BS EN 12309-7:2014

BSI Standards Publication

# 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

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## National foreword

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12309-3:2014, BS EN 12309-4:2014, BS EN 12309-5:2014 and BS EN 12309-6:2014, it supersedes BS EN 12309-2:2000, which is withdrawn.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

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 7 : Dispositions spécifiques pour les appareils hybrides

Gasbefeuerte Sorptions-Geräte für Heizung und/oder Kühlung mit einer Nennwärmebelastung nicht über 70 kW - Teil 7: Spezifische Bestimmungen für Hybridanlagen

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

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**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**



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# Foreword

This document (EN 12309-7:2014) 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of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.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 supersede 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 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 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 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 7 of EN 12309

This part of EN 12309 deals particularly with the specific provisions of hybrid heating appliances based on gas-driven sorption heat pumps as defined in Part 1.

The heating appliances covered by this European Standard are of a hybrid type, an encased assembly or assemblies combining a direct or indirect-fired sorption heat pump for base load and a peak load condensing boiler with only one flue system, electrical supply cable and human machine interface to the end user. The direct- or indirect-fired sorption heat pump integrated in the hybrid appliances in this European Standard could be intermittent or continuously operating ab or adsorption heat pump.

The control system of hybrid heating appliances decides on the transition between the heat pump operation mode to/from the mixed operation mode (heating by both sorption heat pump as well as the peak boiler) and the direct heating mode (only peak boiler) depending on the heating fluid inlet or return temperature, temperature of brine entering the indoor heat exchanger (evaporator) of the heat pump, the required outlet or supply temperature dependent on the outdoor temperature as well as the target value of the indoor or room temperature. Upon transition from the heat pump operation mode to the mixed operation mode, the control system decides also on the degree of mixing based on the above mentioned parameters.

## 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 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[1], *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 12309-4:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 4: Test methods*

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*

## 3 Terms and definitions

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

## 4 Test conditions

### 4.1 General

The types of hybrid heating appliances considered in this European Standard are variable capacity delivering a variable heating fluid outlet temperature dependent on the outdoor (ambient air) and the design indoor (room) temperatures as well as the selected heat sink conditions.

Table 1 presents the design temperatures for heating (the dry bulb outdoor coldest temperature) for each reference heating season, the design indoor (room) temperature ($T_R$) as well as the balance point or heating limit temperature ($T_{BP}$) for the considered three reference heating seasons (climatic conditions) in EN 12309-6:2014; namely colder (C), average (A) and warmer (W). The heating season “Average” corresponds to the weather conditions of Strasburg, while “Warmer” and “Colder” correspond to the weather conditions of Athens and Helsinki, respectively.

**Table 1 — Design temperature, indoor temperature and balance point temperatures for the different reference heating seasons**

| Reference Heating Season | Dry bulb temperature conditions | | |
|---|---|---|---|
| | $T_{designh}$ | $T_R$ | $T_{BP}$ |
| Colder (C) | −22 °C | 20 °C | 16 °C |
| Average (A) | −10 °C | 20 °C | 16 °C |
| Warmer (W) | +2 °C | 20 °C | 16 °C |

In Table 2, the design outlet (supply) and inlet (return) temperatures to and from the building heating network (heating fluid temperatures from the heating appliance to the heating network and backwards, respectively) are listed as defined in EN 12309-3:2014.

[1]) This part of EN 12309 is currently being revised.

**Table 2 — Design outlet and inlet temperatures for the different heat sink conditions**

| Reference Heat Sink condition | Dry bulb temperature conditions | |
|---|---|---|
| | $T_{out\text{-}d}$<br>°C | $T_{in\text{-}d}$<br>°C |
| Low temperature application | 35 | 28 |
| Medium temperature application | 45 | 35 |
| High temperature application | 55 | 41 |
| Very high temperature application | 65 | 48 |

At least one of the given heat sink conditions in Table 2 shall be declared, upon which the seasonal performance can be evaluated according to this document.

The part load ratio at any outdoor temperature can be defined for the building as the ratio between the building part load at any outdoor temperature and the building design heat load. In the same way, the heating appliance part load ratio can be defined as the appliance heating capacity to be delivered at any outdoor temperature divided by the appliance's nominal heating capacity.

The accuracy of estimating the seasonal performance of such hybrid appliances is highly dependent on the uniformity of distributing the reference part load conditions over the building heat demand curve. For hybrid heating appliances, the reference part load ratios of 100 %, 75 %, 60 %, 45 %, 30 % and 15 % have been defined.

Because of the applied 1 K step in the outdoor temperature in the EN 12309-6:2014, the estimated part load ratios deviate from those values. The closest part load value is allocated as a pivot part load ratio for the estimation of the seasonal performance as given in Table 3.

**Table 3 — Reference and pivot part load ratios for the considered reference heating seasons**

| **Reference test condition** | **Reference PLR**<br>% | **Pivot PLR for the Reference Heating Seasons** | | |
|---|---|---|---|---|
| | | **(C)** | **(A)** | **(W)** |
| **A** | **100** | 100 | 100 | 100 |
| **B** | **75** | 74 | 73 | 71 |
| **C** | **60** | 61 | 58 | 57 |
| **D** | **45** | 45 | 46 | 43 |
| **E** | **30** | 29 | 31 | 29 |
| **F** | **15** | 16 | 15 | 14 |

If necessary, at most one more reference test point G between two successive reference test points from A to F may be added. The test conditions should then be linearly interpolated between the two successive standard reference test conditions given in 4.2 and 4.3.

The stated nominal heating capacity of the hybrid heating appliance shall always be higher than or equal to the building design load for heating.

NOTE The measured gas utilization efficiencies at the reference part load conditions are only allowed to be considered in estimating the seasonal performance, if the heating capacity at each reference part load condition is measured within the given deviation limits in EN 12309–4:2014.

## 4.2 Inlet temperatures of the indoor heat exchanger

Fixing the reference test conditions to the part load ratios results in the same indoor heat exchanger inlet and outlet temperatures over the reference heating seasons for every part load ratio. Annex A represents a detailed approach on how to estimate the inlet and outlet temperature into/from the indoor heat exchanger for any part load ratio and reference heating season. The inlet and outlet temperatures have been estimated for the reference test part load ratios defined in 4.1 and presented in Table 4 for both low and medium as well as in Table 5 for both high and very high temperature heat sink conditions, respectively. Annex A gives a more detailed view of this approach.

**Table 4 — Inlet and outlet temperatures of the indoor heat exchanger for the reference part load test conditions of the low and medium temperature heat sink applications**

| **Reference test condition** | **Low temperature application** | | **Medium temperature application** | |
|---|---|---|---|---|
| | Outlet temperature °C | Inlet temperature °C | Outlet temperature °C | Inlet temperature °C |
| **A** | 35,0 | 28,0 | 45,0 | 35,0 |
| **B** | 31,4 | 26,2 | 39,4 | 31,9 |
| **C** | 29,3 | 25,1 | 36,1 | 30,1 |
| **D** | 27,1 | 24,0 | 32,4 | 28,0 |
| **E** | 24,9 | 22,8 | 28,8 | 25,8 |
| **F** | 22,5 | 21,5 | 24,8 | 23,3 |

**Table 5 — Inlet and outlet temperatures of the indoor heat exchanger for the reference part load test conditions of the high and very high temperature heat sink applications**

| **Reference test condition** | **High temperature application** | | **Very high temperature application** | |
|---|---|---|---|---|
| | Outlet temperature °C | Inlet temperature °C | Outlet temperature °C | Inlet temperature °C |
| **A** | 55,0 | 41,0 | 65,0 | 48,0 |
| **B** | 47,6 | 37,1 | 56,0 | 43,3 |
| **C** | 43,1 | 34,7 | 50,4 | 40,2 |
| **D** | 38,2 | 31,9 | 44,3 | 36,7 |
| **E** | 33,2 | 29,0 | 38,0 | 32,9 |
| **F** | 27,4 | 25,4 | 30,5 | 28,0 |

The part load measurements at the reference test conditions shall follow the inlet temperature method of the EN 12309-4:2014.

Each reference part load test condition is strictly defined by both part load and the inlet temperatures to both indoor and outdoor heat exchangers. The inlet temperatures to the indoor heat exchangers shall be taken from Table 4 and Table 5, while the inlet temperatures to the outdoor heat exchanger are defined in 4.3 for the different environmental heat sources.

The listed outlet temperatures in Table 4 and Table 5 shall be the average outlet temperatures over the cycle. They are given to guide the measurements only in case the nominal (design) heating fluid flow rate is kept constant over all part load conditions. Specially, for the low part load ratios (B to F), the heating fluid flow rate can be decreased to enhance the outlet temperature, in order to increase the measurement accuracy and to reduce the auxiliary electrical power consumption. This is only allowed under the condition that the temperature gradient between outlet and inlet temperatures at any part load condition shall not be higher than the temperature gradient at the corresponding design load condition; namely 7 K for the low temperature heat sink as well as 10 K, 14 K and 17 K for the medium, high and very high temperature heat sink applications, respectively.

The recommendations for the hybrid appliance concerning the allowed deviation(s) in the temperature gradients at each reference part load test condition, as described before, shall be followed.

As the type of integrated gas-driven sorption heat pump can be either intermittent or continuously operating a time share between the heat pump and the peak boiler is required at higher heating capacities, the heating capacity should be averaged either over a very long time period (e.g. 24 h) or over a number of complete operation cycles not less than two. A typical operation cycle of a hybrid appliance can be counted between two successive normal burner operations.

For burners with constant air to fuel ratio control, a burner calibration shall not be counted as a normal burner operation. The test shall wait for two successive operation cycles without any automatic burner calibration operations in between. The cyclic operation of the hybrid appliance shall be described in the operating manual and the automatic burner calibration mode may be suppressed within a test operation mode, to allow the test to be carried out more precisely.

## 4.3 Inlet temperatures into the outdoor heat exchanger

### 4.3.1 Air to water hybrid heating appliance

Based on the definition of the part load ratio (PLR(Toutdoor)) given in EN 12309-6:2014, the dry bulb air temperatures entering the outdoor heat exchanger of air to water hybrid heating appliances have been estimated for the pivot part load test conditions given in Table 3 by applying Formula (1) and are listed in Table 6.

$$T_{\text{outdoor}} = 16 + PLR\left(T_{\text{outdoor}}\right)\cdot\left(T_{\text{designh}} - 16\right) \quad (1)$$

**Table 6 — Inlet dry (wet) bulb temperatures of air into the outdoor heat exchangers**

| Reference test condition | Reference Heating Season °C | | |
|---|---|---|---|
| | (C) | (A) | (W) |
| A | −22 (−23) | −10 (−11) | 2 (1) |
| B | −12 (−13) | −3 (−4) | 6 (5) |
| C | −7 (−8) | 1 (0) | 8 (7) |
| D | −1 (−2) | 4 (3) | 10 (9) |
| E | 5 (4) | 8 (7) | 12 (11) |
| F | 10 (9) | 12 (11) | 14 (13) |

The wet bulb temperature is set equal to the dry bulb temperature minus 1 K. For temperature below – 10°C, setting of the wet bulb is not mandatory.

For air to water hybrid heating appliances working with exhaust air as an environmental heat source an inlet air dry(wet) bulb temperature of 20(12) °C shall be considered for all reference test conditions according to the EN 12309-3:2014.

If defrosting of the air heat exchanger takes place under any of the specified test conditions of this subclause, then the defrosting process should be considered in accordance with EN 12309-4:2014.

The installation of the appliance in the climatic chamber shall follow the installation instructions in accordance with prEN 12309-2:2013[2] and EN 12309-4:2014.

#### 4.3.2 Ground water sourced hybrid heating appliances

For ground water sourced hybrid heating appliances, all 6 reference test part loads (A to F) shall be measured with an inlet temperature of 10 °C into the outdoor heat exchanger.

#### 4.3.3 Ground heat sourced hybrid heating appliances

Following the design conditions presented in Annex B, the listed inlet temperatures to the outdoor heat exchanger in Table 7 at each reference part load test condition shall be applied.

**Table 7 — Inlet temperatures to the outdoor heat exchanger (evaporator) for the reference part load test conditions**

| Reference test condition | PLR<br>% | Inlet temperature<br>°C |
|---|---|---|
| **A** | 100 | 5 |
| **B** | 75 | 5 |
| **C** | 60 | 6 |
| **D** | 45 | 7 |
| **E** | 30 | 8 |
| **F** | 15 | 9 |

During the measurements, the stated brine flow rates in the operating manual shall be realized.

#### 4.3.4 Solar sourced hybrid heating appliances

Following Annex C, the brine temperature out of the solar collectors (environmental heat sources) exceeds the outdoor dry bulb temperature by a temperature difference which is correlated to the collector aperture area according to Formula (C.1).

The listed temperature differences ($\Delta T$) in Table 8 shall be added to the reference dry-bulb outdoor temperatures given in Table 6 depending on the collector aperture area and type to obtain the inlet temperature into the outdoor heat exchanger (evaporator) for all reference test conditions A-F.

[2] This part of standard is currently being revised

**Table 8 — Temperature differences between the inlet temperature to the outdoor heat exchanger and the outdoor dry-bulb test conditions given in Table 6**

| Collector aperture area / maximum heat extraction rate | $\Delta T$ | $\Delta T$ |
|---|---|---|
| | Flat plate | Vacuum tube |
| $m^2$/kW | K | K |
| 1 | 2,1 | 2,9 |
| 1,5 | 2,9 | 4,1 |
| 2 | 3,6 | 5,1 |
| 3 | 4,8 | 6,8 |
| 4 | 5,6 | 8,0 |
| 5 | 6,3 | 9,0 |
| 6 | 6,8 | 9,6 |

During the measurements, the stated brine flow rates in the operating manual shall be realized.

In case solar collectors are applied as an alternative environmental heat source to assist an existing ground heat source or an air-brine heat exchanger as an air heat source Annex D could be applied to estimate the inlet temperature into the outdoor heat exchanger.

## 5 Calculation of the seasonal performance in the heating mode

The calculation of the seasonal performance of the hybrid heating appliances follows from the application of the bin method according to the EN 12309-6:2014, 5.3 to 5.7, where the part load gas utilization efficiency and auxiliary energy factor at each bin temperature are determined via linear interpolation of the their respective part load values measured at the reference part load test conditions defined in this document for each reference heating season and heat sink design condition.

The seasonal gas utilization efficiency for sorption heat pump based hybrid heating appliances with partial coverage of the building heating demand by the solar collectors working as an environmental heat source is to be estimated according to Annex E.

Annex F presents a methodology to estimate the seasonal performance of hybrid heating appliances at building heating design loads less than the appliance's nominal heating capacity.

## 6 Standard rating conditions of gas driven sorption heat pump based hybrid heating appliances

For the purposes of marking, comparison or certification of gas-driven sorption heat pump based hybrid heating appliances the seasonal performance figures; namely, seasonal gas utilization efficiency, seasonal auxiliary energy factor and the seasonal primary energy ratio shall be applied.

In addition the hybrid heating appliances can be tested at the standard rating conditions defined in Table 9 for the nominal heating capacity and in Table 10 for the 30 % part load condition.

**Table 9 — Standard rating test conditions for hybrid heating appliances at nominal heating capacity**

| Type of appliance | Outdoor heat exchanger | | Indoor heat exchanger | |
|---|---|---|---|---|
| | Inlet temperature °C | Outlet temperature °C | Inlet temperature °C | Outlet temperature °C |
| **Air sourced** | | | | |
| low temperature | 7 | b | a | 35 |
| medium temperature | 7 | b | a | 45 |
| high temperature | 7 | b | a | 55 |
| very high temperature | 7 | b | a | 65 |
| **Ground water sourced** | | | | |
| low temperature | 10 | b | a | 35 |
| medium temperature | 10 | b | a | 45 |
| high temperature | 10 | b | a | 55 |
| very high temperature | 10 | b | a | 65 |
| **Ground heat sourced** [c] | | | | |
| low temperature | 8 | b | a | 35 |
| medium temperature | 8 | b | a | 45 |
| high temperature | 8 | b | a | 55 |
| very high temperature | 8 | b | a | 65 |
| **Solar sourced** | | | | |
| low temperature | 12 | b | a | 35 |
| medium temperature | 12 | b | a | 45 |
| high temperature | 12 | b | a | 55 |
| very high temperature | 12 | b | a | 65 |

[a] All tests shall be carried out with nominal flow rates stated in the operating manual in cubic meter per second, provided that the difference between the outlet and inlet temperatures at indoor heat exchanger is lower than or equal to a maximum temperature difference ($\Delta T_{max}$) calculated using the following formula:

$$\Delta T_{max} = 7 + \left(\frac{T_{out} - 35}{30}\right) * 10$$

[b] The tests shall be carried out with the flow rate given by the control system of the appliance or, by default, with the flow rate obtained during the test at the corresponding standard conditions provided that, in both cases, the condition on maximum $\Delta T$ is respected. It is intended that the control system of the appliance has the control on pumps such as for the internal pumps.

[c] Specific maximum extraction output per probe meter is 35 W per meter of probe.

**Table 10 — Standard rating test conditions for hybrid heating appliances at 30 % part load condition**

| Type of appliance | Outdoor heat exchanger | | Indoor heat exchanger | |
|---|---|---|---|---|
| | Inlet temperature °C | Outlet temperature °C | Inlet temperature °C | Outlet temperature °C |
| **Air sourced** | | | | |
| low temperature | 7 | [b] | 22,8 | [a] |
| medium temperature | 7 | [b] | 25,8 | [a] |
| high temperature | 7 | [b] | 29,0 | [a] |
| very high temperature | 7 | [b] | 32,9 | [a] |
| **Ground water sourced** | | | | |
| low temperature | 10 | [b] | 22,8 | [a] |
| medium temperature | 10 | [b] | 25,8 | [a] |
| high temperature | 10 | [b] | 29,0 | [a] |
| very high temperature | 10 | [b] | 32,9 | [a] |
| **Ground heat sourced** [c] | | | | |
| low temperature | 8 | [b] | 22,8 | [a] |
| medium temperature | 8 | [b] | 25,8 | [a] |
| high temperature | 8 | [b] | 29,0 | [a] |
| very high temperature | 8 | [b] | 32,9 | [a] |
| **Solar sourced** | | | | |
| low temperature | 12 | [b] | 22,8 | [a] |
| medium temperature | 12 | [b] | 25,8 | [a] |
| high temperature | 12 | [b] | 29,0 | [a] |
| very high temperature | 12 | [b] | 32,9 | [a] |

[a] The part load measurements at the reference test conditions shall follow the inlet temperature method of EN 12309-4:2014. Each reference part load test condition is strictly defined by both part load and the inlet temperatures to both indoor and outdoor heat exchangers. The heating fluid flow rate can be decreased below its nominal value stated in the operating manual, in order to increase the measurement accuracy and to reduce the auxiliary electrical power consumption. This is only allowed under the condition that the temperature gradient between outlet and inlet temperatures at any part load condition shall not be higher than the temperature gradient at the corresponding design load condition; namely 7 K for the low temperature heat sink as well as 10 K, 14 K and 17 K for the medium, high and very high temperature heat sink applications, respectively. The recommendations for of the hybrid appliance concerning the allowed deviation(s) in the temperature gradients at each reference part load test condition, as described before, shall be followed.

[b] The tests shall be carried out with the flow rate given by the control system of the appliance or, by default, with the flow rate obtained during the test at the corresponding standard conditions provided that, in both cases, the condition on maximum $\Delta T$ is respected. It is intended that the control system of the appliance has the control on pumps such as for the internal pumps.

[c] Specific maximum extraction output per probe meter is 35 W per meter of probe

If liquid heat transfer media other than water are used, the specific heat capacity and the density of such heat transfer media shall be determined and taken into consideration in the evaluation.

# Annex A
(informative)

# Estimation of the heating fluid inlet and outlet temperature into/out of the indoor heat exchanger

The average heating fluid flow temperature at any outdoor temperature $T_{\text{HF}}$ ($T_{\text{outdoor}}$) can be calculated with Formula (A.1) as an arithmetic mean between the heating fluid outlet (supply) and inlet (return) temperatures.

$$T_{\text{HF}}\left(T_{\text{outdoor}}\right) = \frac{1}{2} \cdot \left(T_{\text{out}}\left(T_{\text{outdoor}}\right) + T_{\text{in}}\left(T_{\text{outdoor}}\right)\right) \tag{A.1}$$

In the same way, the average design heating fluid flow temperature can be estimated according to Formula (A.2) out of the given design outlet and inlet temperatures at the selected reference heat sink condition out of Table 2 of the main text of this document.

$$T_{\text{HF-d}} = \frac{1}{2} \cdot \left(T_{\text{out-d}} + T_{\text{in-d}}\right) \tag{A.2}$$

With a constant volume/mass flow rate as well as a constant specific heat capacity of the heating fluid, it is possible to write the part load ratio as follows:

$$PLR\left(T_{\text{outdoor}}\right) = \frac{T_{\text{out}}\left(T_{\text{outdoor}}\right) - T_{\text{in}}\left(T_{\text{outdoor}}\right)}{T_{\text{out-d}} - T_{\text{in-d}}} \tag{A.3}$$

The heating capacity of heating surfaces is measured according to [1]. This heating capacity is a function of the heating fluid temperature gradient to the design room temperature ($T_{\text{HF-d}} - T_{\text{R}}$). This function is normally represented by the so-called characteristic curve of the heating surface [1]. The design heating capacity of each heating surface is to be given at the standard atmospheric pressure (101,325 kPa), the design outlet and inlet temperatures of the indoor heat exchanger (to/from the heat sink) and a standard room temperature of 20 °C. Based on the design heat capacity, the heat capacity at any working condition can be estimated by the exponential law given in Formula (A.4) according to

$$PLR\left(T_{\text{outdoor}}\right) = \left[\frac{T_{\text{HF}}\left(T_{\text{outdoor}}\right) - T_{\text{R}}}{T_{\text{HF-d}} - T_{\text{R}}}\right]^{n} \tag{A.4}$$

The heating surface exponent (n) is determined experimentally and depends on the heating surface design and size. For the selected four heat sink conditions; low, medium, high and very high temperature, the heating surface exponents of 1.1, 1.2, 1.3 and 1.4, respectively, have been chosen [5].

Combining the above four formulae and solving for the outlet and inlet temperatures result in the following expressions for both outlet and inlet temperatures of the heating fluid for a given heat sink condition and heating surface exponent at any given outdoor temperature and, consequently, part load ratio.

$$T_{out}\left(T_{outdoor}\right) = T_R + \left(T_{HF-d} - T_R\right) \cdot \left(PLR\left(T_{\text{outdoor}}\right)\right)^{1/n} + \frac{1}{2} \cdot PLR\left(T_{\text{outdoor}}\right) \cdot \left(T_{\text{out-d}} - T_{\text{in-d}}\right) \tag{A.5}$$

$$T_{in}\left(T_{outdoor}\right) = T_R + \left(T_{HF-d} - T_R\right) \cdot \left(PLR\left(T_{\text{outdoor}}\right)\right)^{1/n} - \frac{1}{2} \cdot PLR\left(T_{\text{outdoor}}\right) \cdot \left(T_{\text{out-d}} - T_{\text{in-d}}\right) \tag{A.6}$$

# Annex B
(informative)

# Inlet temperature into the outdoor heat exchanger for ground heat sourced sorption heat pump based hybrid heating appliances

A ground heat source (GHS) is a borehole heat exchanger, which is mounted in the underground (beneath the surface of the earth) and has the main function to deliver environmental heat to the evaporator of the gas-driven heat pump. As the gas-driven sorption heat pump based hybrid heating appliances considered contain a direct or indirect gas fired sorption heat pump for base load and a condensing peak load boiler, the regime of heat extraction out of the GHS is completely different if compared with the heat extraction regime of vapour compression heat pumps. While the heat extraction rate of vapour compression heat pumps attains its maximum at the design temperature for heating ($T_{\text{designh}}$), the heat extraction rate of the hybrid heating appliances may reach zero in case the peak load boiler is solely responsible for covering the peak (or design) heating load. Besides, the implied gas-driven sorption heat pump is designed to cover the base load (e.g. up to 50 % of the nominal heating capacity of the hybrid appliance) during the heat pump operating mode.

Designing a GHS is made more difficult trying to avoid freezing temperatures because of the frost damage in the neighbouring area of the drill. Ground heat sources for gas-driven sorption heat pump based hybrid heating appliances have been designed (their depth has been estimated) according to the regulation VDI 4640-2 [6] under the condition that the brine return temperature out of the GHS does not fall below 4 °C after 25 years of operation. The design work of the GHS has been carried out for two gas-driven ab- or adsorption heat pumps (GAHP). The maximum heat extraction rate of the 1st ab- or adsorption heat pump (GAHP1) is 1,25 kW and of the 2nd (GAHP2) is 2,0 kW. Each GAHP has different extraction characteristics as given in the VDI 4650-2 [7], while the nominal heating capacity of their hybrid heating appliances amount to 10 kW and 12 kW, respectively. For comparison, the GHS has also been designed for a vapour compression heat pump (VCHP) of a nominal capacity of 10 kW to fulfil the same condition (GHS return temperature > 4 °C after 25 years). The design work has been carried out for two different one-family houses, the first is an energy saving house (ESH) having a heating demand of 10,582 kWh/a, while the second is an existing house (EH) having a heating demand of 21,289 kWh/a [7].

Table B.1 represents the obtained depths for the GHS for the energy saving house, while Table B.2 for the existing house.

Applying those evaporator inlet temperatures is only allowed, if same or lower heat extraction characteristics for the GAHP could be proven. For other GAHPs showing different (higher) heat extraction characteristics, the same design procedure should be carried out in order to estimate the required GHS depths to meet the same design condition. In addition, the outdoor heat exchanger (evaporator) inlet temperatures listed in Table 7 can be only applied, if the depths of the GHS for the GAHP1 and GAHP2 are at least equal to those given in Table B.1 and Table B.2 or in case the estimated depths for other GAHPs fulfilling the same design condition (GHS return temperature > 4°C after 25 years).

**Table B.1 — Required GHS depths for the considered GAHP compared to a VCHP of the same nominal capacity for the energy saving house**

| Heat pump | Required depth for the GHS<br><br>m | Specific annual extraction heat per probe meter<br><br>kWh/(m.a) | Specific max. extraction output per probe meter<br><br>W/m |
|---|---|---|---|
| **GAHP1** | 48 | 57,1 | 26,0 |
| **GAHP2** | 62 | 40,5 | 32,3 |
| **VCHP** | 206 | 41,7 | 38,8 |

**Table B.2 — Required GHS depths for the considered GAHP compared to a VCHP of the same nominal capacity for an existing house**

| Heat pump | Required depth for the GHS<br><br>m | Specific annual extraction heat per probe meter<br><br>kWh/(m.a) | Specific max. extraction output per probe meter<br><br>W/m |
|---|---|---|---|
| **GAHP1** | 62 | 81,5 | 20,2 |
| **GAHP2** | 81 | 63,0 | 24,7 |
| **VCHP** | 272 | 63,5 | 29,4 |

# Annex C
(informative)

# Inlet temperature into the outdoor heat exchanger for solar sourced sorption heat pump based hybrid heating appliances

Solar sourced heat pumps are heat pumps utilizing solar energy as an environmental heat source. This annex defines the application of solar flat-plate or vacuum-tube collectors as an environmental heat source for the sorption heat pump based heating appliances.

The temperature of brine flowing out of the flat-plate or vacuum tube solar collector panel (environmental heat source) and entering the outdoor heat exchanger ($T_{\text{OHEX,in}}$) exceeds the outdoor dry bulb temperature ($T_{\text{outdoor}}$) by a temperature difference, which depends on the collector type and aperture area. Formula C.1 gives the correlation between the temperature difference ($T_{\text{OHEX,in}}$-$T_{\text{outdoor}}$) and the collector aperture area [7].

$$T_{\text{OHEX,in}} - T_{\text{outdoor}} = \Delta T_{\text{Ref}} \cdot \left[ 1 - e^{-\left(\frac{A}{A_{\text{Ref}}}\right)} \right] \quad \text{(C.1)}$$

where

$T_{OHEX,in}$ is the inlet temperature into the outdoor heat exchanger;

$A$ is the aperture area of the applied flat plate or vacuum tube collector panel in $m^2$;

$\Delta T_{\text{Ref}}$ is the reference temperature difference estimated by fitting the measured data with the collector aperture area to Formula (C.1); and

$A_{\text{Ref}}$ is the reference collector area estimated by fitting the measured data with the collector aperture area to Formula (C.1).

The values of $\Delta T_{\text{Ref}}$ and $A_{\text{Ref}}$ for both flat plate and vacuum tube collectors are defined in Table C.1.

**Table C.1 — Correlation parameters of Formula (C.1) for flat plate and vacuum tube collectors as environmental heat sources**

| Collector type | $\Delta T_{\text{Ref}}$<br>K | $A_{\text{Ref}}$<br>$m^2$ |
|---|---|---|
| Flat plate | 8,2 | 6,9 |
| Vacuum tube | 11,7 | 6,9 |

The temperature differences estimated by Formula (C.1) and listed in Table 8 of the main text of this document shall be added to the reference dry-bulb test conditions given in Table 6 depending on the collector type and aperture area ($A$) applied as an environmental heat source to obtain the outdoor heat exchanger (evaporator) inlet temperatures at the reference test conditions A-F.

Formula (C.1) and, consequently, the given temperature differences in Table 8 of the main text are valid only for flat plate or vacuum tube collectors and sorption heat pump based hybrid heating appliances having a maximum heat extraction capacity of 2 kW. For higher heat extraction rates or different solar collector types or aperture areas, the same approach described in this annex shall be applied.

# Annex D
(informative)

# Inlet temperature of the outdoor heat exchanger for solar collector assisted sorption heat pump based hybrid heating appliances

## D.1 Introduction

In case solar collectors are applied as an alternative environmental heat source together with an existing ground heat source or an air-brine heat exchanger as an air heat source, Annex D is applied.

## D.2 Solar-assisted ground sourced gas-driven sorption heat pumps

During the measurements of the reference part load test conditions, the respective outdoor heat exchanger's (evaporator) inlet temperature is to be set to the higher value out of Table 7 and those obtained from Formula (C.1) or Table 8 together with Table 6 of the main text of this document. This approach is only valid for alternative use of either GHS or the solar collectors depending on which source offers the highest temperature.

## D.3 Solar-assisted air sourced gas-driven sorption heat pumps

The respective outdoor heat exchanger's (evaporator) inlet temperature (air or brine) to be set with the measurements of the reference part load test conditions is the higher value out of Table 6 and those obtained from Formula (C.1) or Table 8 together with Table 6 of the main text of this document. This approach is only valid for alternative use of either air heat source or the solar collectors depending on which source offers the highest temperature.

# Annex E
(informative)

# Calculation of the seasonal gas utilization efficiency with partial heat demand coverage by the applied solar collectors

The seasonal gas utilization efficiency for sorption heat pump based hybrid heating appliances with partial coverage of the building heating demand by the solar collectors working as an environmental heat source ($SGUEh_s$) is calculated according to Formula (E.1):

$$SGUEh_s = \frac{SGUEh}{1 - X} \quad \text{(E.1)}$$

where

| | |
|---|---|
| $SGUEh_S$ | is the Seasonal Gas Utilization Efficiency for heating with solar contribution |
| $SGUEh$ | is the estimated seasonal gas utilization efficiency as defined by prEN 12309–6:2012, 5.4, Formula (9), according to the test conditions defined by this document for solar sourced hybrid heating appliances; |
| $X$ | is the fraction of the seasonal heating demand of the building covered by the solar collectors. |

# Annex F
(informative)

# Estimation of the seasonal performance of hybrid heating appliances at building design loads deviating from the appliance's nominal heating capacity

The nominal heating capacity is defined as the maximum heating capacity of the hybrid heating appliance. In case the building design heating load is smaller than the nominal heating capacity of the appliance, the whole measuring campaign has to be repeated for every specific building design heating load.

In order to reduce experimental effort, it is suggested that two nominal heating capacities may be defined; namely, the highest and lowest nominal heating capacities for each hybrid heating appliance.

The condition for applying a specific hybrid heating appliance is that the building design load for heating shall lie between the lowest and highest nominal capacities of the considered appliance.

The measuring campaign shall be carried out only for both nominal heating capacities. The reference part load gas utilization efficiency and auxiliary energy factor at each reference test condition shall be linearly interpolated between the corresponding values at the highest and lowest nominal capacities for any building design load for heating located in between.

# Annex G
(normative)

## Calculation of the seasonal space heating energy efficiency for hybrid gas-driven sorption heat pump based heating appliances

The seasonal space heating energy efficiency $\eta_s$ is defined for hybrid gas-driven sorption heat pump based heating appliances as:

$$\eta_s = SPER - \sum F(i) \qquad (G.1)$$

where:

$SPER$ reference Seasonal Primary Energy Ratio

$F(i)$: are corrections calculated according to the following paragraphs and are expressed in %.

Calculation of $F$ (i)

a) Correction factor F(1) accounts for a ***negative*** contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls to seasonal space heating energy efficiency of packages of space heater, temperature control and solar-only system or of packages of combination heater, temperature control, solar-only system and passive flue heat recovery device. For hybrid gas-driven sorption heat pump based space heating appliances and combination heaters, the correction is F(1) = 3 %.

b) Correction factor F(2) accounts for a ***negative*** contribution to the seasonal space heating energy efficiency due to electricity consumptions of pump(s) required to circulate the heat transfer fluid between the hybrid heating appliance and the ambient heat source (ground, water or solar) and is expressed in %. Table G.1 reports the different values of F(2) for each ambient heat source of the hybrid appliances.

**Table G.1 — F(2) values for each ambient heat source of the hybrid appliances**

| **Ambient heat source** | **F(2) in [%]** |
|---|---|
| Ground Water – Water Heat Pumps | 2 |
| Ground/Brine – Water Heat Pumps | 1 |
| Solar – Water Heat Pumps | 1 |

c) Correction factor F(3) accounts for a ***positive*** contribution to the seasonal space heating energy efficiency of hybrid gas-driven sorption heat pump based heating appliances due to the contribution of different temperature controls classes of the packages. The values of F(3) can be assigned according to the control class as specified in Table G.2.

**Table G.2 — F(3) values assigned according to the control class**

| Class | Definition of temperature control | [-F(3)] |
|---|---|---|
| I | On/Off Room Thermostat: A room thermostat that controls the on/off operation of a heater. Performance parameters, including switching differential and room temperature control accuracy are determined by the thermostat's mechanical construction. | 1 |
| II | Weather compensator control, for use with modulating heaters: A heater flow temperature control that varies the set point of the flow temperature of water leaving the heater dependant upon prevailing outside temperature and selected weather compensation curve. Control is achieved by modulating the output of the heater. | 2 |
| III | Weather compensator control, for use with on/off output heaters: A heater flow temperature control that varies the set point of the flow temperature of water leaving the heater dependant upon prevailing outside temperature and selected weather compensation curve. Heater flow temperature is varied by controlling the on/off operation of the heater. | 1,5 |
| IV | TPI room thermostat, for use with on/off output heaters: An electronic room thermostat that controls both thermostat cycle rate and in-cycle on/off ratio of the heater proportional to room temperature. TPI control strategy reduces mean water temperature, improves room temperature control accuracy and enhances system efficiency. | 2 |
| V | Modulating room thermostat, for use with modulating heaters: An electronic room thermostat that varies the flow temperature of the water leaving the heater dependant upon measured room temperature deviation from room thermostat set point. Control is achieved by modulating the output of the heater. | 3 |
| VI | Weather compensator and room sensor, for use with modulating heaters: A heater flow temperature control that varies the flow temperature of water leaving the heater dependant upon prevailing outside temperature and selected weather compensation curve. A room temperature sensor monitors room temperature and adjusts the compensation curve parallel displacement to improve room comfort. Control is achieved by modulating the output of the heater. | 4 |
| VII | Weather compensator and room sensor, for use with on/off output heaters: A heater flow temperature control that varies the flow temperature of water leaving the heater dependant upon prevailing outside temperature and selected weather compensation curve. A room temperature sensor monitors room temperature and adjusts the compensation curve parallel displacement to improve room comfort. Heater flow temperature is varied by controlling the on/off operation of the heater. | 3,5 |
| VIII | Multi-sensor room temperature control, for use with modulating heaters: An electronic control, equipped with 3 or more room sensors that varies the flow temperature of the water leaving the heater dependant upon the aggregated measured room temperature deviation from room sensor set points. Control is achieved by modulating the output of the heater. | 5 |

| | | |
|---|---|---|
| IX | Heating demand control, for use with modulating heaters, which contains a heater flow temperature control that varies the flow temperature of water leaving the heater dependant upon prevailing outside temperature and selected weather compensation curve. On top of that a flow sensor is integrated along with two temperature sensors on the return and supply sides of the house installation. The heating demand control decides on a) when to run the heater and b) with which heater duty in order to compensate for any energy deficit between the demand and supply sides avoiding the inefficient tact operation of the heater and offering the highest comfort level. | 6 |

# 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* [3] */ 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**

| Clauses and subclauses of this EN | Requirements of Commission Regulation (EC) No 813/2013 | Qualifying remarks/Notes |
|---|---|---|
| Clause 5 | Annex II.1 (a) and (b) | |
| Not applicable | Annex II.2 (a) and (b) | |
| Not applicable | Annex II.3 | |
| Not applicable | Annex II.4 | |
| Not applicable | Annex II.5 (a), (b) and (c) | |
| Not applicable | Annex II Table 1 | |
| Not applicable | Annex II Table 2 | |
| Clause 5 | Annex III.2 | |
| Not applicable | Annex III.3 | |
| Clause 5 | Annex III.4 | |
| Not applicable | Annex III.5 | |
| Not applicable | Annex III Table 3 | |
| Not applicable | Annex III Table 4 | |
| Clause 5 | Annex III Table 5 | |
| Not applicable | Annex III Table 6 | |
| Not applicable | Annex III Table 7 | |

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

3) 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* [4] */ 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 |
|---|---|---|
| Clause 5 | Article 3, 1(a), Annex II, 1 | Energy efficiency classes |
| Not applicable | Article 3, 1(a), Annex II, 2 | Water heating energy classes |
| Not applicable | Article 3, 1(a), Annex III and IV | Sound power level |
| Clause 4 (for test conditions) | Article 3, 1(a), Annex III, 1.1 and Annex III, 3. | Tests conditions for measuring the rated heat output to be inserted in the Energy label for space heater |
| Clause 5 | Article 3, 1(a), Annex III, 1.1 and Annex III, 3. | Energy label for space heater |
| Clause 4 (for test conditions) | Article 3, 1(b), Annex IV, 1 and Annex IV, 5. | Tests conditions for measuring the data to be inserted in the product fiche for space heater |
| Not applicable | Article 3, 1(c), Annex V, 1. | 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.

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

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