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Gas-fired domestic appliance producing hot water - Part 6: Assessment of energy consumption of ad-sorption and ab-sorption heat pumps

Appareils domestiques produisant de l'eau chaude sanitaire utilisant les combustibles gazeux - Partie 6 : Évaluation de la consommation énergétique des pompes à chaleur à ad-sorption et ab-sorption

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Gas-fired domestic appliance producing hot water - Part 6: Assessment of energy consumption of ad-sorption and ab-sorption heat pumps

Appareils domestiques produisant de l'eau chaude sanitaire utilisant les combustibles gazeux - Partie 6 : Évaluation de la consommation énergétique des pompes à chaleur à ad-sorption et ab-sorption

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (prEN 13203-6:2015) has been prepared by Technical Committee CEN/TC 109 “Central heating boilers using gaseous fuels”, the secretariat of which is held by NEN.

This document is currently submitted to the CEN Enquiry.

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, ZB, ZC or ZD, which is an integral part of this document.

The safety operation of the boiler is not covered by this standard. Safety must be proved by means of the essential safety requirements of the Gas Appliances Directive 2009/142/EC. This may be achieved by compliance with the appropriate existing harmonized standards.

NOTE Useful standards are EN 15502 (all parts) and EN 12309 (all parts).

1 Scope

This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to sorption heat pumps connected to or including a domestic hot water storage tank. It applies to a package marketed as single unit or fully specified that have:

— a single gas burner for the heat pump and/or an additional gas burner for a peak load appliance;

— a gas heat input not exceeding 70 kW;

— a hot water storage tank capacity not exceeding 500 l.

FprEN 13203-1 sets out in qualitative and quantitative terms the performance in delivery of domestic hot water for a selected variety of uses. It also gives a system for presenting the information to the user.

The present document sets out a method for assessing the energy performance of the appliances. It defines a number of daily tapping cycles for each domestic hot water use, kitchen, shower, bath and a combination of these, together with corresponding test procedures, enabling the energy performances of different gas-fired appliances to be compared and matched to the needs of the user.

When the sorption heat pump cycle does not operate for domestic hot water production in the summer mode, the present standard is not applicable for energy performance assessment, EN 13203-2 should be used instead.

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.

FprEN 13203-1, *Gas fired domestic appliances producing hot water - Part 1: Assessment of performance of hot water deliveries*

EN 13203-2, *Gas-fired domestic appliances producing hot water - Part 2: Assessment of energy consumption*

3 Terms and definitions

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

3.1
control cycle
time cycle for keeping components and/or the storage tank (if any) of the domestic hot water circuit at predetermined temperature level, consists of an «ON» duration time during which the heating of the domestic hot water (by gas energy and/or auxiliary energy) is operating, and an «OFF» duration time during which no heating occurs

3.2
domestic water test temperature
temperature of the delivered water at which the tests are conducted

3.3
nominal domestic hot water heat input
Q_{nw}
value of the heat input stated by the manufacturer for the production of domestic hot water

Note 1 to entry: Q_{nw} is expressed in kilowatt (kW).

3.4
off mode
state of an appliance, selected by the user, in which domestic hot water cannot be provided

3.5
stand-by mode
operating state in which the appliance can provide domestic hot water at any time

Note 1 to entry: In the case of an appliance with a control cycle for keeping components and/or the storage tank (if any) of the domestic hot water circuit at predetermined temperature level, no tapping is made.

3.6
summer mode
conditions during which the appliance supplies energy only for the production of domestic hot water

3.7
storage tank
reservoir for domestic hot water

3.8
useful water
quantity of water delivered at the tap for which the temperature increase is in accordance with the requirement fixed for each individual delivery of the tapping cycles

3.9
wasted water
quantity of water delivered at the tap for which the temperature increase is not in accordance with the requirement fixed for each individual delivery of the tapping cycles

3.10
winter mode
conditions during which the appliance supplies energy for the production of domestic hot water and/or space heating

3.11
indoor ambient air
indoor ambient air is the heat source for a heat pump which absorbs heat by a heat exchanger in direct contact with the air inside a building without any dedicated duct

3.12
brine
heat transfer medium which has a freezing point depressed relative to water

3.13
sorption heat pump
encased assembly or assemblies designed as an appliance whose primary function is delivery of domestic hot water or domestic hot water and heating, where the primary function is dependent on circulation of fluid (refrigerant and/or solution) within the absorption, adsorption or refrigerant circuit(s)

3.14
gas-fired sorption heat pump combined with a gas-fired appliance
appliance which is either placed on the market or specified as a complete package to deliver safely and effectively domestic hot water and/or heating, comprising as relevant:

— gas-fired sorption heat pump;

— gas-fired appliance;

— ducts if appropriate;

— thermal store

3.15
ground heat source
heat source of a sorption heat pump for which a heat exchanger, vertically embedded into the ground, is used to extract heat from the surrounding soil or rock by way of a brine circuit through the evaporator

3.16
solar collector source
heat source of a sorption heat pump for which a solar thermal collector is used to capture radiation energy from the sun by way of a brine circuit through the evaporator.

3.17
useful water flow rate
flow rate of water delivered at the tap for which the temperature increase is in accordance with the requirement fixed for each individual delivery of the tapping cycles

3.18
useful water temperature
water temperature, expressed in degrees Celsius, delivered at the tap

3.19
appliance flow rate
flow rate delivered by the appliance before the mixing device, if applicable

3.20
appliance water temperature
T_d
water temperature, expressed in degrees Celsius, delivered by the appliance before the mixing device

4 General test conditions

4.1 Reference conditions

Unless otherwise stated, the general test conditions are as follows:

— cold water temperature: 10 °C:

  — maximum average variation over the test period: ± 2 K;

— cold water pressure: (2 ± 0,1) bar;

— ambient air temperature: 20 °C:

  — maximum average variation over the test period ± 1 K;

  — maximum variation during the tests ± 2 K;

— electrical supply voltage : (230 ± 2) V (single phase).

4.2 Specific heat source conditions

The tests shall be carried out at the test conditions specified in Table 1 as appropriate.

Table 1 — Test conditions for particular types of systems

Type of heat source	Heat source temperature (°C)	Range of ambient temperature for heat pump (°C)	Ambient temperature of storage tank [a] (°C)
Outside air (heat pump indoor) with air duct	7 ± 0,2 (6 ± 0,3)	20 ± 3	20 ± 3
Outside air (heat pump outdoor)	7 ± 0,2 (6 ± 0,3)	7 ± 3	20 ± 3
Exhaust air	20 ± 0,2 (12 ± 0,3)	20 ± 3	20 ± 3
Water (inlet)	10 ± 0,15	20 ± 3	20 ± 3
Brine (inlet)	0 ± 0,15	20 ± 3	20 ± 3
Ground heat source [b] (Brine, inlet)	7 ± 0,2	20 ± 3	20 ± 3
Solar collector source [c] (Brine, inlet)	12 ± 0,2	20 ± 3	20 ± 3

NOTE 1 All heat source temperatures are inlet temperatures in °C.

NOTE 2 All air temperatures in (brackets) are wet bulb temperatures in °C.

NOTE 3 Permissible external pressure difference and associated internal pressure difference at the outdoor heat exchanger as stated in the installation and/or operation manual in Pascal (Pa) for appliances with duct connection.

[a] In case of outside storage tank the temperature shall be (7 ± 0,2) °C.

[b] Applies to vertical ground heat exchanger with extraction rates lower than 35 W/m, for which brine return temperatures don't fall below 4 °C after 25 years of operation (VDI 4046-2:2001).

[c] Applies to aperture area to heat extraction ratios of > 3 m^2/kW for flat plate collectors and > 2 m^2/kW for vacuum tube collectors.

4.3 Measurement uncertainties

Except where otherwise stated in the clauses describing the tests, the uncertainties of measurements carried out shall be not greater than the maximum uncertainties indicated below.

The standard deviations shall be evaluated taking account of the various sources of uncertainty: contribution from the instrument, repeatability, calibration, ambient conditions:

— water rate: ± 1 %;

— gas rate: ± 1 %;

— time: ± 0,2 s;

— temperatures:

  — ambient air : ± 1 K;

  — air as heat source dry bulb temperature : ± 0,2 K;

  — air as heat source wet bulb temperature : ± 0,3 K;

  — water/brine as heat source: ± 0,15 K;

  — brine from ground or solar source : ± 0,2 K;

  — water: ± 0,5 K;

  — gas: ± 0,5 K;

— mass: ± 0,5 %;

— gas pressure: ± 1 %;

— gas calorific value: ± 1 %;

— gas density: ± 0,5 %;

— electrical energy: ± 2 %.

The stated measurement uncertainties relate to individual measurements. For measurements that combine a number of individual measurements, smaller uncertainties on the individual measurements may be necessary to ensure a total uncertainty within ± 2 % under the steady state conditions.

These uncertainties correspond to two standard deviations (2σ).

4.4 Test conditions

4.4.1 General

Except where otherwise stated, the appliance shall be tested under the following conditions.

The tests shall be carried out only in summer mode as defined in 3.6, and the appliance shall be set in summer mode.

The test conditions are given in Table 1.

If liquid heat transfer media 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.

When the gas-fired sorption heat pump combined with a gas-fired appliance does not operate in heat pump mode for domestic hot water production according to data in Table 1, the test shall be performed according to EN 13203-2 instead.

For all tests defined by this standard, the same adjustment of the appliance shall be maintained.

4.4.2 Test room

The package shall be installed in a well-ventilated, draught-free room (air speed less than 0,5 m/s).

The package shall be protected from direct solar radiation and radiation from heat generators.

If the package incorporates an air source outdoor heat exchanger a further test room is needed. The size of this test room shall be designed to avoid any resistance to air flow at the air inlet and air outlet orifices of the test object. The air flow through this room shall not cause any short circuit between the two orifices, and therefore the velocity of air flow at these two locations shall not exceed 1,5 m/s when the test object is switched off. The air velocity in the room shall also not be greater than the mean velocity through the unit inlet.

Unless otherwise stated in the technical documentation, the air inlet and air outlet orifices shall not be less than 1 m from the surfaces of the test room; this also applies to any measuring ducts.

For sorption heat pumps separated from the storage tank, the liquid flow rate has to be set on the liquid outlet side of the heat pump to the nominal flow rate specified in the installation and/or operation manual.

The sorption heat pump and/or package shall be installed and connected for the test as specified in the installation instructions.

Temperature and pressure measuring points shall be situated in order to obtain significant mean values.

Set points for internal control equipment of the unit such as thermostats, pressure switches or mixing valves shall be set to the values stated in the installation and/or operation instructions.

Air and entrained gases shall be removed from all water and other heat transfer liquid systems.

Each water pipe shall be installed in accordance with the installation instructions to the maximum stated length or 5 m whichever is shorter. Thermal insulation shall be applied to the pipes in accordance with the installation instructions.

4.4.3 Water supply

For the tests:

— the domestic water pressure is the static inlet pressure under dynamic conditions measured as close as possible to the appliance;

— the inlet and outlet temperatures of the domestic water shall be measured in the centre of the flow and as close as possible to the appliance.

The inlet temperatures are measured immediately upstream of the water inlet connection. Except where otherwise stated, the outlet temperatures shall be measured immediately downstream of the outlet connection or, in case of an appliance with spout delivery, by means of an immersed temperature measuring device, e.g. a u-tube fitted at the outlet of a tube of the same length as the minimum length of the spout normally supplied together with the appliance.

The hot water temperature shall be measured with a rapid response thermometer:

"Rapid response thermometer" means a measuring instrument with a response time such that 90 % of the final temperature rise, from 15 °C to 100 °C, is obtained within about 1 s, when the sensor is plunged into still water.

4.4.4 Steady state

Steady state operating conditions shall be regarded as established when the appliance operates for sufficient time to reach thermal stabilization. The steady state is reached when the water temperature at the outlet does not vary by more than ± 0,5 K.

NOTE This condition can be reached with a gas which is different from the specified test gas, provided that the appliance is supplied with the specified test gas for at least 5 min before the requirements are verified.

4.4.5 Initial adjustment of the appliance

The appliance shall be installed in accordance with the installation instructions.

The heat input shall be adjusted to within ± 2 % of the nominal domestic hot water heat input.

The delivered water temperature (T_d) at the appliance outlet shall be as follows (see Figures A.1 and A.2):

a) Appliances with an adjustable temperature: the tests shall be carried out at a temperature not greater than 65 °C, with a minimum temperature increase equal to or greater than 45 K above water inlet temperature;

b) Appliances with a fixed temperature: the tests shall be carried out at the temperature specified in the appliance documentation, with a minimum temperature increase equal to or greater than 45 K.

The same conditions of initial adjustment stated in the appliance documentation shall be used for all the tests.

These conditions shall be included in the test report.

4.4.6 Electrical supply

The appliance shall be supplied with the nominal voltage or a voltage included within the range of nominal voltages stated in the installation instructions.

5 Determination of the energy consumption of the appliance

5.1 General

This clause defines the test methods to be employed in determining the energy consumption of appliances.

5.2 Tapping cycles

All patterns define a 24 h measurement cycle and within that cycle the starting times and the total energy content (in kWh equivalent of hot water tapped) of each draw-off are defined.

Furthermore, the draw-off can be characterized in two ways, either “basin” type draw-off versus “continuous flow” draw-off.

The aim of the “basin” type is to arrive at an average temperature of the tub, so all supplied energy can be considered useful from the very beginning of the draw-off (minimum useful temperature increase is 0 K). The average temperature rising (ΔT desired) to be achieved during tapping, shall be for floor cleaning and bath 30 K and for the dish washes 45 K.

The aim of the “continuous flow” type is to use only the water with a minimum temperature. For the shower, household cleaning and large draw-offs a temperature rise of 30 K shall be reached before counting the useful energy. For the small draw-offs a temperature rise of 15 K shall be reached.

NOTE 1 The temperature rises (in K) stated above are equivalent to the temperatures (in °C) given by the load profiles tables in Regulations n° 811/2013, n° 812/2013, n° 813/2013 and n° 814/2013 based on 10 °C inlet water temperature. The tapping flow rates used to perform the different types of tapping of each of the seven tapping cycles defined by Table 2 to Table 8.

When the tapping rates result in a tapping period of less than 15 s the flow rate should be decreased such that the tapping period is (16 ± 1) s.

In the tapping cycles, the requirements for flow and temperatures are based on the delivery on the taps in a mix of hot and cold water. Under the conditions of the initial adjustment, the appliance itself produces hot water with a minimum temperature rise of 45 K.

To fulfil the requirements stated in Table 2 to Table 8 mixing hot water from the appliance with cold water of 10 °C at the tap is allowed either by using a mixing device (see Figure B.5) or by recalculating the minimum appliance flow rate (see 3.19) according to the following formula:

$$D_{\min} = D_{\text{useful}(\Delta T)} \cdot \frac{\Delta T_{\text{useful}}}{\Delta T_{\text{d}}} \quad (1)$$

where

$D_{\min}$ is the minimum test rig setting for the appliance flow rate of each individual tapping at temperature rise corresponding to ΔT_{d}, in l/min;

$D_{\text{useful }(\Delta T)}$ is the useful water flow rate according to Tables 2 to 8, in l/min;

ΔT_{d} is the delivered water temperature rise with a minimum of 45 K, in K;

ΔT_{useful} is the higher value between the temperature rise to be achieved and the minimum temperature rise for counting the useful energy according to Table 2 to Table 8, in K.

The tests shall be performed by using the useful flow rates defined by Table 2 to Table 8. If the appliance cannot deliver these flow rates, for instance due to the flow restrictor, it shall be checked that the requirements are fulfilled by checking that $D_{\min}$ is delivered.

If by design the appliance is fitted with a flow restrictor, the tests shall be carried out with this flow restrictor.