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Gas-fired domestic appliance producing hot water - Part 5: Assessment of energy consumption of gas fired appliances combined with electrical heat pump

Gasbeheizte Geräte für die sanitäre Warmwasserbereitung für den Hausgebrauch - Teil 5: Bewertung des Energieverbrauchs von Gasgeräten mit elektrischer Wärmepumpe

Appareils domestiques produisant de l'eau chaude sanitaire utilisant les combustibles gazeux - Partie 5: Evaluation de la consommation énergétique - Appareils à gaz combinés à une pompe à chaleur électrique

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Gas-fired domestic appliance producing hot water - Part 5: Assessment of energy consumption of gas fired appliances combined with electrical heat pump

Appareils domestiques produisant de l'eau chaude sanitaire utilisant les combustibles gazeux - Partie 5: Evaluation de la consommation énergétique des appareils utilisant les combustibles gazeux combinés à une pompe à chaleur électrique

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Foreword

This document (prEN 13203-5:2012) 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.

1 Scope

This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to both instantaneous and storage gas-fired appliances combined with electrical heat pump.

It applies to a package marketed as single unit or fully specified by a manufacturer that have:

— a gas heat input not exceeding 70 kW;

— a hot water storage capacity not exceeding 500 litres.

This European Standard EN 13203 is formed in several parts which cover aspects of domestic hot water production.

Standard EN 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. This first part complements EN 26, EN 89 and EN 625.

This Part 5 sets out a method for assessing the energy performance of gas fired appliances combined with heat pump with electrically driven compressor according to EN 16417.

This European standard does not apply for gas boilers with recovery systems using combustion products as heat source for the electrical heat pump.

When the electrical heat pump does not work for domestic hot water production in the summer period, the present standard is not applicable for energy performances assessing, EN 13203-2 must be used for energy performances assessing.

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 26, *Gas-fired instantaneous water heaters for sanitary uses production, fitted with atmospheric burners (Including Corrigendum 1998)*

EN 89, *Gas-fired storage water heaters for the production of domestic hot water.*

EN 625, *Gas-fired central heating boilers - Specific requirements for the domestic hot water operation of combination boilers of nominal heat input not exceeding 70 kW.*

EN 13203-1:2006, *Gas-fired domestic appliances producing hot water – Appliances not exceeding 70 kW heat input and 300 litres water storage capacity. Part 1: Assessment of performance of hot water deliveries.*

EN 13203-2, *Gas-fired domestic appliances producing hot water – Appliances not exceeding 70 kW heat input and 300 litres water storage capacity. Part 2: Assessment of energy consumption.*

EN 14511-3:2011, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 1: Tests methods.*

EN 16147, *heat pumps with electrically driven compressors – Testing and requirements for marking for domestic hot water units.*

3 Terms and definitions

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

3.1
control cycle
time cycle for keeping components and/or the 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 mean temperature
average temperature of the water delivered during the time Δt

$$T_m = \frac{1}{\Delta t}\int T \cdot dt$$

SYMBOL T_m

3.3
domestic water test temperature
temperature of the delivered water at which the tests are conducted

3.4
nominal domestic hot water heat input
value of the heat input stated by the manufacturer for the production of domestic hot water[1].

SYMBOL Q_{nw}

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

3.5
off mode
state of an appliance, selected by the user, in which domestic hot water can not be provided

3.6
stand-by mode
operating state in which the appliance can provide domestic hot water at any time. In the case of an appliance with a control cycle for keeping components and/or the tank (if any) of the domestic hot water circuit at predetermined temperature level, no tapping is made

3.7
summer mode
conditions during which the appliance supplies energy only for the production of domestic hot water

[1] The manufacturer is the organisation or company which assumes responsibility for the product.

3.8
tank (storage tank)
reservoir for domestic hot water and or central heating water

3.9
useful water
quantity of water delivered for which the temperature increase is in accordance with the requirement fixed for each individual delivery of the tapping cycles

3.10
wasted water
quantity of water delivered for which the temperature increase is not in accordance with the requirement fixed for each individual delivery of the tapping cycles

3.11
winter mode
conditions during which the appliance supplies energy for the production of domestic hot water and/or space heating

3.12
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

3.13
brine
heat transfer medium which has a freezing point depressed relative to water

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

— electrical heat pump;

— gas-fired appliance;

— ducts if appropriate;

— thermal store.

4 General test conditions

4.1 Reference conditions

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

— cold water temperature: (10 ± 2), in °C;

— cold water pressure: (2 ± 0,1), in bar;

— ambient air temperature: (20 ± 3), in °C;

— electrical supply voltage:

  — (230 ± 2), in V single phase;

  — (400 ± 4), in V three phases;

4.2 Specific heat source conditions

The tests shall be carried out at the test conditions specified in Tables 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 (°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 [a)]	20 ± 3
Exhaust air	20 ± 0,2 (12 ± 0,3)	20 ± 3 [a)]	20 ± 3 [a)]
Water (inlet)	10 ± 0,15	20 ± 3	20 ± 3
Brine (inlet)	0 ± 0,15	20 ± 3	20 ± 3
Direct evaporation	4 ± 0,5	20 ± 3	20 ± 3

[a)] In this case the ambient temperature of the heat pump is the same as the temperature of the heat source (the difference with EN 16147 is justified because of the possible installation of the appliance into a living room)

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 shall be indicated by the manufacturer in Pascal (Pa) for appliances with duct connection.

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 laboratory evaluates these standard deviations taking account of the various sources of uncertainty: contribution from the instrument, repeatability, calibration, ambient conditions etc.:

— water rate: ± 1 %;

— gas rate:± 1 %;

— time: ± 0,2 s;

— temperatures:

  — ambient air: ± 1 °C;

- air as heat source dry bulb temperature: ± 0,2°C;
- air as heat source wet bulb temperature: ± 0,3°C;
- water: ± 0,5 °C;
- gas: ± 0,5 °C;

— mass: ± 0,5 %;

— gas pressure: ± 2 %;

— 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 ± 5 % (2σ).

4.4 Test conditions

4.4.1 General

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

For combination boilers the tests are carried out only in summer mode.

The test conditions are given in Table 1.

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

4.4.2 Test installations

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

The package is protected from direct solar radiation.

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 by the manufacturer, the air inlet and air outlet orifices shall not be less than 1m from the surfaces of the test room; this also applies to any measuring ducts.

Any direct heat radiation (p. ex. solar radiation) from heating units in the test room onto the heat pump or onto the temperature measuring points shall be avoided

The setting of the external static pressure difference on the air side for heat pumps with duct connection is described in EN 14511-3:2011 (see sub-clauses 4.4.1.1 to 4.4.1.3).

For heat pumps separated from the tank, the liquid flow rate has to be set on the liquid outlet side of the heat pump to the nominal flow rate specified by the manufacturer.

The package shall be installed and connected for the test as specified by the manufacturer in his installation and operation manual.

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 by the manufacturer.

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

In the case of package incorporating a single split heat pump, the following installation conditions shall be complied with for the tests:

a) each refrigerant line shall be installed in accordance with the manufacturer's instructions. The length of each line must be between 5 m and 7,5 m;

b) the lines shall be installed so that the difference in elevation does not exceed 1 m;

c) thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions;

d) unless constrained by the design at least half of the interconnecting lines shall be exposed to the outdoor conditions with the rest of the lines exposed to the indoor conditions.

For indirect systems each water line shall be installed in accordance with the manufacturer's instructions to the maximum stated length or 5 m whichever is shorter. Thermal insulation shall be applied to the lines in accordance with the manufacturer's 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 are 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 are measured immediately downstream of the outlet connection or, in the 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 by the manufacturer.

The hot water temperature is 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 rate of change of the domestic hot water temperature at the appliance outlet has become less than the temperature fluctuation at constant water rate ΔT_2 according to sub-clause 3.8 of EN 13203-1:2006.

4.4.5 Initial adjustment of the appliance

The appliance is installed in accordance with the manufacturer's instructions.

The heat input shall be adjusted to within ± 2 % of the nominal domestic hot water heat input under the conditions prevailing at the time of the test.

The delivered water temperature at the appliance outlet is defined as follows (see Figures A.1.1 and A.1.2):

a) appliances with an adjustable temperature: the tests are 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 are carried out at the temperature specified by the manufacturer, with a minimum temperature increase equal to or greater than 45 K.

The same conditions of initial adjustment stated by the manufacturer shall be used for all the tests. These conditions shall be included in the test report.

4.4.6 Electrical supply

The appliance is supplied with the nominal voltage or a voltage included within the range of nominal voltages.

5 Determination of the energy consumption of appliances

5.1 General

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

5.2 Tapping cycles

5.2.1 General

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:

a) “Basin” type draw-off (bath, dishwash) versus “continuous flow” draw-offs (shower, etc).

   The aim of the former 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 latter start to be useful only from a certain temperature (minimum useful temperature increase is 15 K lower than the desired temperature), or

b) “Dish washing” type draw-off which is carried out with a water temperature increase of 45 K rather than the 30 K in a).

The tapping flow rates used to perform the different types of tapping of each of the five tapping cycles defined by Tables 3 to 7 should be taken as given by Table 2.

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

If by design of the appliance the test cannot be carried out with these low flow rates, the minimum flow rate for the ignition of the appliance is taken.

If by design the appliance is fitted with an excess flow valve, the tests are carried out with this excess flow rate.

Table 2 — Tapping flow rates

Type of tapping	Energy (kWh)	Hot water flow rates corresponding to a temperature rise of 45 K (l/min)
Household cleaning	0,105	3 ± 0,5
Small	0,105	3 ± 0,5
Floor cleaning	0,105	3 ± 0,5
Dish washing	0,315	4 ± 0,5
Dish washing	0,420	4 ± 0,5
Dish washing	0,735	4 ± 0,5
Large (cycle n°1)	0,525	4 ± 0,5
Shower	1,400	6 ± 0,5
Shower (cycles n°4 et n°5)	1,800	6 ± 0,5
Bath	3,605	10 ± 0,5
Bath (cycle n°4)	4,420	10 ± 0,5
Shower + Bath (cycle n°5)	6,240	16 ± 0,5

NOTE For all other temperature rises a proportional correction is applied to the hot water flow rate, as follows: K = (55 – 10) / (delivered water temperature defined by 4.3.5 – 10).

Table 3 — Tapping cycle n° 1

	Start (h.min)	Energy (kWh)	Type of delivery	Δ*T* desired (K), to be achieved during tapping	Min. Δ*T* (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.30	0,105	Small		15
3	08.30	0,105	Small		15
4	09.30	0,105	Small		15
5	11.30	0,105	Small		15
6	11.45	0,105	Small		15
7	12.45	0,315	Dish washing	45	0
8	18.00	0,105	Small		15
9	18.15	0,105	Household cleaning		30
10	20.30	0,420	Dish washing	45	0
11	21.30	0,525	Large		30
Total		2,1			

Equivalent hot water litres at 60 °C | 36 |