BS EN 13203-2:2015

BSI Standards Publication

Gas-fired domestic appliances producing hot water

Part 2: Assessment of energy consumption

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National foreword

This British Standard is the UK implementation of EN 13203-2:2015. It supersedes BS EN 13203-2:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/29, Gas-fired central heating boilers (domestic and non-domestic) and domestic gas-fired water heaters.

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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Compliance with a British Standard cannot confer immunity from legal obligations.

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Foreword

This document (EN 13203-2:2015) has been prepared by Technical Committee CEN/TC 109 “Central heating boilers using gaseous fuels”, the secretariat of which is held by NEN.

This 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of an identical text or by endorsement, at the latest by November 2015, and conflicting national standards shall be withdrawn at the latest by November 2015.

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 supersedes EN 13203-2:2006.

The main purpose of this revision is to provide a means of conforming to requirements of Commission Delegated Regulation (EC) n° 813/2013, (EC) n° 811/2013, (EC) n° 812/2013 and (EC) n° 814/2013.

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 Regulation(s).

For relationship with EU Regulation(s), see informative Annexes ZA, ZB, ZC or ZD, which are integral parts of this document.

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Introduction

The safety operation of the boiler or water heater is not covered by this standard. Safety should 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 26, EN 89, EN 15502-1, EN 15502-2-1 and EN 15502-2-2.

1 Scope

This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to both instantaneous and storage tank appliances; waters-heaters and combination boilers that have:

— a heat input not exceeding 70 kW; and

— a hot water storage tank capacity (if any) not exceeding 500 l.

In the case of combination boilers, with or without storage tank, domestic hot water production is integrated or coupled, the whole being marketed as a single unit.

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. 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. Where other technologies are combined with a gas-fired boiler or a water heater to produce domestic hot water, specific parts of EN 13203 apply.

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.

Not applicable.

3 Terms and definitions

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

3.1
storage tank
reservoir for domestic hot water

3.2
nominal domestic hot water heat input (Q_{nw})
value of the heat input for the production of domestic hot water stated in the instructions

— Symbol: Q_{nw}

— Unit: kilowatt (kW)

3.3
summer mode
conditions during which the appliance supplies energy only for the production of domestic hot water

3.4
winter mode
conditions during which the combination boiler supplies energy for the production of domestic hot water and space heating

3.5
domestic water test temperature
temperature of the delivered water at which the tests are conducted

3.6
control cycle
the 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

3.7
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

3.8
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

3.9
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.

3.10
off mode
state of an appliance, selected by the user, in which domestic hot water cannot be provided

3.11
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

3.12
useful water temperature
water temperature, expressed in degrees Celsius, delivered at the tap

3.13
appliance flow rate
flow rate delivered by the appliance before the mixing device, if applicable

3.14
appliance water temperature (T_d)
water temperature, expressed in degrees Celsius, delivered by the appliance before the mixing device

3.15
water temperature rise (ΔT_m) in K
difference between the useful water temperature and the cold water temperature, at which hot water is contributing to the reference energy as specified in the tapping cycles

3.16
water temperature rise for basin tapping types (ΔT_p) in K
difference between the useful water temperature and the cold water temperature, calculated as a mean value over the water

4 General test conditions

4.1 Reference conditions

Unless otherwise stated, the general test conditions shall be 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 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, etc.

— water rate: ± 1 %;

— gas rate: ± 1 %;

— time: ± 0,2 s;

— temperatures:

  — ambient: ± 1 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).

4.3 Test conditions

4.3.1 General

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

For combination gas boiler, the tests shall be carried out only in summer mode as defined in 3.3, and the appliance shall be set in summer mode.

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

4.3.2 Test room

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

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

4.3.3 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 shall be 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 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 together with the appliance.

The hot water temperature shall be measured with a rapid response temperature sensor.

"Rapid response temperature sensor" 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.

4.3.4 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.

4.3.5 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 Figure A.1 and Figure 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.

4.3.6 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) 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 are defined by Tables 1 to 7.

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 (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 Tables 1 to 7 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 3.13) 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 1 to 7, in l/min;

ΔT_{d} is the delivered water temperature rise with a minimum of 45 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 Tables 1 to 7.

The tests shall be performed by using the useful flow rates defined by Tables 1 to 7. 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.

Table 1 — Load profile S

Tapping n°	**Start (h.min)**	**Energy (kWh)**	**Type of draw off**	**Useful water flow rate at the tap (l/min)**	**ΔT_{p} to be achieved during tapping[a] (K)**	**Minimum ΔT_{m} for counting useful energy (K)**
1	07.00	0,105	Small	3		15
2	07.30	0,105	Small	3		15
3	08.30	0,105	Small	3		15
4	09.30	0,105	Small	3		15
5	11.30	0,105	Small	3		15
6	11.45	0,105	Small	3		15
7	12.45	0,315	Dish washing n°1	4	45	0
8	18.00	0,105	Small	3		15
9	18.15	0,105	Household cleaning	3		30
10	20.30	0,420	Dish washing n°2	4	45	0
11	21.30	0,525	Large	5		35
Q_{ref}		2,100				

[a] On continuous basis

Equivalent hot water litres at 60°C | 36 |

Table 2 — Load profile M

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	0,105	Small	3		15
2	07.05	1,400	Shower n°1	6		30
3	07.30	0,105	Small	3		15
4	08.01	0,105	Small	3		15
5	08.15	0,105	Small	3		15
6	08.30	0,105	Small	3		15
7	08.45	0,105	Small	3		15
8	09.00	0,105	Small	3		15
9	09.30	0,105	Small	3		15
10	10.30	0,105	Floor cleaning	3	30	0
11	11.30	0,105	Small	3		15
12	11.45	0,105	Small	3		15
13	12.45	0,315	Dish washing n°1	4	45	0
14	14.30	0,105	Small	3		15
15	15.30	0,105	Small	3		15
16	16.30	0,105	Small	3		15
17	18.00	0,105	Small	3		15
18	18.15	0,105	Household cleaning	3		30
19	18.30	0,105	Household cleaning	3		30
20	19.00	0,105	Small	3		15
21	20.30	0,735	Dish washing n°3	4	45	0
22	21.15	0,105	Small	3		15
23	21.30	1,400	Shower n°1	6		30
Q_{ref}		5,845				

[a] On continuous basis

Equivalent hot water litres at 60 °C | 100,2 |

Table 3 — Load profile L

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	0,105	Small	3		15
2	07.05	1,400	Shower n°1	6		30
3	07.30	0,105	Small	3		15
4	07.45	0,105	Small	3		15
5	08.05	3,605	Bath n°1	10	30	0
6	08.25	0,105	Small	3		15
7	08.30	0,105	Small	3		15
8	08.45	0,105	Small	3		15
9	09.00	0,105	Small	3		15
10	09.30	0,105	Small	3		15
11	10.30	0,105	Floor cleaning	3	30	0
12	11.30	0,105	Small	3		15
13	11.45	0,105	Small	3		15
14	12.45	0,315	Dish washing n°1	4	45	0
15	14.30	0,105	Small	3		15
16	15.30	0,105	Small	3		15
17	16.30	0,105	Small	3		15
18	18.00	0,105	Small	3		15
19	18.15	0,105	Household cleaning	3		30
20	18.30	0,105	Household cleaning	3		30
21	19.00	0,105	Small	3		15
22	20.30	0,735	Dish washing n°3	4	45	0
23	21.00	3,605	Bath n°1	10	30	0
24	21.30	0,105	Small	3		15
Q_{ref}		11,655				

[a] On continuous basis

Equivalent hot water litres at 60 °C | 199,8 |

Table 4 — Load profile XL

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	0,105	Small	3		15
2	07.15	1,820	Shower n°2	6		30
3	07.26	0,105	Small	3		15
4	07.45	4,420	Bath n°2	10	30	0
5	08.01	0,105	Small	3		15
6	08.15	0,105	Small	3		15
7	08.30	0,105	Small	3		15
8	08.45	0,105	Small	3		15
9	09.00	0,105	Small	3		15
10	09.30	0,105	Small	3		15
11	10.00	0,105	Small	3		15
12	10.30	0,105	Floor cleaning	3	30	0
13	11.00	0,105	Small	3		15
14	11.30	0,105	Small	3		15
15	11.45	0,105	Small	3		15
16	12.45	0,735	Dish washing n°3	4	45	0
17	14.30	0,105	Small	3		15
18	15.00	0,105	Small	3		15
19	15.30	0,105	Small	3		15
20	16.00	0,105	Small	3		15
21	16.30	0,105	Small	3		15
22	17.00	0,105	Small	3		15
23	18.00	0,105	Small	3		15
24	18.15	0,105	Household cleaning	3		30
25	18.30	0,105	Household cleaning	3		30
26	19.00	0,105	Small	3		15
27	20.30	0,735	Dish washing n°3	4	45	0
28	20.46	4,420	Bath n°2	10	30	0
29	21.15	0,105	Small	3		15
30	21.30	4,420	Bath n°2	10	30	0
Q_{ref}		19,070				

[a] On continuous basis

Equivalent hot water litres at 60°C | 325 |

Table 5 — Load profile XXL

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	0,105	Small	3		15
2	07.15	1,820	Shower n°2	6		30
3	07.26	0,105	Small	3		15
4	07.45	6,240	Shower + bath	16	30	0
5	08.01	0,105	Small	3		15
6	08.15	0,105	Small	3		15
7	08.30	0,105	Small	3		15
8	08.45	0,105	Small	3		15
9	09.00	0,105	Small	3		15
10	09.30	0,105	Small	3		15
11	10.00	0,105	Small	3		15
12	10.30	0,105	Floor cleaning	3	30	0
13	11.00	0,105	Small	3		15
14	11.30	0,105	Small	3		15
15	11.45	0,105	Small	3		15
16	12.45	0,735	Dish washing n°3	4	45	0
17	14.30	0,105	Small	3		15
18	15.00	0,105	Small	3		15
19	15.30	0,105	Small	3		15
20	16.00	0,105	Small	3		15
21	16.30	0,105	Small	3		15
22	17.00	0,105	Small	3		15
23	18.00	0,105	Small	3		15
24	18.15	0,105	Household cleaning	3		30
25	18.30	0,105	Household cleaning	3		30
26	19.00	0,105	Small	3		15
27	20.30	0,735	Dish washing n°3	4	45	0
28	20.46	6,240	Shower + bath	16	30	0
29	21.15	0,105	Small	3		15
30	21.30	6,240	Shower + bath	16	30	0
Q_{ref}		24,530				

[a] On continuous basis

Equivalent hot water litres at 60 °C	420

Table 6 — Load profile 3XL

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	11,2	General use n°3	48		30
2	08.01	5,04	General use n°8	24		15
3	09.00	1,68	General use n°9	24		15
4	10.30	0,84	General use n°10	24	30	0
5	11.45	1,68	General use n°9	24		15
6	12.45	2,52	General use n°11a	32	45	0
7	15.30	2,52	General use n°11	24		15
8	18.30	3,36	General use n°12	24		15
9	20.30	5,88	General use n°13	32	45	0
10	21.30	12,04	General use n°5	48		30
Q_{ref}		46,76				
[a] On continuous basis						

Equivalent hot water litres at 60 °C | 800 |

Table 7 — Load profile 4XL

Tapping n°	Start (h.min)	Energy (kWh)	Type of draw off	Useful water flow rate at the tap (l/min)	ΔT_p to be achieved during tapping[a] (K)	Minimum ΔT_m for counting useful energy (K)
1	07.00	22,4	General use n°6	96		30
2	08.01	10,08	General use n°2	48		15
3	09.00	3,36	General use n°12a	48		15
4	10.30	1,68	General use n°9a	48	30	0
5	11.45	3,36	General use n°12a	48		15
6	12.45	5,04	General use n°8b	64	45	0
7	15.30	5,04	General use n°8a	48		15
8	18.30	6,72	General use n°1	48		15
9	20.30	11,76	General use n°4	64	45	0
10	21.30	24,08	General use n°7	96		30
Q_{ref}		93,52				
[a] On continuous basis						

Equivalent hot water litres at 60 °C | 1600 |

There are seven different tapping cycles, depending on the use.

For each use, the tapping cycle(s) is (are) based respectively on Tables 1, 2, 3, 4, 5, 6 and 7. Each individual tapping of the load profiles shall be completed, that means the valve shall be closed, and a delay of at least one minute is required, before starting the following delivery.

Beginning and ending of the tapping cycles:

— for appliances with no energy consumption between deliveries (gas or electricity), the measured programme starts at 07h00 with the appliance cold and finishes when the burner is extinguished after the 21h30 tapping (see Figure A.3).

— for appliances with energy consumption between deliveries (gas or electricity), the tapping start with the tapping at 21h30. The measured cycles start from the time the burner is extinguished following the 21h30 delivery. The measured cycles end when the burner is extinguished following the last tapping at 21h30 on the next day.

It shall be ensured that the thermal stabilization at the beginning and at the end of the test is met.

NOTE 2 The above indicated test conditions ensure that the test results are equivalent to the required measurement conditions of Regulations n° 811/2013, n° 812/2013, n° 813/2013 and n° 814/2013.

NOTE 3 This measurement can be performed after a 24 h preliminary tapping cycle in order to ensure the thermal stabilization.

5.3 Measurement of the energy recovered by the useful water

The appliance shall be installed and adjusted in the initial state conditions and in the initial adjustment conditions defined in 4.3.5.

The useful energy recovered by the water Q_{H2O} (kWh) is given by the formula:

$$Q_{H_2O} = c_w \sum_{i=1}^{n} \int_0^{t_i} D_i \cdot \Delta T_i(t)\, dt \qquad (2)$$

where

n is the number of draw offs;

D_i is the water rate delivered, in l/min;

ΔT_i (t) is the instantaneous temperature rise during the tapping, in K;

t_i is the tapping duration of the useful water, in min;

c_w Is equal to $1{,}163.10^{-3}$ is the specific heat capacity of water, in kWh/l.K.

The useful energy recovered at each individual tapping shall be set against the values given in Tables 1, 2, 3, 4, 5, 6 and 7.

For each individual tapping, the accuracy of the value shall be ± 10 Wh or ± within 2 % of the energy content of this specific individual tapping. For the overall tapping cycle the accuracy of the value shall be within ± 2 %.

5.4 Calculation of gas energy

5.4.1 Calculation of daily gas energy consumption in summer mode

The daily gas energy consumption in summer mode shall be calculated according to the following formula:

$$Q_{\text{gas,S}} = \frac{V_{\text{g}} \cdot \text{K} \cdot \text{NCV} \cdot Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}} \tag{3}$$

where

$Q_{\text{gas,S}}$ is the daily gas energy consumption in summer mode calculated using NCV, in kWh;

V_{g} is the measured gas consumption during the tapping cycle, in m^3;

NCV is the net calorific value (at 15 °C and 1013,25 mbar), in kWh/m^3;

Q_{H2O} is the measured energy recovered by the water according to 5.3, in kWh;

Q_{ref} is the total delivered energy of used tapping cycle , value from Tables 1, 2, 3, 4, 5, 6 and 7, in kWh.

and

$$\text{K} = \frac{p_{\text{a}} + p_{\text{g}}}{1013{,}25} \cdot \frac{288{,}15}{T_{\text{g}} + 273{,}15} \tag{4}$$

with

p_{a} is the atmospheric pressure, in mbar;

p_{g} is the gas pressure, in mbar;

T_{g} is the gas temperature, in °C.

5.4.2 Calculation of daily gas energy consumption in winter mode

For the dedicated water heaters $Q_{\text{gas,W}}$ is equal to $Q_{\text{gas,S}}$.

For the combination boilers, the daily gas energy consumption in winter mode shall be calculated according to the following formula:

$$Q_{\text{gas,W}} = \frac{Q_{\text{gas,S}}}{1 + 0{,}5 \cdot \left[\frac{\eta_{\text{CH-nom}} \times Q_{\text{gas,S}}}{Q_{\text{ref}}} - 1 \right]} \tag{5}$$

where

$Q_{\text{gas,W}}$ is the daily gas energy consumption calculated in winter mode using NCV, in kWh;

$Q_{\text{gas,S}}$ is the daily gas energy consumption calculated in summer mode using NCV according to 5.4.1, in kWh;

$\eta_{\text{CH-nom}}$ is the useful efficiency at nominal heat input and at an average temperature of 70 °C for the space heating function;

Q_{ref} is the total energy delivered of the tapping cycle used, value from Tables 1, 2, 3, 4, 5, 6 and 7, in kWh.

NOTE Unlike water heaters combination boilers have two functions in the winter mode, space heating and domestic hot water. They switch between space heating and domestic hot water functions to fulfil demands as required by the consumer.

In the summer mode the combination boiler is 24 h in domestic hot water mode or standby mode.

The heat engine for a combination boiler in winter mode spends most of the demand time on space heating, outside any night (or day) set-back periods (which require a lower room temperature and hence heating load).

When a combination boiler switches from space heating to domestic hot water mode and back to space heating the standby losses usually generated from the domestic hot water mode are not lost but are instead used in the space heating mode.

That means combination heaters have lower domestic hot water heat losses in winter mode than in summer mode.

These energy savings benefits of combination boilers will be taken in account.

5.4.3 Daily gas energy consumption seasonally weighted

The daily gas energy consumption is weighted, to take into account both summer and winter modes, by the following formula:

$$Q_{\text{gas,p}} = Q_{\text{gas,W}} \cdot \frac{D_{\text{W}}}{D_{\text{W}} + D_{\text{S}}} + Q_{\text{gas,S}} \cdot \frac{D_{\text{S}}}{D_{\text{W}} + D_{\text{S}}} \quad (6)$$

with

$Q_{\text{gas,p}}$ is the weighted daily gas energy consumption calculated using NCV, in kWh;

$Q_{\text{gas,W}}$ is the daily gas energy consumption calculated in winter mode using NCV, in kWh;

$Q_{\text{gas,S}}$ is the daily gas energy consumption in summer mode calculated using NCV, in kWh;

D_{W} is the number of days of winter mode, this number is equal to 200;

D_{S} is the number of days of summer mode, this number is equal to 165.

5.5 Calculation of daily electrical energy

The daily electrical energy of all the electrical auxiliaries necessary to achieve the tapping programme(s) at nominal use as described in the appliance documentation will be measured even if these auxiliaries are not integrated in the appliance.

Where an electrical auxiliary (e.g. a pump) necessary for the delivery of hot water is not included as an integral part of the appliance, then the essential characteristics of the component shall be specified in the appliance installation instructions. An appropriate component shall be used for test procedures.

The measurement of the electrical consumption starts at the same time and finishes at the same time as the measurement of the gas consumption.

This measurement shall be corrected according to the following formula:

$$E_{\text{elecco}} = E_{\text{elecmes}} \cdot \frac{Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}} \quad (7)$$

where

E_{elecco} is the corrected total electrical energy, in kWh;

$E_{elecmes}$ is the measured total electrical energy, in kWh;

Q_{H2O} is the measured energy delivered to the water according to 5.3, in kWh;

Q_{ref} is the total delivered energy of used tapping cycle , value from Tables 1, 2, 3, 4, 5, 6 and 7, in kWh.

5.6 Measurement of energy consumption in standby mode

5.6.1 General

Unless specified, the consumed energy in standby mode shall be measured for a 24 h period without tapping.

However:

— for the appliances without a control cycle the gas and auxiliary energy consumption may be measured for a duration time equal to 1 h;

— for the appliances with repeated control cycles for a 24 h period, the gas and auxiliary energy consumption may be measured for a duration time (t_a) equal to one or several control cycles, once the appliance is operating in a regular manner (see Figure A.5).

5.6.2 Calculation of daily gas energy consumption in standby mode

The daily consumption of gas in standby mode shall be calculated according to the following formula:

$$Q_{gas.stb} = V_g \cdot K \cdot NCV \cdot \frac{24}{t_a} \quad (8)$$

where

$Q_{gas.stb}$ is the daily gas energy consumption in standby mode calculated using NCV, in kWh;

V_g is the measured gas consumption during the test, in m^3;

NCV is the net calorific value (at 15 °C and 1013,25 mbar), in kWh/m^3;

t_a is the duration of the test in hour (t_a = 1 h for the appliances without control cycle).

and

$$K = \frac{p_a + p_g}{1013,25} \cdot \frac{288,15}{T_g + 273,15} \quad (9)$$

with

p_a is the atmospheric pressure, in mbar;

p_g is the gas pressure, in mbar;

T_g is the gas temperature, in °C.

5.6.3 Calculation of daily auxiliary energy in standby mode

The daily consumption of auxiliary energy in standby mode shall be calculated according to the following formula:

$$E_{\text{elecco.stb}} = E_{\text{elecmes.stb}} \cdot \frac{24}{t_{\text{a}}} \tag{10}$$

where

$E_{\text{elecco.stb}}$ is the daily consumption of auxiliary energy in standby mode, in kWh;

$E_{\text{elecmes.stb}}$ is the auxiliary energy measured during the test in standby mode, in kWh;

t_{a} is the duration of the test in hour (t_{a} = 1 h for the appliances without control cycle).

5.7 Measurement of daily auxiliary energy consumption in off mode

The auxiliary energy consumption is measured for a duration time equal to 1 h.

The daily consumption of auxiliary energy in off mode shall be calculated according to the following formula:

$$E_{\text{elecco.off}} = E_{\text{elecmes.off}} \cdot 24 \tag{11}$$

where

$E_{\text{elecco.off}}$ is the daily consumption of auxiliary energy in off mode, in kWh;

$E_{\text{elecmes.off}}$ is the auxiliary energy measured during the test in off mode, in kWh.

6 Determination of the wasted water

The total quantity of the useful water (V_{u}) is equal to the sum of the useful water quantities for the declared tapping cycle of 5.2.

$$V_{\text{u}} = \sum_{\text{i=1}}^{\text{n}} \int_{0}^{t_{\text{u,i}}} d_{\text{i}}(t)\,\text{dt} \tag{12}$$

where

V_{u} is the total quantity of useful water, in l;

$d_{\text{i}}(t)$ is the water rate as a function of time, delivered in l/min;

$t_{u,i}$ is the tapping duration of the useful water, in min;

i is the number of draw-off i in the tapping cycle of 5.2;

n is the last draw-off in the tapping cycle of 5.2.

The total quantity of the wasted water (V_{w}) is equal to the sum of the wasted water quantities for all tapping in the declared tapping cycle of 5.2.

$$V_{\text{w}} = \sum_{\text{i=1}}^{\text{n}} \int_{0}^{t_{\text{w,i}}} d_{\text{i}}(t)\,\text{dt} \tag{13}$$

where

V_{w} is the total quantity of wasted water in l;

d_i (t) is the water rate as a function of time, delivered in l/min;

$t_{w,i}$ is the tapping duration of the wasted water in min;

i is the number of draw-off in the tapping cycle of 5.2;

n is the last draw-off in the tapping cycle of 5.2.

This value (R) of the wasted water of the tapping cycle is expressed in percentage of the overall quantity of the useful water.

$$R = \frac{V_w}{V_u + V_w} \cdot 100 \quad (14)$$

where

V_w is the total quantity of wasted water, in l;

V_u is the total quantity of useful water, in l;

R is the percentage of the wasted water.

7 Eco design Related Products Data

7.1 Water heating energy efficiency

The water heating energy efficiency (η_{wh}), in %, using GCV and including primary energy for electricity is calculated as:

— For appliances without smart control:

$$\eta_{wh} = \frac{Q_{ref}}{(Q_{fuel} + CC \cdot E_{elecco}) + Q_{cor}} \cdot 100 \quad (15)$$

— For appliances with smart control:

$$\eta_{wh} = \frac{Q_{ref}}{(Q_{fuel} + CC \cdot E_{elecco}) \cdot (1 - SCF \cdot smart) + Q_{cor}} \cdot 100 \quad (16)$$

where

Q_{ref} is the total energy delivered of the tapping cycle used, value from Tables 1, 2, 3, 4, 5, 6 and 7, in kWh.

CC is the conversion coefficient' (CC) means a coefficient reflecting the estimated average EU generation efficiency referred to in Directive 2006/32/EC of the European Parliament and of the Council; the value of the conversion coefficient is CC = 2,5.

E_{elecco} is the consumption of electricity for water heating over 24 consecutive hours under the declared load profile, expressed in kWh, in terms of final energy. See 5.5.

Q_{fuel} is the daily fuel consumption for domestic hot water over 24 consecutive hours under the declared load profile, expressed in kWh, in terms of GCV.

where

$$Q_{\text{fuel}} = Q_{\text{gas,p}} \cdot \frac{\text{GCV}}{\text{NCV}} \tag{17}$$

where

$Q_{\text{gas,p}}$ is the daily gas energy consumption seasonally weighted kWh calculated using Net Calorific Value (NCV). See 5.4.3;

GCV is the gross calorific value (at 15 °C and 1013,25 mbar), in kWh/m^3;

NCV is the net calorific value (at 15 °C and 1013,25 mbar), in kWh/m^3;

SCF smart control factor (SCF) means the water heating energy efficiency gain due to smart control (see Regulation n°814/2013, Annex IV, clause 4);

smart is the smart control coefficient, is equal to 0 without smart control or 1 with smart control;

Q_{cor} is the ambient correction term, is equal to 0 for load profiles 2XL to 4XL, or for load profiles 3XS to XL is equal to the following formula:

NOTE For water heaters, $Q_{\text{fuel}} = Q_{\text{gas,p}}$.

$$Q_{\text{cor}} = -0{,}23 \cdot \left(Q_{\text{fuel}} \cdot \left(1 - SCF \cdot smart\right) - Q_{\text{ref}}\right) \tag{18}$$

7.2 Annual fuel consumption (AFC)

The annual fuel consumption AFC in GJ in terms of GCV shall be calculated according to the following formula:

$$\text{AFC} = 0{,}6 \cdot \left(D_{\text{W}} + D_{\text{S}}\right) \cdot \left[Q_{\text{fuel}} \cdot \left(1 - SCF \cdot smart\right) + Q_{\text{cor}}\right] \cdot \frac{3{,}6}{1000} \tag{19}$$

where

D_{W} is the number of days of winter mode, this number is equal to 200;

D_{S} is the number of days of summer mode, this number is equal to 165;

SCF smart control factor (SCF) means the water heating energy efficiency gain due to smart control (see Regulation n°814/2013, Annex IV, clause 4);

smart is the smart control coefficient, is equal to 0 without smart control or 1 with smart control;

Q_{cor} is the ambient correction term, is equal to 0 for load profiles 2XL to 4XL, or equal to (see 7.1) for load profiles 3XS to XL.

NOTE Factor 0,6 represents a factor to calculate the yearly gas consumption.

7.3 Annual electricity consumption (AEC)

The annual electricity consumption AEC in kWh shall be calculated according to the following formula:

$$AEC = 0{,}6 \cdot (D_{\text{w}} + D_{\text{s}}) \cdot \left[E_{\text{elecco}} \cdot (1 - SCF \cdot smart) + \frac{Q_{\text{cor}}}{CC}\right] \tag{20}$$

where

E_{elecco} is the consumption of electricity for water heating over 24 consecutive hours under the declared load profile, expressed in kWh in terms of final energy. See 5.5;

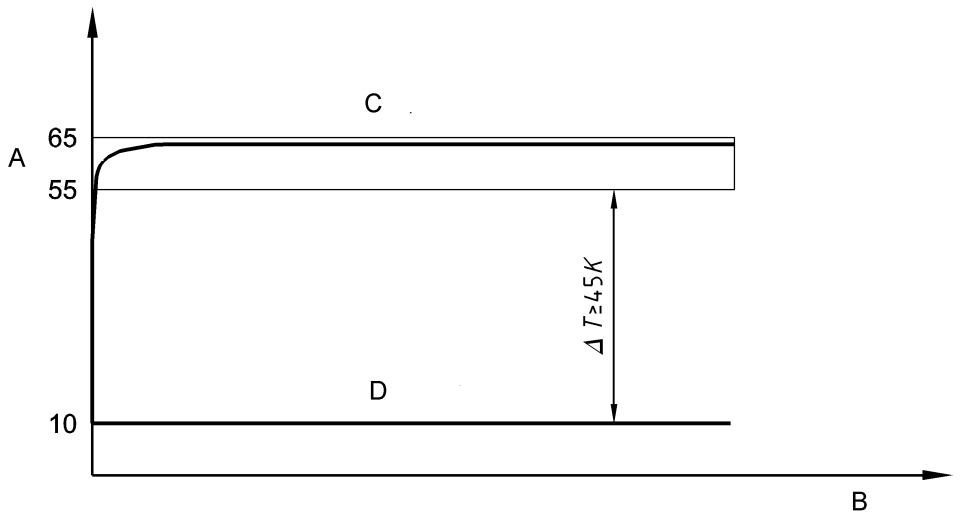
NOTE 1 Factor 0,6 represents a factor to calculate the yearly electricity consumption.

NOTE 2 Formula (21) below is wrong because (Q_{cor}) is based on gas consumption and needs to be corrected for electrical consumption. Formula (20) above will be used:

$$\mathrm{AEC} = 0{,}6 \cdot \left(D_{\mathrm{W}} + D_{\mathrm{S}}\right) \cdot \left[E_{\mathrm{elecco}} \cdot \left(1 - SCF \cdot smart\right) + \frac{E_{\mathrm{elecco}}}{Q_{\mathrm{gas,p}}} \cdot \frac{Q_{\mathrm{cor}}}{CC} \right] \quad (21)$$

Annex A
(informative)

Test conditions



Key

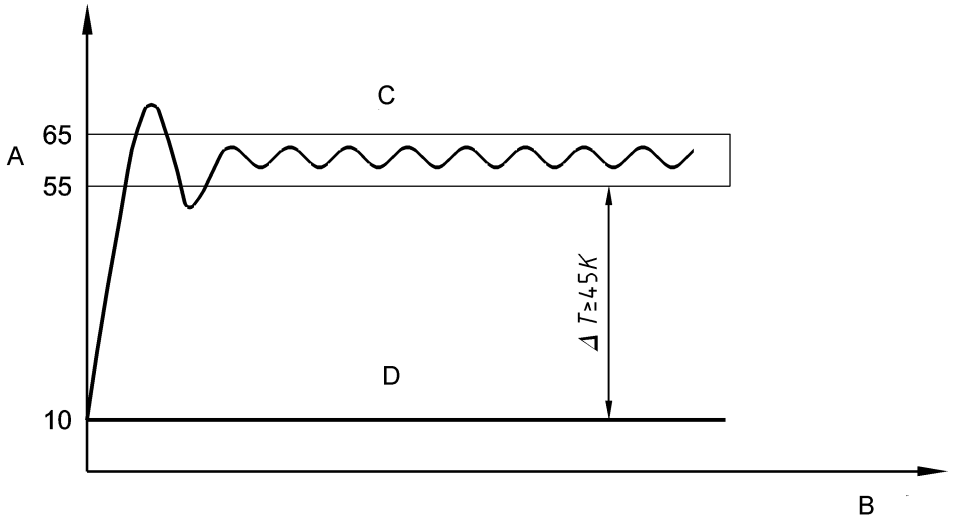
A temperature (°C)

B time (min)

C hot water

D cold water

Figure A.1 — Initial adjustment of the appliance with storage tank maintained in temperature



Key

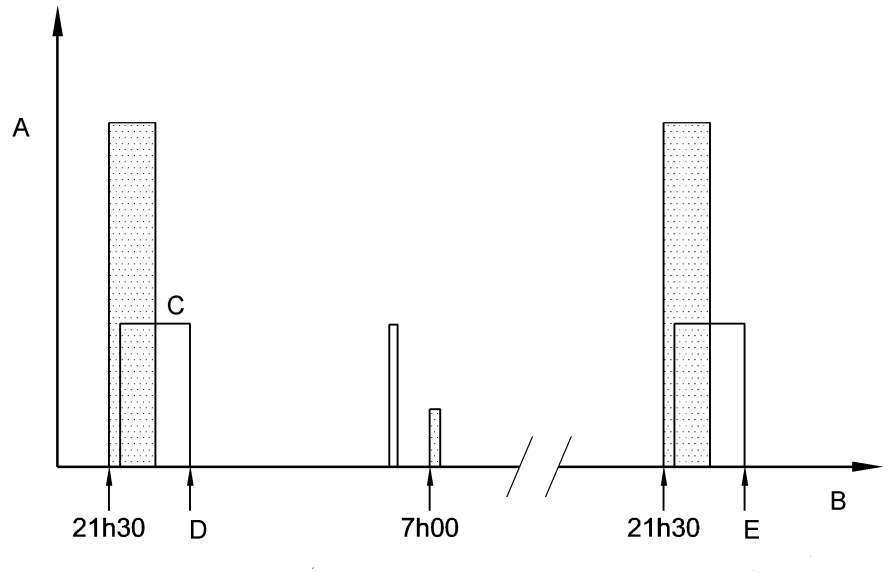
A temperature (°C)

B time (min)

C hot water

D cold water

Figure A.2 — Initial adjustment of the appliance without storage tank maintained in temperature



Key

A delivered elementary energy (kWh)

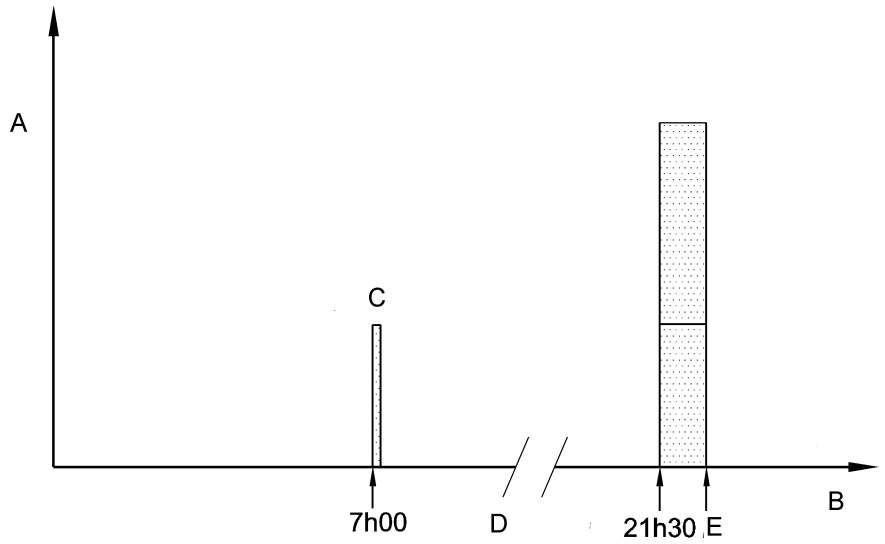
B time (h.min)

C gas rate

D beginning of the measurement programme

E end of the measurement programme

Figure A.3 — Tapping cycle – Test cycle for measurement of the energy consumption of the appliance with storage tank maintained in temperature



Key

A delivered elementary energy (kWh)

B time (h.min)

C gas rate

D beginning of the measurement programme

E end of the measurement programme

Figure A.4 — Tapping cycle – Test cycle for measurement of the energy consumption of the appliance without storage tank maintained in temperature

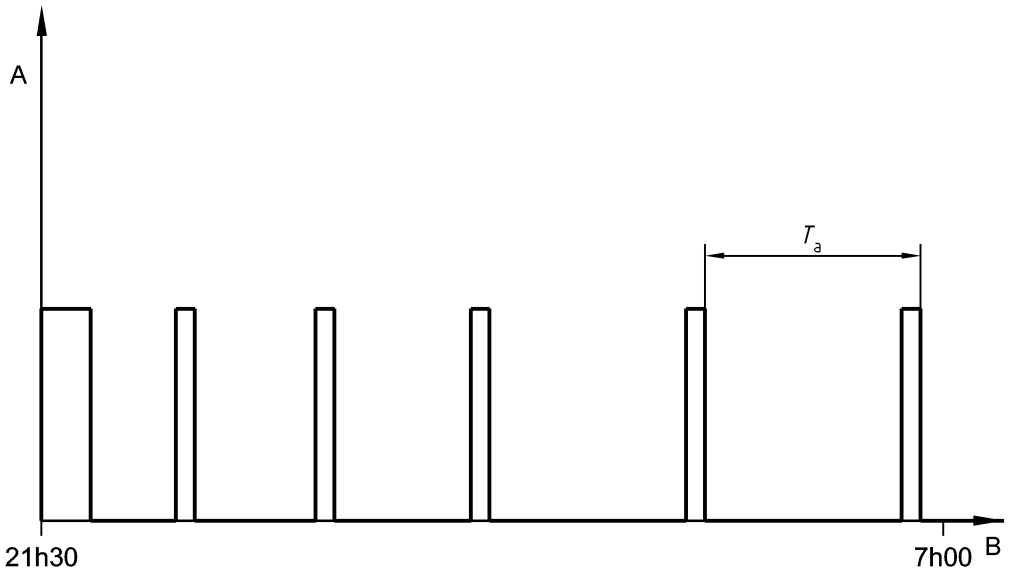


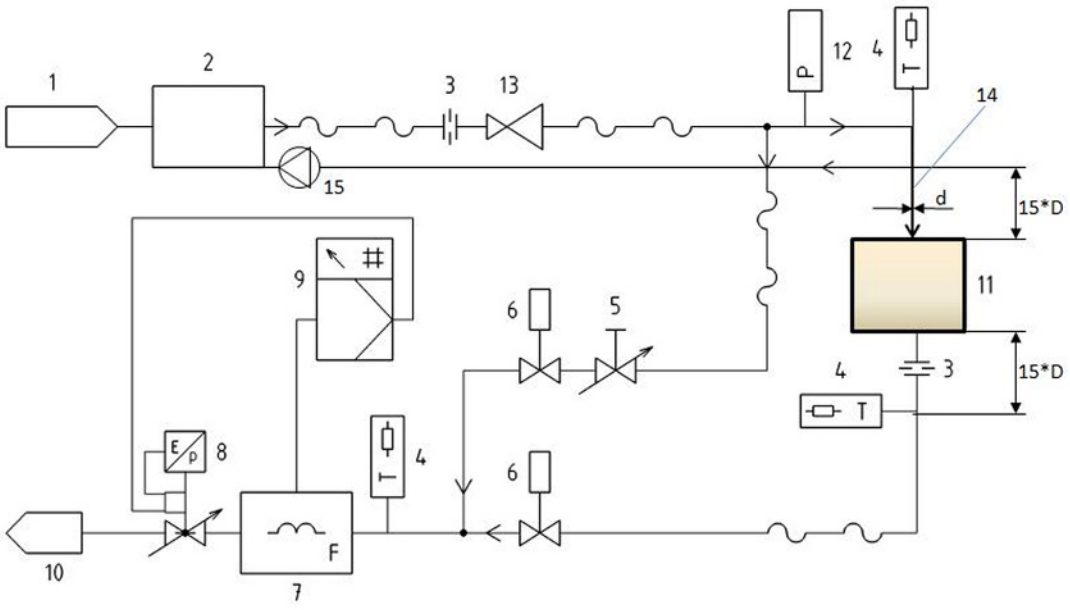
Figure A.5 — Standby mode with control cycles

Annex B
(informative)

Test rig and measurement devices

B.1 General

A general diagram of a possible test rig is shown in Figure B.1.



Key

1 water
2 preparator of water at 10 °C
3 diaphragm to homogenise the temperature and pressure profile across the tube diameter
4 temperature measurement device
5 equilibrium valve
6 electrovalve
7 flowmeter
8 control valve
9 rate control
10 drain
11 appliance in test
12 pressure measurement device
13 pressure control
14 cold water connection part consist of stainless steel
15 circulator of cold water circuit

Figure B.1 — Example of test rig

B.2 Pressure measurement

An example of the pressure measurement device is shown in Figure B.2. The lengths of the pipe upstream and downstream of the pressure measurement device are 15D and 5D, where (D) is the diameter of the pipe.

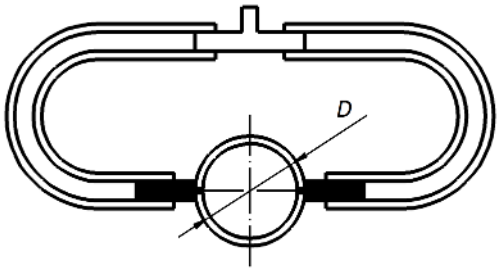


Figure B.2 — Example of pressure measurement device

B.3 Temperature measurement

Temperature sensors used in the test rig could be:

— Thermocouples of type T, class 1, diameter of 0,5 mm;

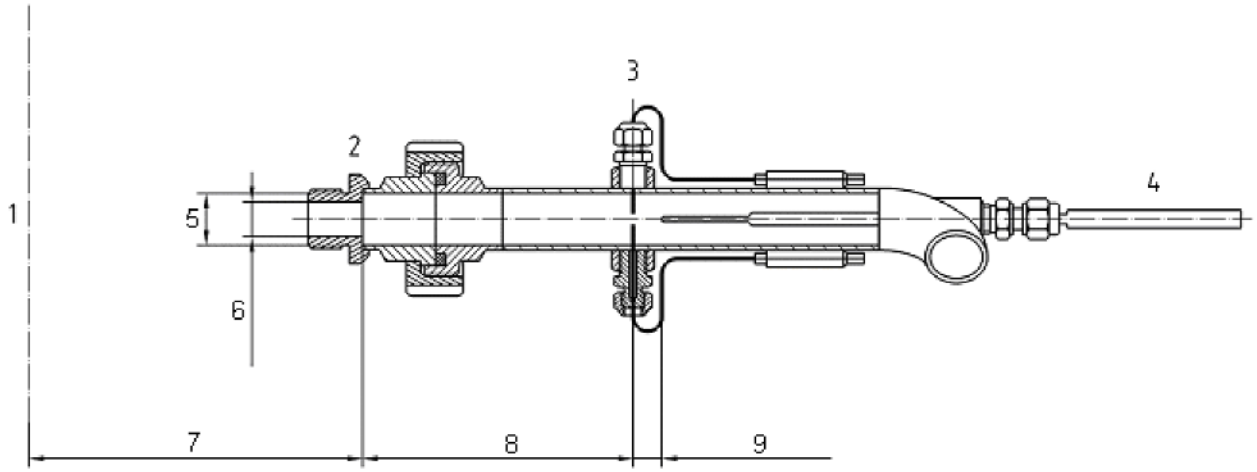
— Low inertia Pt 100 probe, diameter of 2 mm.

The temperature measurement device could be equipped with:

— 3 thermocouples + 1 Pt 100 probe, diameter 2 mm; or

— 4 thermocouples + 1 Pt 100 probe, diameter 2 mm.

An example of a temperature measurement device is shown in Figure B.3.



Key

1 outlet of the appliance in test (hole with ØD)

2 diaphragm to homogenise the temperature and pressure profile across the tube diameter

3 thermocouple

4 platine probe

5 ØD

6 0,7 x ØD

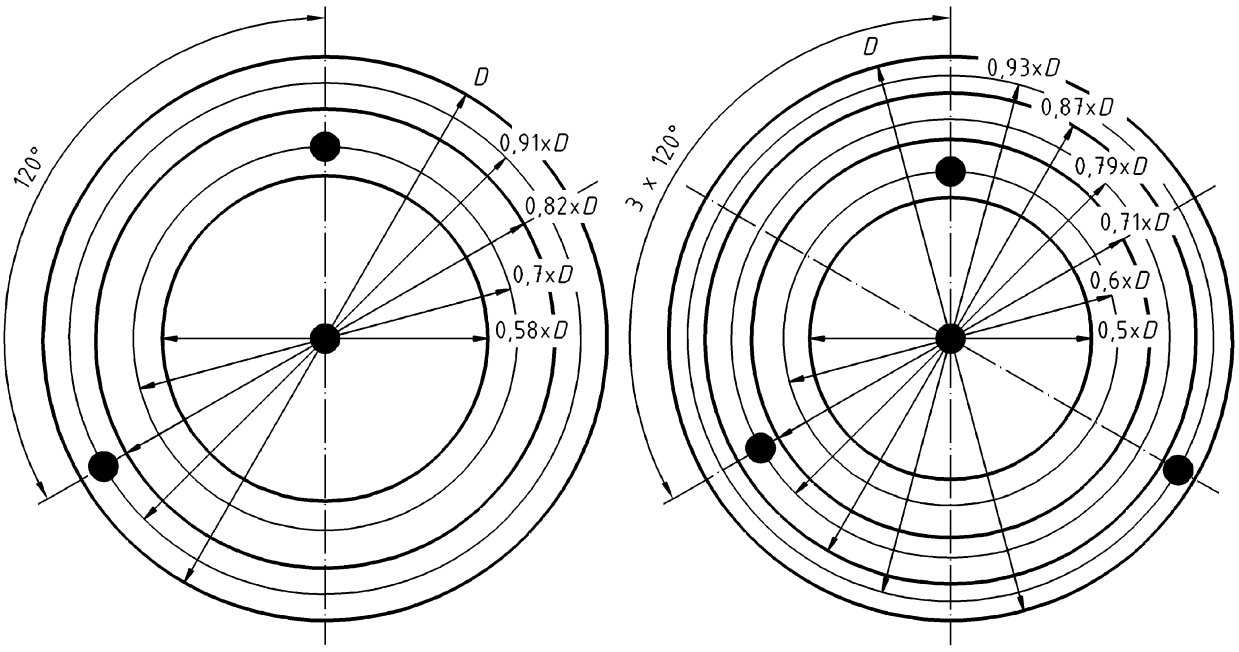
7 < 10 x ØD

8 5 x ØD

9 > 0,5 D and < D

Figure B.3 — Example of temperature measurement device

The position of the thermocouples (three or four with one thermocouple at the centre of the flow) could be as shown in Figure B.4.

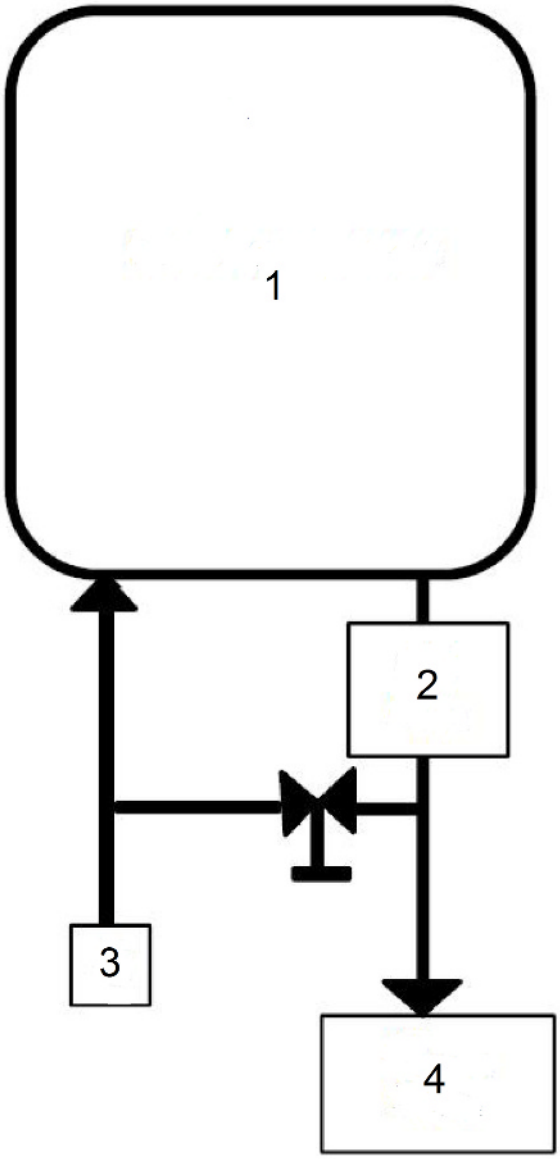


Key

- thermocouples

Figure B.4 — Example of position of thermocouples - Method of surfaces

Other measuring instruments may be used provided the results required in the standard are obtainable.



key

1 gas appliance

2 $\frac{\Delta T_d}{D_{min}}$

3 T_d

4 $\frac{\Delta T_{useful}}{D_{useful}}$

Figure B.5 — Useful and delivered flow rates and temperatures

Annex ZA
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) n° 814/2013

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 (EU) n° 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco design requirements for water heaters and hot water storage tanks.

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) n° 814/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) n° 814/2013	Qualifying remarks/Notes
7.1	Annex II, 1.1 a), b), c) Requirements for water heating energy efficiency	

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

Annex ZB
(informative)

Relationship between this European Standard and the requirements of Commission Regulation n° 812/2013

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 Delegated Regulation (EU) n° 812/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of water heaters, hot water storage tanks and packages of water heater 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) n° 812/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) n° 812/2013	Qualifying remarks/Notes
7.2	Annex III, point 1.1.1 or 1.1.2, and Annex VIII, 2 Annual Electricity Consumption (AEC)	
7.3	Annex III, point 1.1.1 or 1.1.2, and Annex VIII, 2 Annual Fuel Consumption (AFC)	

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

Annex ZC
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EU) n° 813/2013

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Table ZC.1 — Correspondence between this European Standard and Commission Regulation (EC) n° 813/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) n° 813/2013	Qualifying remarks/Notes
7.1	Annex II, 2(a), 2(b) Requirements for water heating energy efficiency	

Annex ZD
(informative)

Relationship between this European Standard and the requirements of Commission Delegated Regulation (EU) n° 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 Delegated Regulation (EC) n° 811/2013 of 18 February 2013 implementing Directive 2005/32/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 ZD.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 ZD.1 — Correspondence between this European Standard and Commission Regulation (EC) n° 811/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) n° 811/2013	Qualifying remarks/Notes
7.2	Annex V, table 7, and Annex VI, 2 Annual Electricity Consumption (AEC)	
7.3	Annex V, table 7, and Annex VI, 2 Annual Fuel Consumption (AFC)	

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[1] EN 13203-1, *Gas-fired domestic appliances producing hot water - Appliances not exceding 70 kW heat input and 300 l water storage capacity - Part 1: Assessment of performance of hot water deliveries*

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