayed until the appliance initiates an automatic defrost.

4.5.2.3.6.4 If either 4.5.2.3.6.2 or 4.5.2.3.6.3 apply, then the restart shall begin 10 min after the defrost cycle terminates with a new equilibrium period of 1 h. This second attempt shall follow the requirements of 4.5.2.3.3 and 4.5.2.3.4 and the test procedure of 4.5.2.3.5.

4.5.2.3.7 Test procedure for transient operation tests

When, in accordance with 4.5.2.3.5, the test is designated a transient operation test, the following adjustments shall apply.

To constitute a valid transient operation test, the test tolerances specified in Table 6 shall be achieved during both the equilibrium period and the data collection period. As noted in Table 6, the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each heating interval, with the exception of the first 10 min after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min of the subsequent heating interval.

The test tolerance parameters in Table 6 shall be determined throughout the equilibrium and data collection periods. All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 6 test tolerances. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 6 compliance. Compliance is based on evaluating data from each interval separately.

The data collection period shall be extended until 3 h have elapsed or until the appliance completes three complete cycles during the period, whichever occurs first. If at an elapsed time of 3 h, the appliance is conducting a defrost cycle, the cycle shall be completed before terminating the collection of data. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination.

Table 6 — Permissible deviations on the set values in heating mode when using the transient test procedure

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
	Interval H [a]	Interval D [b]	Interval H [a]	Interval D [b]
Temperature of air entering outdoor-side:				
- dry-bulb[c]	± 0,6 K	± 1,5 K	± 1,0 K	±5,0 K
- wet-bulb	± 0,3 K	± 1,0 K	± 0,6 K	/
Inlet water temperature for inlet temperature method or inlet temperature leading to target outlet temperature for outlet temperature method (reference method) or inlet temperature leading to target mean temperature for mean temperature method	±0,2 K	/	±0,5 K	/
Outlet or mean temperature	±0,5 K	/	/	
Water flow rate	±2 %	/	5 %	/
Electrical input - voltage	±4 %		±4 %	

NOTE Permissible deviation includes the regulating capability of the test apparatus during transient occurrences.

[a] Applies when the appliance is in the heating mode, except for the first 10 min after termination of a defrost cycle.

[b] Applies during the defrost cycle and during the first 10 min after the termination of a defrost cycle when the appliance is operating in the heating mode.

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

4.5.2.3.8 Measurement of heating capacity, gas and electrical power inputs

During defrost cycles plus the first 10 min following defrost termination, data used in evaluating the heating capacity, the gas input and the electrical power input of the appliance could be sampled more frequently than during the rest of the data collection period. All data shall be collected during the same period at the same frequency(ies).

4.5.2.3.9 Measurement of GUE

A GUE is calculated using heating capacity and gas heat input during the same data collection period.

4.5.2.3.10 Reduced capacity tests

For tests at reduced capacity, a deviation of ± 2,0 % of the full load capacity compared to the target value of the capacity is admitted to validate the test. For deviations up to 4,0 % of the full load capacity, a second measurement shall be carried out to get a measurement above the target value and a measurement below the target value. In this case, the result is determined by linear interpolation. Any test with heating capacity which deviate more than ± 4,0 % of the full load capacity is rejected.

4.5.3 Cyclical operation

4.5.3.1 Basic principles

Capacities, gas and electrical power inputs are obtained from a number of complete stabilized “calculation cycles” of the energy “released” and of the energy consumption, respectively.

A “calculation cycle” may consist of more than one “burner cycle”.

A “burner cycle” consists of a period from an ignition of the burner to the following ignition of the burner.

The data collection period shall be extended until the appliance completes four complete “calculation cycles”.

The effective capacities shall be obtained from the measured capacities and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger. The effective electrical power input shall be obtained from the measured electrical power input and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and the pump(s) or the fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, if relevant.

Periodic fluctuations of measured quantities caused by the operation of regulation and control devices of the appliance are permissible on condition the value of such fluctuations do not exceed the permissible deviations listed in Table 7, Table 8 or Table 9.

Table 7 — Permissible deviations on the set values for cyclical operation tests for fixed delta T method (reference method in cooling mode)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb)[a]	± 1,5 K (/)		± 2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Outdoor water or brine				
Inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
Flow rate	rated capacities others capacities	± 4 % /	rated capacities others capacities	/ /
Indoor water or brine				
Inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
Flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Electrical input				
- voltage	± 4 %		± 4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb is doubled.				

Table 8 — Permissible deviations on the set values for cyclical operation tests for outlet temperature method (heating reference method) and mean temperature method

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb)[a]	± 1,5 K (/)		± 2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Outdoor water or brine				
Inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
Flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Indoor water or brine				
Inlet temperature leading to the target outlet or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
Outlet temperature or mean temperature	entire load range	± 0,5 K	entire load range	/
Flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Electrical input				
- voltage	± 4 %		± 4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb is doubled.				

Table 9 — Permissible deviations on the set values for cyclical operation tests for inlet temperature method

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb)[a]	± 1,5 K (/)		± 2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Outdoor water or brine				
Inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,5 K ± 0,7 K ± 0,9 K
Flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	± 5 % /
Indoor water or brine				
Inlet temperature leading to the target outlet or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	± 0,2 K ± 0,2 K ± 0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % load < 40 %	±0,5 K ±0,7 K ±0,9 K
Flow rate	rated capacities others capacities	± 2 % /	rated capacities others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb is doubled.				

Fluctuations of the four different calculation cycles GUE (calculation results) is permissible on condition the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value do not exceed 5,0 %.

4.5.3.2 Reduced capacity tests

Valid reduced capacity tests may deviate by ± 2,0 % of the full load capacity compared to the target value. For deviations up to 4,0 % of the full load capacity, a second measurement shall be carried out to get a measurement closer to the target value. If the result is a measure above the target value and a measure below, the result is determined by linear interpolation. Any test with heating capacity which deviates more than ± 4,0 % of the full load capacity is rejected.

4.6 Test methods for electric power consumption during thermostat off mode, standby mode and off mode

4.6.1 Measurement of electrical power consumption during thermostat off mode

In cooling mode (for cooling only or reversible appliances), the thermostat set point is increased until the burner stops. The electrical power consumption is measured over a time period of not less than 1 h to determine the thermostat off power. For heating mode, the same principle applies but the thermostat set point should be decreased until the burner stops.

4.6.2 Measurement of the electrical power consumption during standby mode

The appliance is stopped with the control device. After 10 min, the electrical power consumption is measured over a time period of not less than 1 h and assumed to be the standby mode electrical power consumption.

4.6.3 Measurement of the electric power consumption during off mode

Following the standby mode electrical power consumption test, the appliance should be switched to off mode while remaining plugged in and supplied with power. After 10 min, the electrical power consumption is measured for a time period of not less than 1 h and assumed to be the off mode electrical power consumption. In case no off mode switch is available on the appliance, the standby mode electrical power is assumed to be equal to the off mode electrical power.

4.7 Test results

The data to be recorded for capacities, inputs and rational use of energy measurements is given in Table 10. The table identifies the general information required but is not intended to limit the data to be obtained.

NOTE In this clause, the result of a calculation based on various data is considered as data.

The data will be the integrated values taken over the data collection period except time measurement during transient and cyclical operation tests, gas density, Wobbe index and gas calorific value when gas used is from a tank and this tank is not been changed all over the tests).

Table 10 — Data to be recorded

Measurement quantity	Unit
Ambient conditions	
- air temperature, dry bulb	°C
- atmospheric pressure	mbar
Gas quantities	
- gas flow rate	m^3/h or kg/h
- gas pressure (absolute or relative)	mbar
- gas temperature	°C
- gas calorific value (net and gross)	MJ/m^3 or MJ/kg
- gas density (absolute or relative)	kg/m^3 or kg.m^3/kg.m^3
or	
Wobb index (net or gross)	MJ/m^3 or MJ/kg
Electrical quantities	
- voltage	V
- total current	A
- total power input, P_T	W
- effective power input, P_E	W
- power consumption during thermostat off mode	W
- power consumption during standby mode	W
- power consumption during off mode	W
Thermodynamic quantities	
Outdoor heat exchanger	
Air	
- inlet temperature, dry bulb	°C
- inlet temperature, wet bulb	°C
- outlet temperature, dry bulb	°C
- outlet temperature, wet bulb	°C
- external/internal static pressure difference	Pa
- volume flow rate	m^3/s
Water or brine	
- inlet temperature	°C
- outlet temperature	°C
- flow rate	m^3/s or kg/s
- pressure drop	kPa
- pump speed setting, if applicable	-
indoor heat exchanger (water or brine)	
- inlet temperature	°C

Measurement quantity	Unit
- outlet temperature - flow rate - pressure drop - pump speed setting, if applicable	°C m^3/s or kg/s kPa -
Heat recovery heat exchanger - inlet temperature - outlet temperature - volume flow rate - pressure drop - pump speed setting, if applicable	 °C °C m^3/s kPa -
Heat transfer medium (other than water) - density - specific heat	 kg/m^3 J/kg.K
Defrost - defrost period - operating cycle with defrost	 s s
Data collection period	S
Capacities - effective heating capacity (Q_{Eh}) - effective cooling capacity (Q_{Ec}) - effective heat recovery capacity (QE_{hr})	 W W W
Ratios - GUEh and $GUEh_{GCV}$ - GUEc and $GUEc_{GCV}$ - AEFh - AEFc	 W/W W/W W/W W/W

Annex A
(normative)

Determination of the pump efficiency

A.1 General

The method for calculating the efficiency of the pump, whether the pump is an integral part of the appliance or not, is based on the relationship between the efficiency of the pump and its hydraulic power.

If the pump is an integral part of the appliance but that a static pressure difference is measured, the total power input of the pump is the sum of its electric power and the complementary required power calculated from Formula (A.2).

A.2 Hydraulic power of the pump

A.2.1 The pump is an integral part of the appliance

When the pump is an integral part of the appliance, the hydraulic power which shall be taken into account is defined as:

$$P_{\text{hydrau}} = q \times \Delta p_{\text{e}} \tag{A.1}$$

where

P_{hydrau} is the total hydraulic power of the pump, in watts;

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

Δp_{e} is the measured available external static pressure difference, in pascals.

A.2.2 The pump is not an integral part of the appliance

When the pump is not an integral part of the appliance, the hydraulic power which shall be taken into account is defined as:

$$P_{\text{hydrau}} = q \times (-\Delta p_{\text{i}}) \tag{A.2}$$

where

P_{hydrau} is the total hydraulic power of the pump, in watts;

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

Δp_{i} is the measured internal static pressure difference, in pascals.

A.3 Efficiency of the pump

The declared efficiency of the pump in a report from an accredited laboratory may be used. Otherwise, the efficiency of the pump required to deliver the hydraulic power is determined by using the following formula:

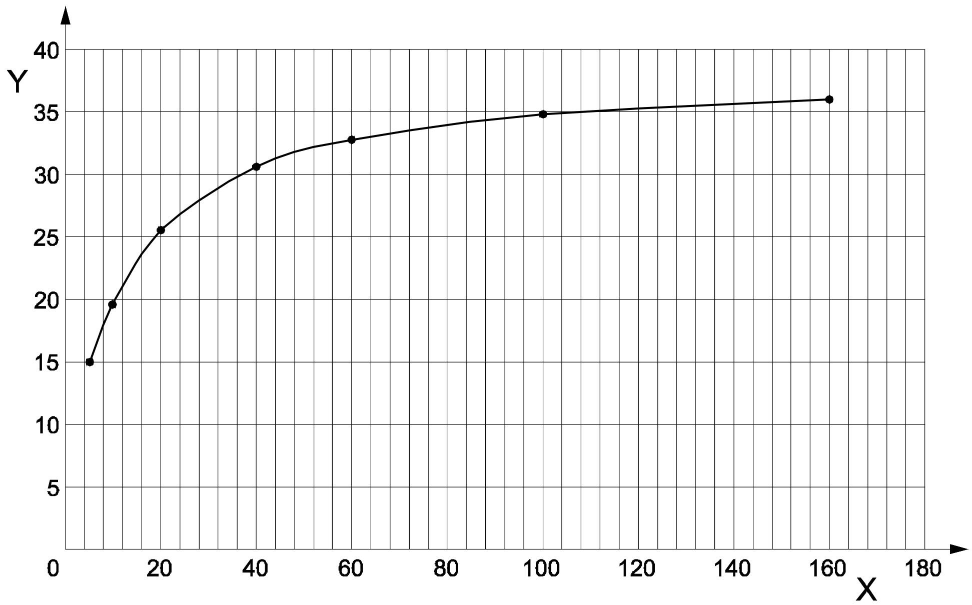
$$\eta = 0,3826 \times \frac{P_{\text{hydrau}}}{P_{\text{hydrau}} + 10 \times (1 - e^{-0,3 \times P_{\text{hydrau}}})} \quad \text{(A.3)}$$

where

η is the efficiency of the pump, watts per watt;

P_{hydrau} is the total hydraulic power of the pump, in watts.

For information, the graph of the efficiency of the pump versus its hydraulic power are given below.



Key

X P_{hydrau} [W]

Y efficiency of calculating pumps

Figure A.1 — Efficiency of the pump versus its hydraulic power graph

Annex B
(normative)

"Individual" corrections to include in the "global" electrical power input correction depending on the appliance

Appliance	Electrical auxiliary responsible for circulating the heat transfer medium through the outdoor heat exchanger	$c_{outdoor}$	Electrical auxiliary responsible for circulating the heat transfer medium through the indoor heat exchanger	C_{pump}
Air/water without duct connection	The fan is an integral part of the appliance	No correction	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
			The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$
Air/water with duct connection	The fan is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The fan is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The fan is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$
	The fan is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$
Water/water or Brine/water	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$
	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$	The pump is an external part of the appliance	$\frac{q \times (-\Delta p_i)}{\eta \times 1000}$

Annex C
(informative)

Primary energy efficiency - Calculation at a single operating point

C.1 General

Increasingly, the assessment of the energy effectiveness of a heating or cooling appliance is judged on its seasonal or annual effectiveness relative to the primary energy. However, it may be interesting to know this value for a given operating point. This informative annex addresses this potential need.

C.2 Primary energy ratio in heating mode

The primary energy ratio in heating mode shall be determined using the following formula:

$$PERh = \frac{1}{Prim_{\text{gas}} \times \left(\frac{1}{GUEh} \right) + Prim_{\text{elec}} \times \left(\frac{P_{\text{Eh}}}{Q_{\text{Eh}}} \right)} \qquad \text{(C.1)}$$

where

$PERh$	is the heating primary energy ratio based on gross calorific value, in kilowatts per kilowatt;
$GUEh$	is the heating gas utilization efficiency based on gross calorific value, in kilowatts per kilowatt;
$Prim_{\text{gas}}$	is the primary energy factor for gas;
$Prim_{\text{elec}}$	is the primary energy factor for electricity;
P_{Eh}	is the effective heating electrical power input, in kilowatts;
Q_{Eh}	is the effective heating capacity, in kilowatts.

NOTE Primary energy factors for gas and electricity are defined in EN 12309–1:2014. However, other values are allowed only when those values are explicitly stated in the document giving the *PER*h value.

C.3 Primary energy ratio in cooling mode

The primary energy ratio in cooling mode without heat recovery shall be determined using the following formula:

$$PERc = \frac{1}{\mathrm{Pr}\,im_{\text{gas}} \times \left(\frac{1}{GUEc}\right) + \mathrm{Pr}\,im_{\text{elec}} \times \left(\frac{P_{\text{Ec}}}{Q_{\text{Ec}}}\right)} \quad \text{(C.2)}$$

where:

$PERc$	is the cooling primary energy ratio based on gross calorific value, in kilowatts per kilowatt;
$GUEc$	is the cooling gas utilization efficiency based on gross calorific value, in kilowatts per kilowatt;
$Prim_{\text{gas}}$	is the primary energy factor for gas;
$Prim_{\text{elec}}$	is the primary energy factor for electricity;
P_{Ec}	is the effective cooling electrical power input, in kilowatts;
Q_{Ec}	is the effective cooling capacity, in kilowatts.

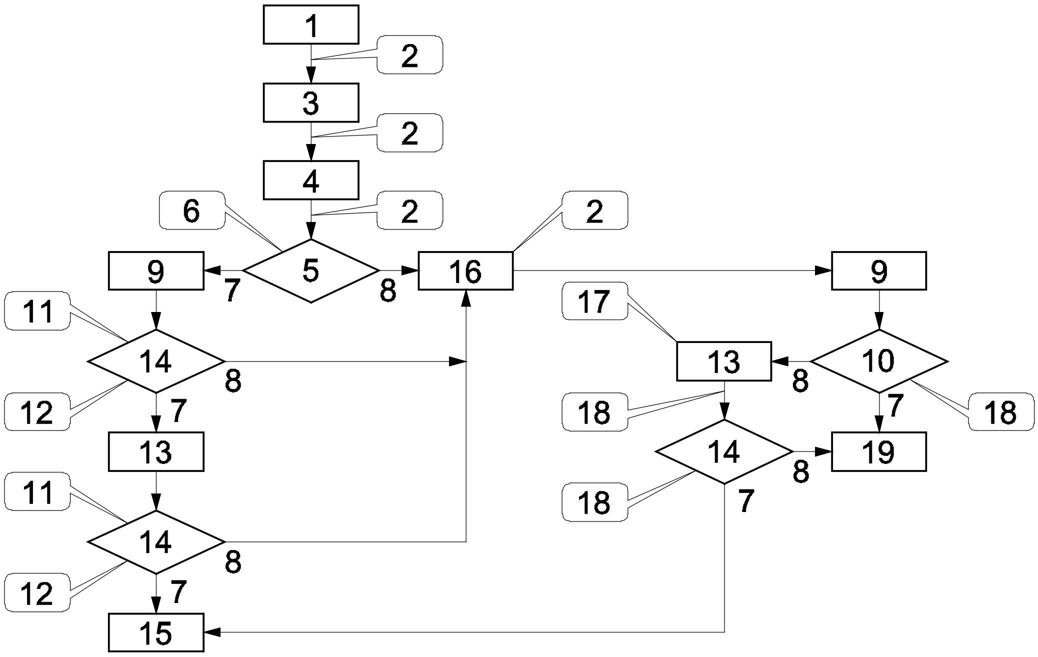
NOTE Primary energy factors for gas and electricity are defined in EN 12309–1:2014. However, other values are allowed only when those values are explicitly stated in the document giving the *PER*c value.

Annex D
(informative)

Heating capacity tests - Flow chart and examples of different test sequences

D.1 Flow chart

Figure D.1 illustrates with a flow chart the test procedure described in 4.5.2.3.1.



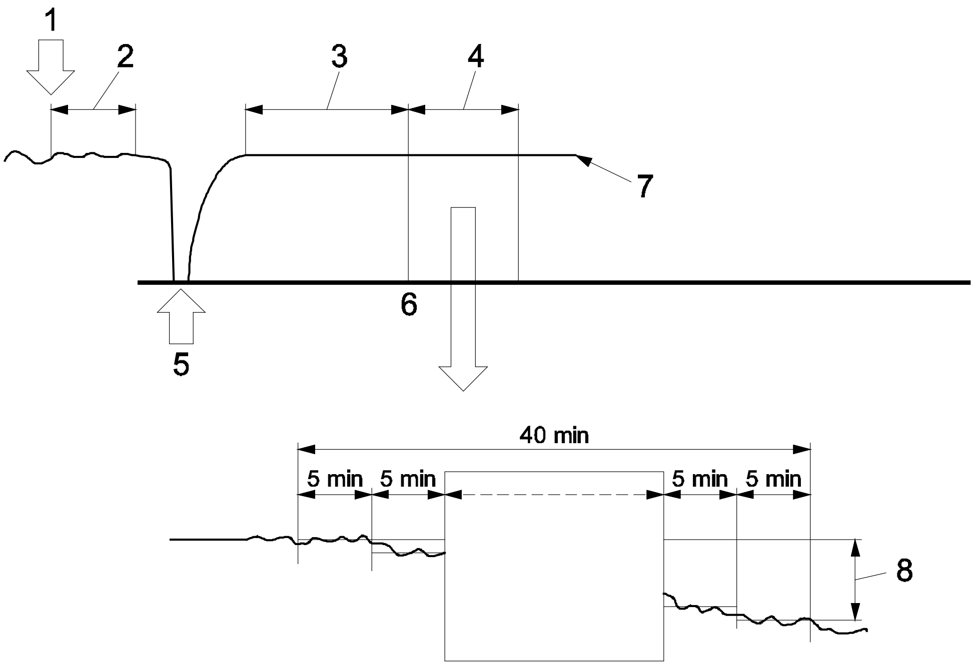
Key

1	start of the test apparatus and start of the appliance	11	test procedure when a defrost cycle does not end the preconditioning period (4.5.2.3.6.1)
2	pre conditioning period (4.5.2.3.2)	12	test procedure when a defrost cycle does not end the preconditioning period (4.5.2.3.6.2)
3	operation until test tolerances of Table 2 or Table 3 or Table 4 and Table 5 are fulfilled	13	data collection period (40 min) according to 4.5.2.3.4
4	start of the pre-conditioning period	14	during the data collection period: $\%\Delta T < 2,5\ \%$ and no defrost operation
5	No defrost cycle at the end of pre-conditioning period	15	Steady-state test procedure according to 4.5.2.3.4
6	test procedure when a defrost cycle ends the preconditioning period (4.5.2.3.5)	16	At least 10 min operation after defrost cycle
7	yes	17	test procedure when a defrost cycle does not end the preconditioning period (4.5.2.3.6.3)
8	no	18	test procedure when a defrost cycle ends the preconditioning period (4.5.2.3.5)
9	start of the equilibrium period according to 4.5.2.3.3	19	transient test procedure according to 4.5.2.3.7
10	during the equilibrium period: or $\%\Delta T > 2,5\ \%$ or defrost operation		

Figure D.1 — Flow chart

D.2 Examples of test profiles

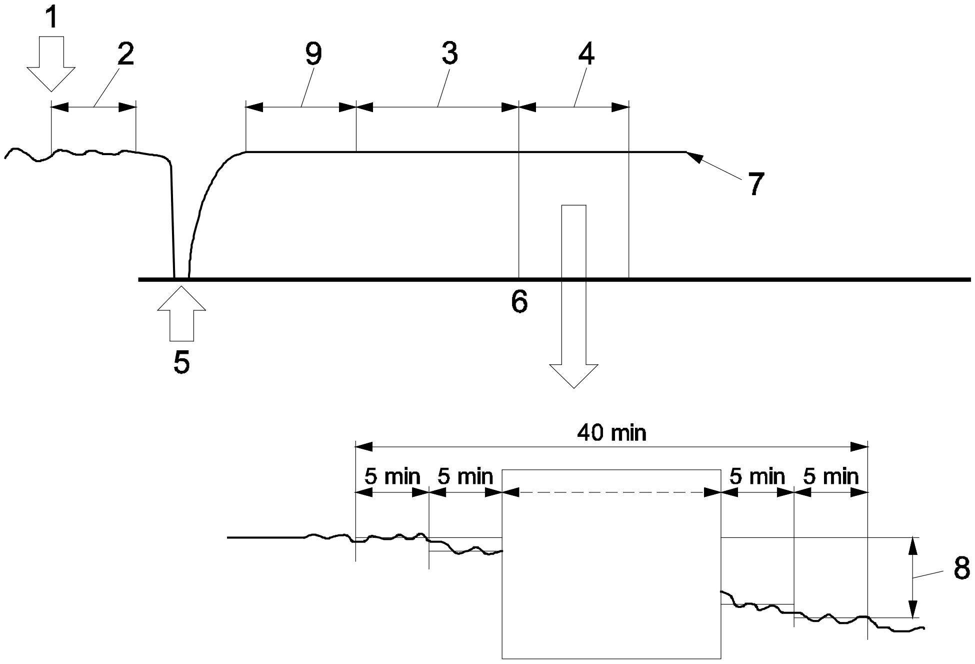
The Figure D.2, Figure D.3, Figure D.4, Figure D.5, Figure D.6 and Figure D.7 given below show several of the cases that could occur while conducting a heating capacity test as specified in 4.5.2.3. All examples show cases where a defrost cycle ends the preconditioning period.



Key

1	compliance with test tolerances first achieved	5	defrost at end of preconditioning period
2	preconditioning period (10 min minimum)	6	point 4 expanded for detail
3	equilibrium period 30 min	7	ΔT_{water} *(indoor side)*
4	data for capacity calculation data collection period 40 min	8	ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

Figure D.2 — Steady-state heating capacity test with defrost at end of preconditioning period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 data for capacity calculation
data collection period 40 min

5 defrost during preconditioning period

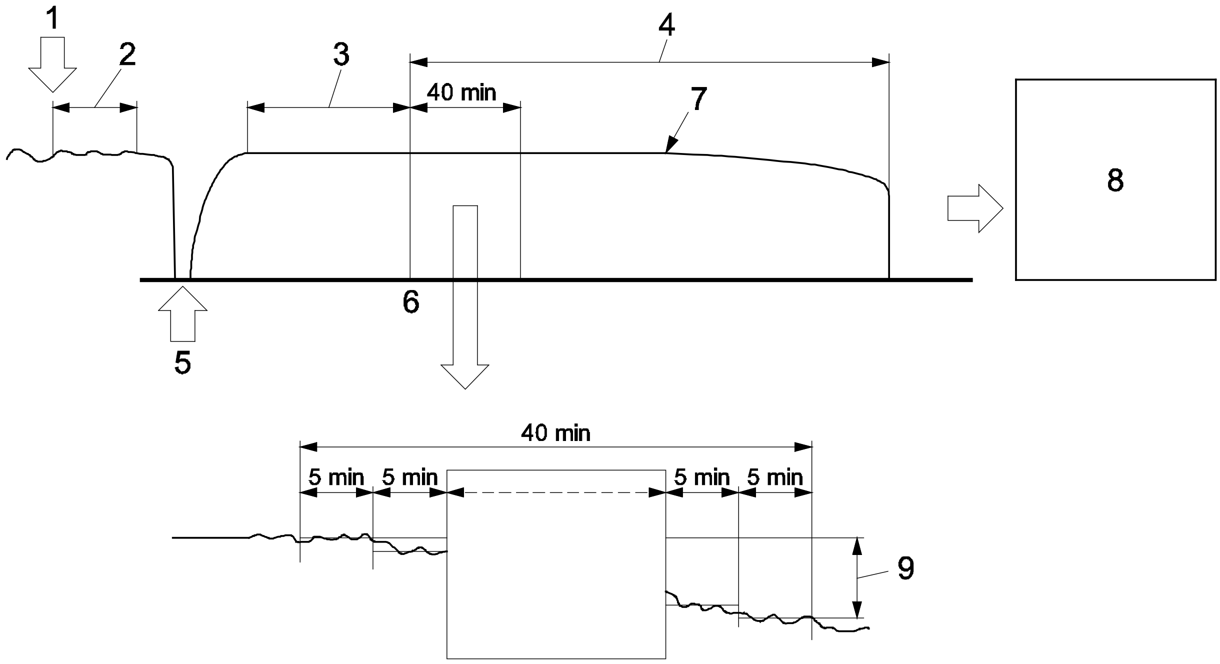
6 point 4 expanded for detail

7 ΔT_{water} *(indoor side)*

8 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

9 10 min after the defrost cycle that ends the preconditioning period

Figure D.3 — Steady-state heating capacity test with defrost during preconditioning period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 data for capacity calculation
data collection period 3 h

5 defrost at end of preconditioning period

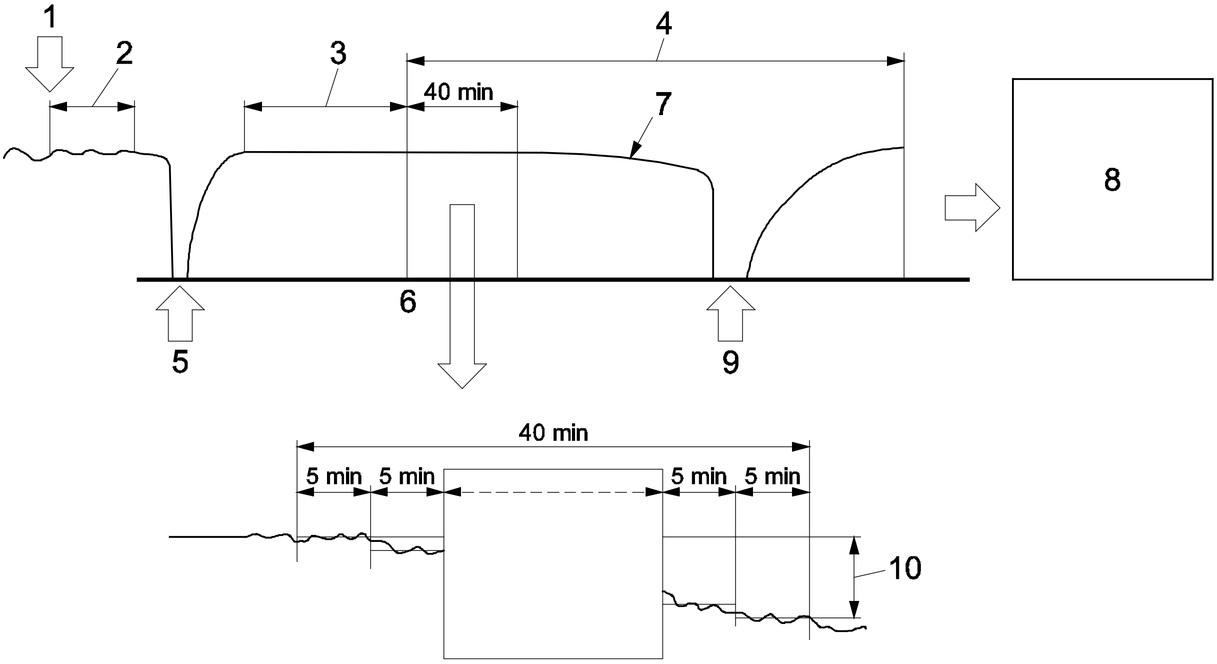
6 40 min of Point 4 expanded for detail

7 ΔT_{water} *(indoor side)*

8 transient test.
terminate test when data collection period equals 3 h

9 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

Figure D.4 — Transient heating capacity test with no defrost period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 data for capacity calculation
data collection period 3 h

5 defrost at end of preconditioning period

6 40 min of Point 4 expanded for detail

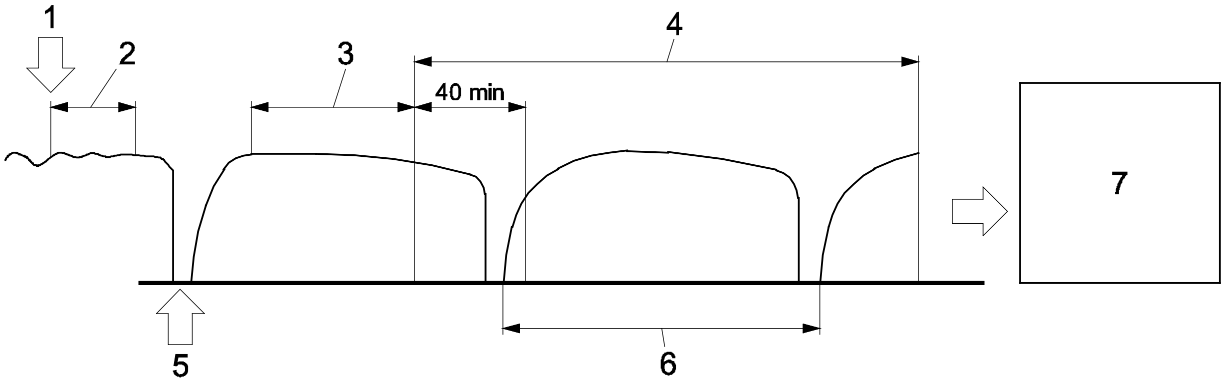
7 ΔT_{water} *(indoor side)*

8 transient test.
terminate test when data collection period equals 3 h

9 automatic defrost cycle occurs

10 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

Figure D.5 — Transient heating capacity test with one defrost period during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

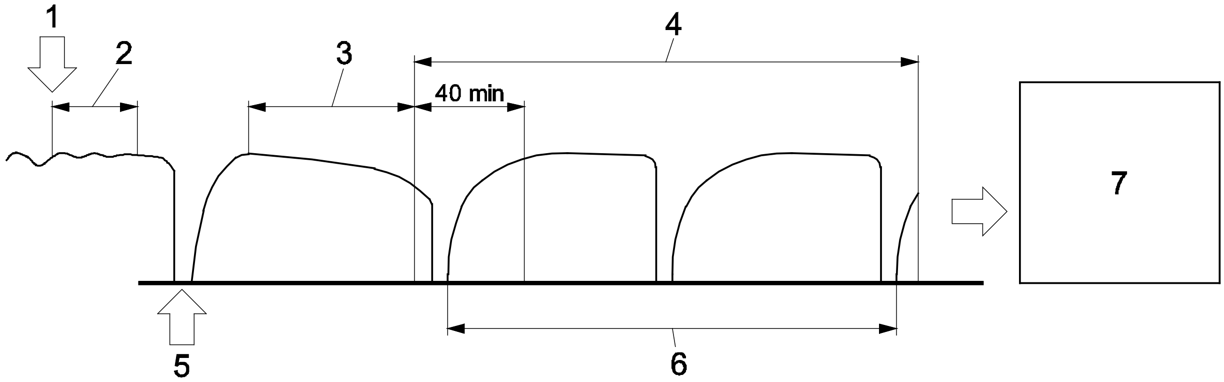
4 data collection period 3 h

5 defrost at end of preconditioning period

6 1 complete cycle
data for capacity calculation

7 transient test.
terminate test when data collection period equals 3 h

Figure D.6 — Transient heating capacity test with one complete cycle with defrost during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

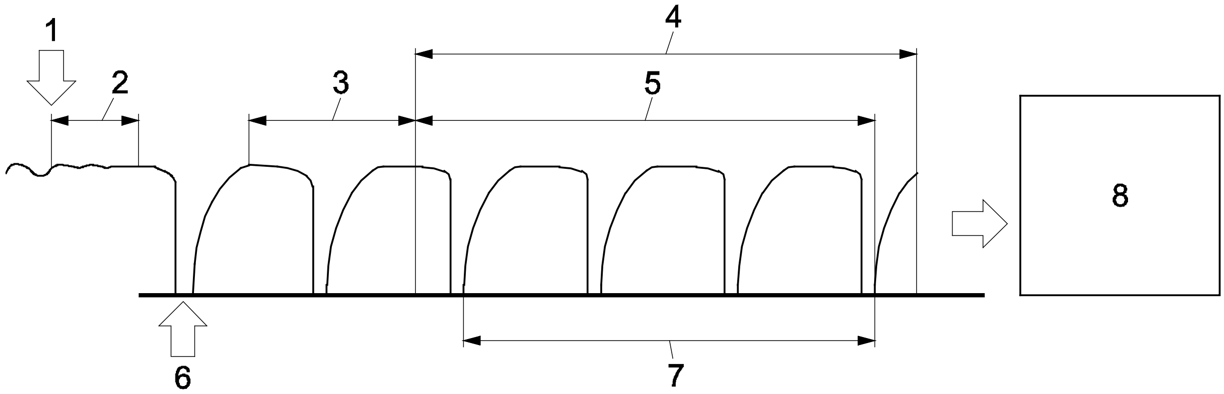
4 data collection period 3 h

5 defrost at end of preconditioning period

6 2 complete cycles
data for capacity calculation

7 transient test.
terminate test when data collection period equals 3 h

Figure D.7 — Transient heating capacity tests with two complete cycles with defrost during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 3 h

5 data collection period

6 defrost at end of precondioning period

7 3 complete cycles
data for capacity calculation

8 transient test.
terminate test when data collection period equals 3 h

Figure D.8 — Transient heating capacity test with three complete cycles with defrost during the data collection period

Annex E
(informative)

Direct method for air-to-water (brine) and water (brine) to water (brine) appliances

E.1 General

Annex E provides examples of compensation systems that can be used for the full and reduced capacity tests of air-to water (see E.2) or water (brine) to water (brine) (see E.3) appliance in cooling and heating mode.

E.2 Compensation system air to water appliances

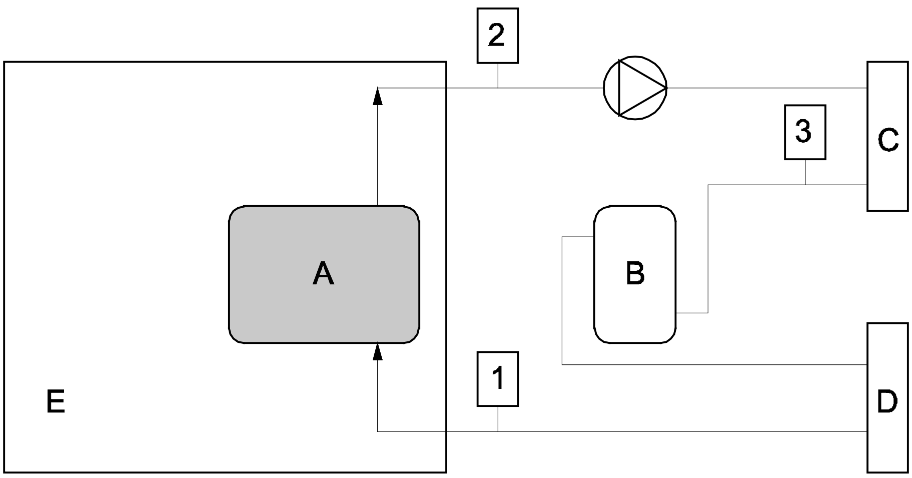
The outdoor heat exchanger of the air to water appliance recovers air energy from a closed climatic test room within the dry and wet bulb temperature are maintained within the ranges tolerated.

The indoor heat exchanger of the appliance is connected to a test rig that includes

— Primary compensation and secondary compensation heat exchangers, to compensate for the cooling and the heating capacity of the appliance,

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW),

as described in Figure E.1.



Key

A	appliance under test	E	climatic test room
B	storage tank	1	inlet temperature of the indoor heat exchanger of the appliance
C	Primary compensation heat exchanger	2	outlet temperature of the indoor heat exchanger of the appliance
D	Secondary compensation heat exchanger	3	intermediate temperature for test rig control with 3 < 2 and 3 < 1

Figure E.1 — Test installation for air to water (brine) appliance at full or reduced capacity in heating mode

The outlet temperature (2) of the indoor heat exchanger is set from the system control of the appliance (A) under test. The quantity of heat flowing through the heat exchanger (C) varies depending on the desired intermediate temperature whose value is on the initiative of the test supervisor and determined by the control system of the test rig. This first control stage (supplemented by the addition of one or more storage tanks (B)) allows to attenuate the effect of the large variations in the output temperature of the heat exchanger of the appliance (2) (in particular when it operates cyclically). The second control stage of the test rig is located at the heat exchanger (D) where the quantity of heat flowing therein is adjusted according to the desired inlet temperature of the indoor heat exchanger of the appliance (A).

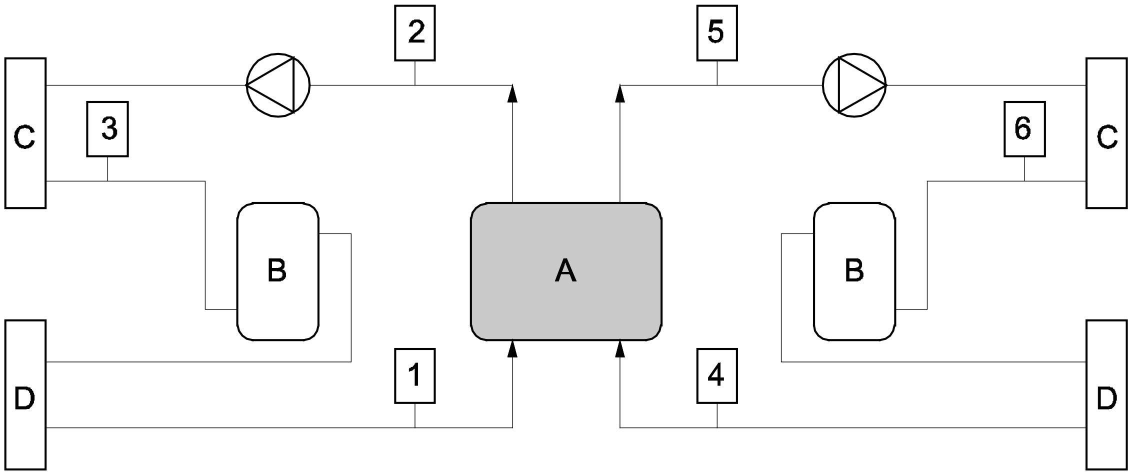
E.3 Compensation system for water/brine to water appliances

The appliance under test is installed in a test rig that includes:

— heating and cooling heat exchangers, to compensate for the cooling and the heating capacity of the appliance;

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW),

as described in Figure E.2.



Key

A appliance under test

B storage tank

C Primary compensation heat exchanger

D Secondary compensation heat exchanger

1 inlet temperature of the outdoor heat exchanger of the appliance

2 outlet temperature of the outdoor heat exchanger of the appliance

3 intermediate temperature for test rig control with 3 < 1 and 3 < 2

4 inlet temperature of the indoor heat exchanger of the appliance

5 outlet temperature of the indoor heat exchanger of the appliance

6 intermediate temperature for test rig control with 6 < 5 and 6 < 4

Figure E.2 — Test installation for water (brine) to water (brine) appliance at full or reduced capacity

Annex F
(informative)

Measurement control criteria for water (brine) to water (brine) appliances

F.1 General

This annex is a “quality” tool which can be used to detect a possible measurement error due to a bad operation of a measuring device, especially when the test result is not consistent with the expected result.

F.2 Water (brine)-to-water (brine) heat pump in heating mode

For water (brine) to water(brine) heat pump for which an energy balance may be calculated (see Formula (F.2)), the energy balance coefficient calculated according to Formula (F.3) may not exceed $0,37 \times \Delta T^{-0,53}$ (where ΔT is the difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger).

The calculation of the energy balance coefficient requires the measurement and calculation of additional parameters which are not strictly required in this standard. These parameters are the capacity of the outdoor heat exchanger, the flue gas losses and the jacket losses.

For jacket losses, a default value of 4 % of nominal gas input can be used. For other parameters, the characteristics of the devices necessary to determine them were reasonably chosen according to their relative importance in meeting the criterion.

For flue gas losses, the following formula could be used:

$$Flueloss = \frac{Q_{\text{gmh(Hi)}}}{100} \times q_c \qquad \text{(F.1)}$$

where

$Flueloss$	is the flue gas losses, in kilowatts;
$Q_{\text{gmh(Hi)}}$	is the measured heating net heat input, in kilowatts;
q_c	is the flue gas losses as defined in EN 15502-2-2:2014, 8.101.2.2, in percent of the heat input.

The energy balance is calculated by the following formula:

$$Ebalance_h = \frac{Q_{\text{gmh(Hs)}} + Pt_{\text{h}} + Q_{\text{outside}} - Q_{\text{h}} - Flueloss - Jloss}{Q_{\text{gmh(Hi)}}} \qquad \text{(F.2)}$$

where

$Ebalance_{\text{h}}$	is the energy balance in heating mode, in kilowatts per kilowatt;
$Q_{\text{gmh(Hs)}}$	is the measured heating gross heat input, in kilowatts;
$Q_{\text{gmh(Hi)}}$	is the measured heating net heat input, in kilowatts;
P_{th}	is the measured electrical power input in heating mode, in kilowatts;

Q_{outside} is the measured capacity across the outdoor heat exchanger(s), in kilowatts;

Q_{h} is the measured heating capacity, in kilowatts;

$Flueloss$ is the flue gas losses, in kilowatts;

$Jloss$ is the jacket losses, in kilowatts.

The energy balance coefficient is calculated by the following formula:

$$CoefEbalance_h = \left|Ebalance_h\right| + \left|UcEbalance_h\right| \qquad \text{(F.3)}$$

where

$CoefEbalance_{\text{h}}$ is the energy balance coefficient in heating mode, in kilowatts per kilowatt;

E_{balanceh} is the energy balance in heating mode, in kilowatts per kilowatt;

$UcEbalance_{\text{h}}$ is the overall uncertainty of the energy balance in heating mode, in kilowatts per kilowatt.

F.3Water (brine)-to-water (brine) chiller or chiller/heater in cooling mode

For Water (brine) to water(brine) chiller or chiller/heater in cooling mode for which an energy balance may be calculated (see Formula F.5), the energy balance coefficient calculated according to Formula (F.6) may not exceed $0{,}37 \times \Delta T^{-0{,}53}$ (where ΔT is the difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger).

The calculation of the energy balance coefficient requires the measurement and calculation of additional parameters which are not strictly required in this standard. These parameters are capacity of the outdoor heat exchanger, the flue gas losses and the jacket losses.

For jacket losses, a default value of 4 % of nominal gas input can be used. For other parameters, the characteristics of the devices necessary to determine them were reasonably chosen according to their relative importance in meeting the criterion.

For flue gas losses, the following formula could be used:

$$Flueloss = \frac{Q_{\text{gmh(Hs)}}}{100} \times q_c \qquad \text{(F.4)}$$

where

$Flueloss$ is the flue gas losses, in kilowatts;

$Q_{\text{gmh(Hs)}}$ is the measured heating gross heat input, in kilowatts;

q_c is the flue gas losses as defined in EN 15502-2-2:2014, 8.101.2.2, in percent of the heat input.

The energy balance is calculated by the following formula:

$$Ebalance_c = \frac{Q_{\text{gmc(Hs)}} + Pt_{\text{c}} + Q_{\text{c}} - Q_{\text{outside}} - Q_{\text{hr}} - Flueloss - Jloss}{Q_{\text{gmc(Hi)}}} \qquad \text{(F.5)}$$

where

$Ebalance_c$	is the energy balance in cooling mode, in kilowatts per kilowatt;
$Q_{gmc(Hs)}$	is the measured cooling gross heat input, in kilowatts;
$Q_{gmc(Hi)}$	is the measured cooling net heat input, in kilowatts;
P_{tc}	is the measured electrical power input in cooling mode, in kilowatts;
$Q_{outside}$	is the measured capacity across the outdoor heat exchanger(s), in kilowatts;
Q_c	is the measured cooling capacity, in kilowatts;
Q_{hr}	is the measured heat recovery capacity in cooling mode, in kilowatts;
$Flueloss$	is the flue gas losses, in kilowatts;
$Jloss$	is the jacket losses, in kilowatts.

The energy balance coefficient is calculated by the following formula:

$$CoefEbalance_c = \left|Ebalance_c\right| + \left|UcEbalance_c\right| \quad \text{(F.6)}$$

where

$CoefEbalance_c$	is the energy balance coefficient in cooling mode, in kilowatts per kilowatt;
$Ebalance_c$	is the energy balance in cooling mode, in kilowatts per kilowatt;
$UcEbalance_c$	is the overall uncertainty of the energy balance in cooling mode, in kilowatts per kilowatt.

Annex G
(normative)

Measurement in ON/OFF cycling mode

G.1 General

This method for measurement of monovalent air/water, water/water and brine/water appliances which enter in ON-OFF cycling is based on:

— Reaching equilibrium at reduced capacity when the burner operates at the minimal heat input stated in the operating instructions,

— Imposing an "ON duration" and calculating the "OFF duration" on the basis of the required load.

G.2 Test Procedure for measurement in ON/OFF cycling

The test procedure for measurement in ON/OFF cycling shall be conducted according to basic principles described in 4.5.3.1 by using the inlet temperature method (see Table 9), and according to the following sequence:

— Step 0: Calculate Inlet temperature related to the fixed water flow rate determined at standard rating test conditions given in EN 12309-3:2014, and related to the required partial load,

— Step 1: Put appliance controller in manual mode, set temperatures and flow rate according to the part load test condition and operate appliance's burner at the minimal heat input allowed in continuous operation mode,

— Step 2: Reach equilibrium period of 60 min where appliance shall operate while meeting the appropriate test tolerances specified in Table 9,

— Step 3: Start cycle with an OFF period of 20 min,

— Step 4: Start with ON period of 20 min,

— Step 5: Complete cycle with OFF period of duration equals to $20 \times \left(\frac{Q_E}{P} - 1 \right)$ min

where

Q_E is the effective capacity during the ON period,

P is the required partial load

— Step 6: Repeat steps 4 and 5 for addition three times (total 4 cycles),

— Step 7: If measured partial load exceeds the tolerance limit of ± 4 %, repeat steps 1 to 6 using an OFF period whose duration allows interpolation or extrapolation of results at targeted partial load.

EXAMPLE Case of an air source appliance in heating mode:

— Design heating load = 10 kW;

— PLR according to condition C of Table 11 of EN 12309–6:2014 (Part load conditions for reference seasonal performance calculation in heating mode of air-to-water units for high temperature application for the reference heating season “A” = average) = 0,35;

— Required partial load = 3,5 kW;

— Flow rate at standard rating test conditions: 1,1 m^3/h;

— Inlet temperature = 33,3 °C (related to Outlet temperature = 36°C, flow rate and required partial load = 3,5 kW);

— Effective heating capacity during ON period at minimum heat input = 6 kW;

— ON duration = 20 min;

— OFF duration = $20 \times \left(\frac{6}{3,5} - 1 \right)$ = 14,3 min;

— If Partial Load measured < 3,36 kW or > 3,64 kW, repeat test with different OFF cycle, else measurement is accepted.

Annex H
(informative)

Test report

H.1 General information

The test report may at least contain:

a) date;

b) test institute;

c) test location;

d) test method;

e) test supervisor;

f) appliance designation:

- type;
- serial / sample number;
- name of the manufacturer;
- flue type;
- gas family;

g) type of refrigerant;

h) mass of refrigerant;

i) type of absorbent or adsorbent;

j) mass of absorbent or adsorbent;

k) properties of heat transfer medium if different from water or air

l) reference to this European Standard.

H.2 Additional information

Additional information given on the rating plate may be noted and any other information relevant for the test. Particularly, it may be stated whether the testing is performed on a new appliance or one that is in use. In the case of a test performed on an appliance in use, information relative to the year of installation, and on the cleaning of the heat exchange tubes may be given.

H.3 Rating test results

Effective capacities, gas and electrical power inputs, GUE, AEF, internal or external static pressure may be given together with the corresponding rating conditions.

Annex ZA
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) No 813/2013

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to requirements of *Commission Regulation (EC) No 813/2013 of 6 September 2013 implementing Directive 2005/32/EC* [1] */ 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters.*

Once this standard is cited in the Official Journal of the European Union under that Commission Regulation, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding requirements of that and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Commission Regulation (EC) No 813/2013

Clause and subclauses of this EN	Requirements of Commission Regulation (EC) No 813/2013	Qualifying remarks/Notes
4.1	Annex II.3	
4.2; 4.3; 4.5	Annex III.4	
Clause 4: Table 4, Table 5 and Table 6	Annex III.4	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

[1] The Directive was replaced by the Directive 2009/125/EC.

Annex ZB
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) No 811/2013

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to requirements of *Commission Regulation (EC) No 811/2013 of 6 September 2013 implementing Directive 2005/32/EC* [2] */ 2009/125/EC of the European Parliament and of the Council with regard to energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.*

Once this standard is cited in the Official Journal of the European Union under that Commission Regulation, compliance with the clauses of this standard given in Table ZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding requirements of that and associated EFTA regulations.

Table ZB.1 — Correspondence between this European Standard and Commission Regulation (EC) No 811/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) No 811/2013	Qualifying remarks/Notes
Not applicable	Article 3, 1(a), Annex II, 1	Energy efficiency classes
Not applicable	Article 3, 1(a), Annex II, 2	Water heating energy classes
4.1	Article 3, 1(a), Annex III and IV	Test protocol to measure the sound power level
4.2.1	Article 3, 1(a), Annex III, 1.1 and Annex III, 3.	Tests protocols for measuring the rated heat output to be inserted in the Energy label for space heater
4.1, 4.2, 4.3, 4.5	Article 3, 1(b), Annex IV, 1 and Annex IV, 5.	Tests protocols for measuring the data to be inserted in the product fiche for space heater
4.1, 4.2, 4.3, 4.5	Article 3, 1(c), Annex V, 1.	Tests protocols for measuring the data to be inserted in the technical documentation for space heater
Not applicable	Article 3, 2(a), Annex III, 2.1 and Annex III, 4.	Energy label for combination heater
Not applicable	Article 3, 2(b), Annex IV, 2 and Annex IV, 6.	Product fiche for combination space heater
Not applicable	Article 3, 2(c), Annex V, 2	Technical documentation for combination heater

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

2) The Directive was replaced by the Directive 2009/125/EC.

Bibliography

[1] CEN/TR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)*

[2] EN 15502-2-2:2014, *Gas-fired central heating boilers - Part 2-2: Specific standard for type B1 appliances*

[3] EN 12309-5:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 5: Requirements*

[4] EN 12309-6:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 6: Calculation of seasonal performances*

[5] EN 14511, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling*

[6] EN 14825, *Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance*

[7] Full and part load efficiency measurements for boilers – contract N° MAT 1-CT92-009 funded by the European Union under MEASUREMENTS & TESTING programme – Directorate General XII – final report – June 1996

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