BRITISH STANDARD

BS 6332-6:
1990

Thermal performance of domestic gas appliances —

Part 6: Specification for thermal performance of combined appliances: fanned-circulation ducted-air heater/circulator

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Gas Standards Policy Committee (GSE/-) to Technical Committee GSE/17, upon which the following bodies were represented:

Association for Consumer Research (ACRE)
British Gas plc
British Non-Ferrous Metals Federation
Consumer Policy Committee of BSI
Department of Energy (Energy Efficiency Office)
Department of the Environment (Building Research Establishment)
Department of Trade and Industry (Consumer Market Division)
Department of Trade and Industry (Consumer Safety Unit, C A Division)
Gas Consumers Council
Institution of Gas Engineers
Liquefied Petroleum Gas Industry Technical Association (UK)
National Caravan Council Limited
Royal Society for the Prevention of Accidents
Society of British Gas Industries

The following body was also represented in the drafting of the standard, through subcommittees and panels:

Co-opted member

This British Standard, having been prepared under the direction of the Gas Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 June 1990

The following BSI references relate to the work on this standard:
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Contents

Foreword

This Part of BS 6332 has been prepared under the direction of the Gas Standards Policy Committee to provide a specification for the thermal performance of combined gas-fired fanned-circulation ducted-air heaters/circulators and thus complements the safety requirements for such appliances specified in BS 5258-9. The performance requirements of air heaters and circulators individually given in BS 6332-5 and BS 6332-1, respectively, form the bases of this Part of BS 6332.

In anticipation of this Part of BS 6332, being the subject of third party certification schemes, as are other Parts of BS 6332, it provides for a claim by the appliance manufacturer of a numerical value for the thermal efficiency of a product model. The test authority can then ascertain that a sample submitted for type approval meets this claimed value within a specified test equipment tolerance. Subsequently any sample selected from production of the particular model is expected to comply with a verification value, which also takes into account a specified production tolerance.

Also in common with other Parts of BS 6332, efficiency values are based on the use of net calorific values, instead of gross values as formerly, in alignment with European practice.

Parts of BS 6332 already published are as follows.

— *Part 1: Specification for thermal performance of central heating boilers and circulators;*

— *Part 2: Specification for thermal performance of gas fires;*

— *Part 3: Specification for thermal performance of combined appliances: gas fire/back boiler;*

— *Part 4: Specification for thermal performance of independent convector heaters;*

— *Part 5: Specification for thermal performance of fanned-circulation ducted-air heaters.*

As a consequence of the initiation, by the CEC, of the Gas Appliance Directive and the preparation of European Standards in support of this Directive, it is probable that Parts of BS 6332 will be withdrawn, in due course, and replaced by new British Standards aligned with CEN standards.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 6332 specifies the thermal efficiency requirements and associated methods of test for gas-fired appliances consisting of a fanned-circulation ducted-air heater of rated heat input not exceeding 60 kW[1)] combined with a circulator of rated heat input not exceeding 8 kW[1)]. The combined appliance is usually of integral construction, the circulator being fitted inside the air heater casing.

It also covers fanned-circulation ducted-air heaters which are designed to be fitted with circulators, as a purchaser's option.

This standard only applies to circulators intended for use as an integral part of the combined appliance. Circulators intended for independent use are covered by BS 6332-1.

This Part covers appliances of the following categories, as described in **A.1.3** of BS 4947:1984:

I_T, I_N, $I_{L/B}$, $I_{L/P}$;

II_{TN}, II_{NL}, $II_{NL/B}$, $II_{NL/P}$;

III, $III_{TNL/B}$, $III_{TNL/P}$;

and of the following types, as defined in BS 1179-6:1980:

type B: open-flued appliances;

type C: room-sealed appliances;

type C_1: balanced-flue appliances;

type C_2: Se-duct appliances.

This Part is only applicable to the appliances listed above that comply with BS 5258-9.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6332, the definitions given in BS 1179:1967 and BS 1179-6:1980 apply, together with the following.

2.1
claimed efficiency

the efficiency of an appliance claimed by the manufacturer. It may be a net efficiency or a gross efficiency. Where the term is used in this Part, it always relates to net efficiency, either the efficiency as claimed or the equivalent value calculated from a claimed gross efficiency in accordance with the relationship given in the footnote to Table 1

2.2
gross efficiency

the efficiency of an appliance calculated on the assumption that the heat content of the test gas is its gross calorific value

2.3
net efficiency

the efficiency of an appliance calculated on the assumption that the heat content of the test gas is its net calorific value

2.4
test house efficiency

the net efficiency of an appliance measured at the test house on a sample submitted for type approval purposes

2.5
verification efficiency

the net efficiency of an appliance measured during any surveillance or check testing of production appliances

3 Thermal performance

3.1 Efficiency requirements: fanned-circulation ducted-air heater

3.1.1 *General*

3.1.1.1 The appliance shall comply with **3.1.2** and, as appropriate, with **3.1.3.1**, **3.1.3.2** or **3.1.3.3**.

3.1.1.2 Efficiency values shall pertain to and shall be measured by the method described in **4.1** and **4.2.1**.

3.1.2 *Efficiency: still air conditions (all types of appliance)*

3.1.2.1 The manufacturer shall claim a net efficiency value which shall be not less than that given in Table 1.

3.1.2.2 The corresponding test house efficiency shall be not less than the claimed efficiency minus 2.

3.1.2.3 The corresponding verification efficiency shall be not less than the claimed efficiency minus 5.

3.1.3 *Efficiency: adverse flue conditions*

3.1.3.1 *Type B appliances*

3.1.3.1.1 The test house efficiency, measured under the conditions specified in **3.1.3.1.2**, shall be not less than the claimed efficiency minus 9.

[1)] Based on gross calorific value.

Table 1 — Minimum net efficiency of air heater under still air conditions: claimed value

Appliance rating	Heat input at which measurement made	Minimum claimed efficiency (net)[a]
		%
fixed	rated	80
range	minimum of range	77
	maximum of range	80

[a] The gross efficiency value is related to the net value for the four reference gases as follows:

for TGA (4) gross value = 0.899 × net value
for NGA gross value = 0.901 × net value
for LPGA gross value = 0.926 × net value
for LPGC gross value = 0.922 × net value

3.1.3.1.2 The appliance shall be operated at the rated heat input or at the maximum of the rated range, as appropriate.

A gas sampling probe shall be inserted 200 mm below the top of the 1 m vertical secondary flue to enable the average CO_2 content across the flue to be determined. An extraction fan shall then be connected to the flue and arranged to create a flue flow such that the CO_2 content is reduced to half its original value.

3.1.3.2 *Type C_1 appliances*

3.1.3.2.1 The test house efficiency measured under the conditions specified in **3.1.3.2.2**, shall be not less than 70 %.

3.1.3.2.2 The appliance shall be operated at the rated heat input or at the maximum of the rated range, as appropriate.

The appliance shall be set up on the wind test rig described in Appendix B of BS 5258-9:1989 and shall be tested with a horizontal wind of 4.5 m/s directly on the terminal.

3.1.3.3 *Type C_2 appliances*

3.1.3.3.1 The test house efficiency, measured under the conditions specified in **3.1.3.3.2**, shall be not less than 70 %.

3.1.3.3.2 The appliance shall be operated at the rated heat input or at the maximum of the rated range, as appropriate.

The appliance shall be set up on the test duct as described in Appendix C of BS 5258-9:1989 in such a way that the distance between the back of the appliance and the end of the outlet connecting duct is twice the diameter of the latter (see Figure 1). If it is necessary to increase the length of the connecting ducts using extension ducts, suitable extension ducts shall be supplied by the manufacturer.

The appliance shall be tested with an upward air flow of velocity 1.5 m/s.

3.2 Efficiency requirements: circulator

3.2.1 ***General***

3.2.1.1 The appliance shall comply with **3.2.2**. A natural draught type B appliance shall also comply with **3.2.3**.

3.2.1.2 Efficiency values shall pertain to and shall be measured by the method described in **4.1** and **4.2.2**.

3.2.2 ***Efficiency: still air conditions***

3.2.2.1 The manufacturer shall claim an efficiency value which shall be not less than that given in Table 2.

Table 2 — Minimum net efficiency of circulator under still air conditions: claimed value

Appliance rating	Heat input at which measurement made	Minimum claimed efficiency (net)[a]
		%
fixed	rated	79
range	minimum of range	76
	maximum of range	79

[a] The gross efficiency value is related to the net value for the four reference gases as follows:

for TGA (4) gross value = 0.899 × net value
for NGA gross value = 0.901 × net value
for LPGA gross value = 0.926 × net value
for LPGC gross value = 0.922 × net value

3.2.2.2 The corresponding test house efficiency shall be not less than the claimed efficiency value minus 2.

3.2.2.3 The corresponding verification efficiency shall be not less than the claimed efficiency value minus 5.

3.2.3 ***Efficiency requirements for natural draught type B appliances: adverse flue conditions***

3.2.3.1 *Test house efficiency*

3.2.3.1.1 The test house efficiency, measured under the conditions specified in **3.2.3.1.2**, shall be not less than 75 %.

3.2.3.1.2 The appliance shall be operated at the rated heat input, or the maximum rated heat input if range-rated.

A gas sampling probe shall be inserted at 200 mm below the top of the 1 m secondary flue to enable the average CO_2 content across the flue to be determined. An extraction fan shall then be connected to the flue and arranged to create a flue flow such that the CO_2 content is reduced to half its original value.

3.2.3.2 *Verification efficiency*

3.2.3.2.1 The manufacturer shall supply to the test authority, along with the type approval sample, drawings of the draught diverter.

Performance requirements of production appliances under adverse flue conditions shall be deemed to be met provided that the dimensions of the draught diverter are within the tolerances given.

3.2.3.2.2 If it is necessary to test production appliances under adverse flue conditions, the verification efficiency shall be not less then the corresponding test house efficiency minus 3.

4 Test methods

4.1 General conditions of test

4.1.1 *Test room*

The room shall be adequately ventilated but free from draughts likely to affect the performance of the appliance. The room temperature shall be maintained at 20 ± 5 °C and, during the course of a test, it shall not vary by more than 2 °C.

4.1.2 *Preparation of appliance*

4.1.2.1 *All appliances*

The appliance shall be set up in the free standing condition, taking due account of the manufacturer's instructions. It shall be adjusted in accordance with the manufacturer's instructions, using the reference test gas(es) in accordance with clause **4** of BS 4947:1984 and corresponding to the appliance category, and inlet pressure(s), as follows.

NOTE Except in cases of dispute, typical distributed gases may be used for this test.

Family	Test gas	Inlet pressure
		mbar[a]
1st	TGA	17.5
2nd	NGA	20
3rd	LPGA	28
	LPGC	37
[a] 1 mbar = 0.1 kPa = 10^2N/m^2.		

The setting pressure of the burner shall be adjusted, if necessary, according to the Wobbe number of the gas used for the test.

Before any tests are made, the appliance shall be operated at its working temperature for a period sufficient to dry any insulation and remove any temporary finish that might interfere with observations.

4.1.2.2 *Type B appliances*

An appliance with a vertical flue outlet shall be fitted with 1 m of vertical secondary flue of the same nominal diameter as the flue outlet.

An appliance with a horizontal flue outlet shall be fitted, in accordance with the manufacturer's instructions, with a horizontal flue of the minimum length necessary to pass through a wall of 300 mm thickness and connected, via the manufacturer's specified method of adaptation, to a 1 m length of vertical flue.

The secondary flue shall be made from sheet metal and shall be thermally insulated with glass wool of at least 20 mm thickness.

NOTE If the circulator is flued independently of the air heater, then it will not be necessary to insulate the circulator flue.

4.1.2.3 *Type C_1 appliances*

Appliances shall be tested with the flue ducts and terminal assembled in accordance with the manufacturer's instructions for a wall thickness of 300 mm.

4.1.2.4 *Type C_2 appliances*

Appliances shall be tested with the connecting ducts assembled in accordance with the manufacturer's instructions but, except where otherwise stated, not connected to a test duct.

4.2 Measurement of efficiency

4.2.1 *Fanned-circulation ducted-air heater*

4.2.1.1 *Test conditions*

The circulator is switched off. The appliance is supplied with typical distributed gas(es) or the reference test gas(es) corresponding to its category and operated within ± 2 % of the specified heat input(s) against the maximum static pressure in the warm air delivery duct recommended by the manufacturer. The fan speed is such that the temperature rise of the delivered air is 50 ± 5 °C when the appliance is operated at the maximum rated heat input.

The gas rate is measured by timing an integral number of revolutions of the gas meter over a period of at least 100 s.

The CO_2 content and the temperature of the combustion products are measured by means of a suitable probe, incorporating a temperature measuring device, located in the secondary flue or combustion products duct, as appropriate.

For type B appliances, the test probe to be used is as shown in Figure 2 and is positioned 200 mm from the top of the flue. The sampling rate of combustion products for the measurement of temperature is 8 L/min to 12 L/min.

For type C appliances, the test probe to be used is as shown in Figure 3. Where possible, it is positioned as shown in Figure 4 with type C_1 appliances or as shown in Figure 5 with type C_2 appliances. Where a transfer box(es) is fitted between the appliance and the Se-duct, the test probe is between the transfer box and the Se-duct. The sampling rate of combustion products for the measurement of temperature is 4 L/min to 5 L/min.

NOTE For type C appliances where the aforementioned locations are not appropriate, the sampling position will be by agreement between the manufacturer and the test authority, sufficient measurements being taken to ensure consistency of results.

4.2.1.2 *Test procedure*

With the appliance installed and adjusted as described in **4.2.1.1**, the appliance is operated for a sufficient time to reach equilibrium. Measurements are then made of the temperature and the CO_2 content of the combustion products and of the combustion air.

4.2.1.3 *Accuracy of measurement*

The measurements are made with the appropriate accuracy, as follows, to give an overall accuracy of the test result of ± 2 units of percentage:

Quantity measured	Measurement accuracy
Combustion air temperature	± 0.5 °C
Combustion products temperature	± 2 °C
CO_2 content of the combustion air and the combustion products	± 5 % of the sample concentration
Calorific value	± 0.5 %

4.2.1.4 *Calculation of efficiency*

The symbols used in the determination are defined as follows:

q_1 is the heat of the dry products of combustion (% of heat released per unit volume of gas);

q_2 is the heat of the water vapour contained in the products of combustion (% of heat released per unit volume of gas);

C_1 is the mean specific heat of the dry products of combustion (in MJ/m^3.°C) (see Figure 6);

t_1 is the average combustion air temperature (in °C);

t_2 is the average temperature of the products of combustion (in °C);

H_i is the net calorific value of the gas at 1013.25 mbar and 15 °C, dry (in MJ/m^3);

H_s is the gross calorific value of the gas at 1013.25 mbar and 15 °C, dry (in MJ/m^3);

V_f is the volume of dry products of combustion per unit volume of gas (in m^3).

V_f is calculated from the volume of CO_2 (V_{CO_2}) produced by the combustion of one cubic metre of gas, the average CO_2 content of the products of combustion (CO_2 %) and from the CO_2 content of the room air (CO_2 % $_{AIR}$):

$$V_f = \frac{V_{CO_2}}{CO_2\% - CO_2\%_{AIR}} \times 100$$

The values of H_i, H_s and V_{CO_2}, are appropriate to the test gases used. In borderline cases, the appropriate reference test gases defined in clause **4** of BS 4947:1984 are used to judge compliance with the requirements given in **3.1**. The values of H_i, H_s and V_{CO_2} for these gases are as follows.

Reference test gas	Net calorific value H_i	Gross calorific value H_s	V_{CO_2}
	MJ/m^3	MJ/m^3	m^3
TGA	17.20	19.13	0.41
NGA	34.09	37.85	1.0
LPGA	116.69	126.08	4.0
LPGC	88.34	95.85	3.0

The net efficiency, E (net) (in %) is given by:

$$E \text{ (net)} = 100 - (q_1 + q_2)$$

where

$$q_1 = C_1 \times V_f \frac{t_2 - t_1}{H_i} \times 100$$

and

$$q_2 = 0.077 \frac{H_s - H_i}{H_i} (t_2 - t_1)$$

4.2.2 ***Circulator***

4.2.2.1 *Test conditions*

The appliance is connected to a test rig capable of allowing it to be operated at the rated heat input(s) and at the flow and return temperatures specified. A suitable test rig is shown in Figure 7 but any other arrangements having the same capability may be used.

Means are provided for measuring temperatures t_1 and t_2 to within ± 0.5 °C and temperatures t_3 and t_4 to within ± 0.1 °C. The flow and return of the appliance (1) are short-circuited via a connecting pipe containing a circulating pump (2) and control valve I (3). Cold water at a temperature t_3 is fed into the return pipe after the control valve (3) from the raised tank (4) which ensures a static head on the system. An equivalent amount of water at the temperature t_4 flows out of the system via a ventilated offtake.

The water flow rate corresponding to the required flow temperature at the preset output is regulated by control valve II (9). The specified temperature difference ($t_2 - t_1$) °C is set by means of control valve I.

NOTE Numbers in brackets refer to Figure 7.

It is advisable to fit flowmeters into the rig, as shown, in order to adjust rapidly to the specified temperatures.

4.2.2.2 *Test procedure*

The fanned-circulation ducted-air heater is switched off. Control valves I and II are adjusted to give a flow temperature, t_2, of 60 ± 1 °C and return temperature, t_1, of 30 ± 1 °C, with the appliance operating at its rated heat input.

If the specified flow and return temperature difference is not suitable for the appliance, the flow temperature is set to the prescribed value and the return temperature is set as near to the prescribed value as the manufacturer's instructions permit.

The appliance is set to the prescribed conditions and, using the appropriate reference test gas(es), allowed sufficient time to reach thermal equilibrium, which will be at least 30 min.

Efficiency measurements are made only when the appliance and test rig are at thermal equilibrium. Thermal equilibrium is considered to exist when the mean of the temperatures t_1 and t_2, measured over a one minute period, does not differ by more than 0.3 °C from a similar measurement made 10 min after the first.

When all the prescribed conditions are met, accurate readings are taken of the temperature of the water entering the system (t_3), the temperature of the water leaving the system (t_4), the water rate and the gas rate. The measurement period, during which water is collected for weighing and the gas rate is determined (by timing an integral number of revolutions of the gas meter), is at least 200 s. At the end of each measurement period, it is checked that thermal equilibrium still exists.

4.2.2.3 *Accuracy of measurement*

The measurements are made with the appropriate accuracy, as follows, to give an overall accuracy of the test result of ± 2 units of percentage.

Quantity measured	Measurement accuracy
Atmospheric air pressure	± 1 mbar
Gas pressure	± 0.1 mbar
Gas quantity	± 0.5 % by volume
Time	± 0.5 s
Water mass	± 0.1 %
Water temperature	± 0.1 °C
Calorific value	± 0.5 %

4.2.2.4 *Calculation of efficiency*

The net efficiency E(net) (in %) is given by:

$$E(\text{net}) = \frac{(WST) + C}{GH_i} \times 100$$

where

W is the water flow rate (in kg/s);

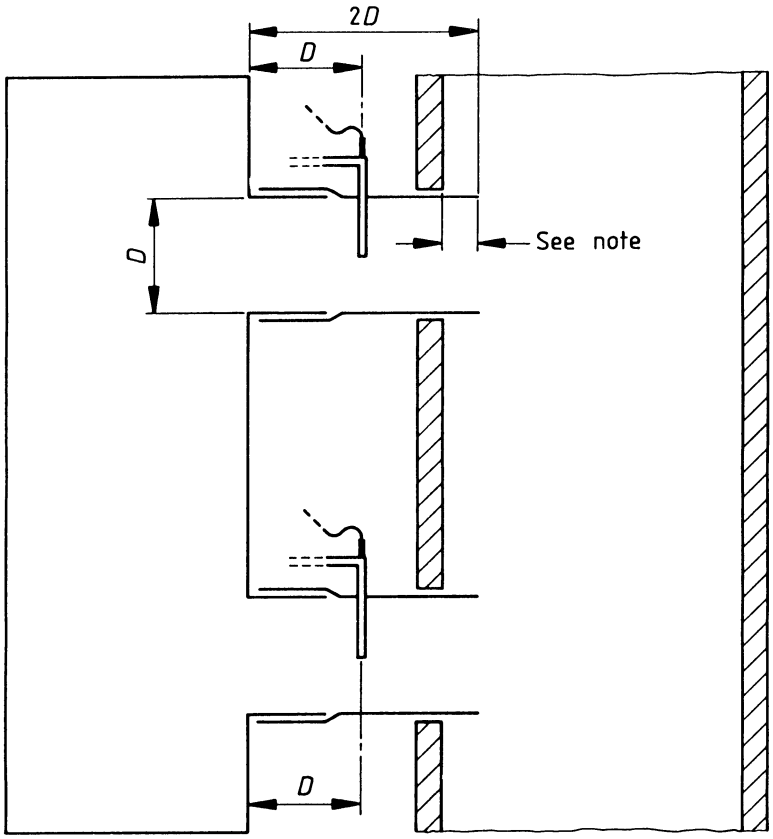
S is the specific heat of water [in kJ/(kg °C)];

T is the temperature rise across the rig (in °C), i.e. ($t_4 - t_3$);

G is the gas rate corrected to 1013.25 mbar, 15 °C and dry (in m^3/s);

H_i is the net calorific value of the gas at 1013.25 mbar and 15 °C, dry (in kJ/m^3);

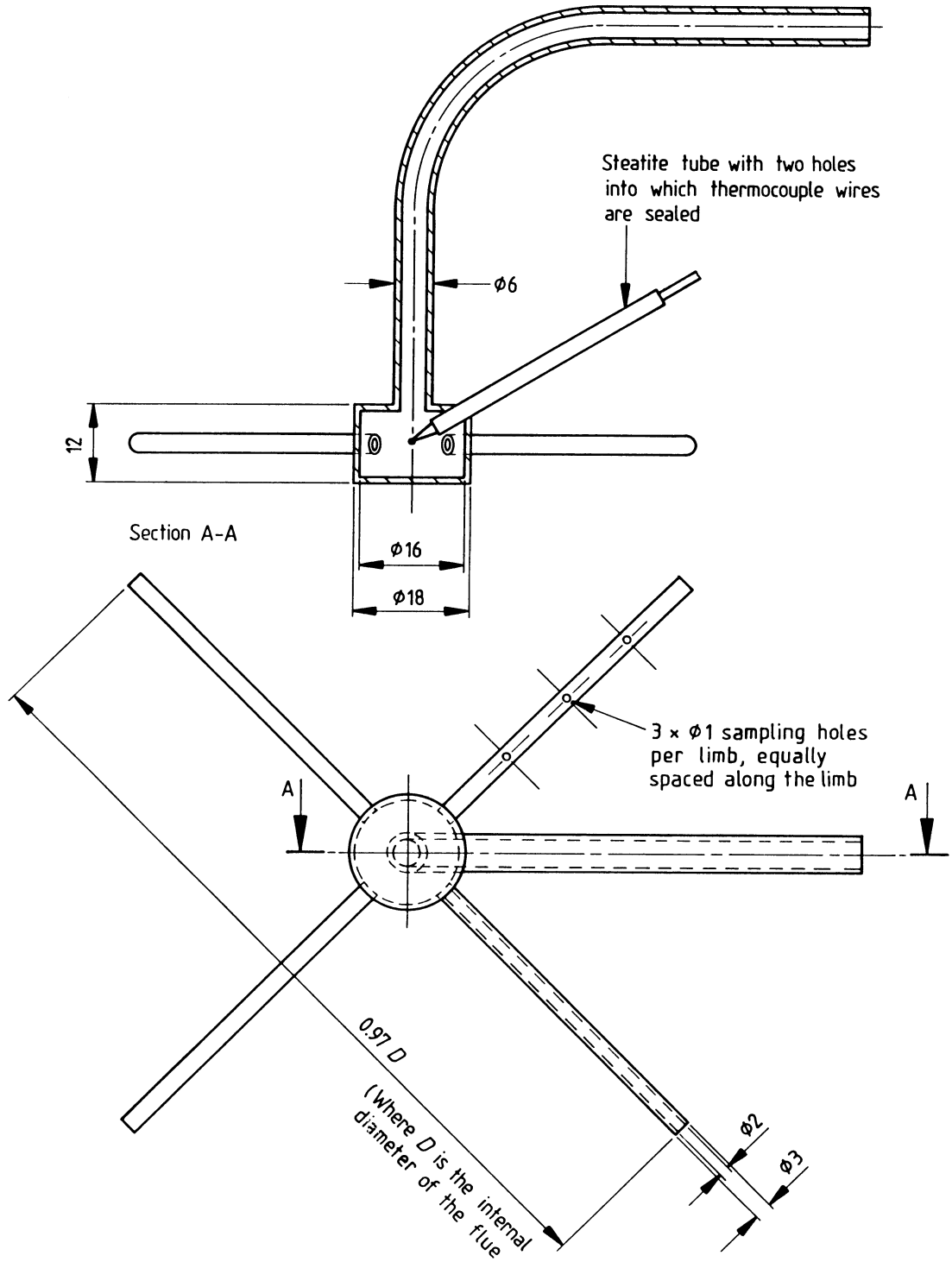
C is the rig correction (in kW).



D is the internal diameter of the flue.

NOTE As specified in the manufacturer's instructions.

Figure 1 — Installation of a type C_2 air heater on the test duct



NOTE The material is stainless steel with a polished finish.
All dimensions are in millimetres.

Figure 2 — Sampling probe for type B air heaters

NOTE 1. The material is stainless steel with a polished finish.

NOTE 2. Dimension Y should be chosen according to the diameter of the air inlet duct and its insulation.

NOTE 3. Dimensions for 6 mm diameter probe (suitable for products outlet ducts of diameter (D) over 75 mm) are as follows:

outside diameter of probe (d) 6 mm;

wall thickness 0.6 mm;

diameter of sampling holes (x) 1.0 mm;

twin bore ceramic sleeve
ϕ3 mm × 0.5 mm bore;

thermocouple wire ϕ0.2 mm

For products outlet ducts less than 75 mm diameter a smaller probe should be used with d and x chosen such that:

(a) the area obstructed by the probe is less than 5 % of the cross section of the duct;

(b) the total area of the sampling holes is less than three-quarters of the cross section of the probe.

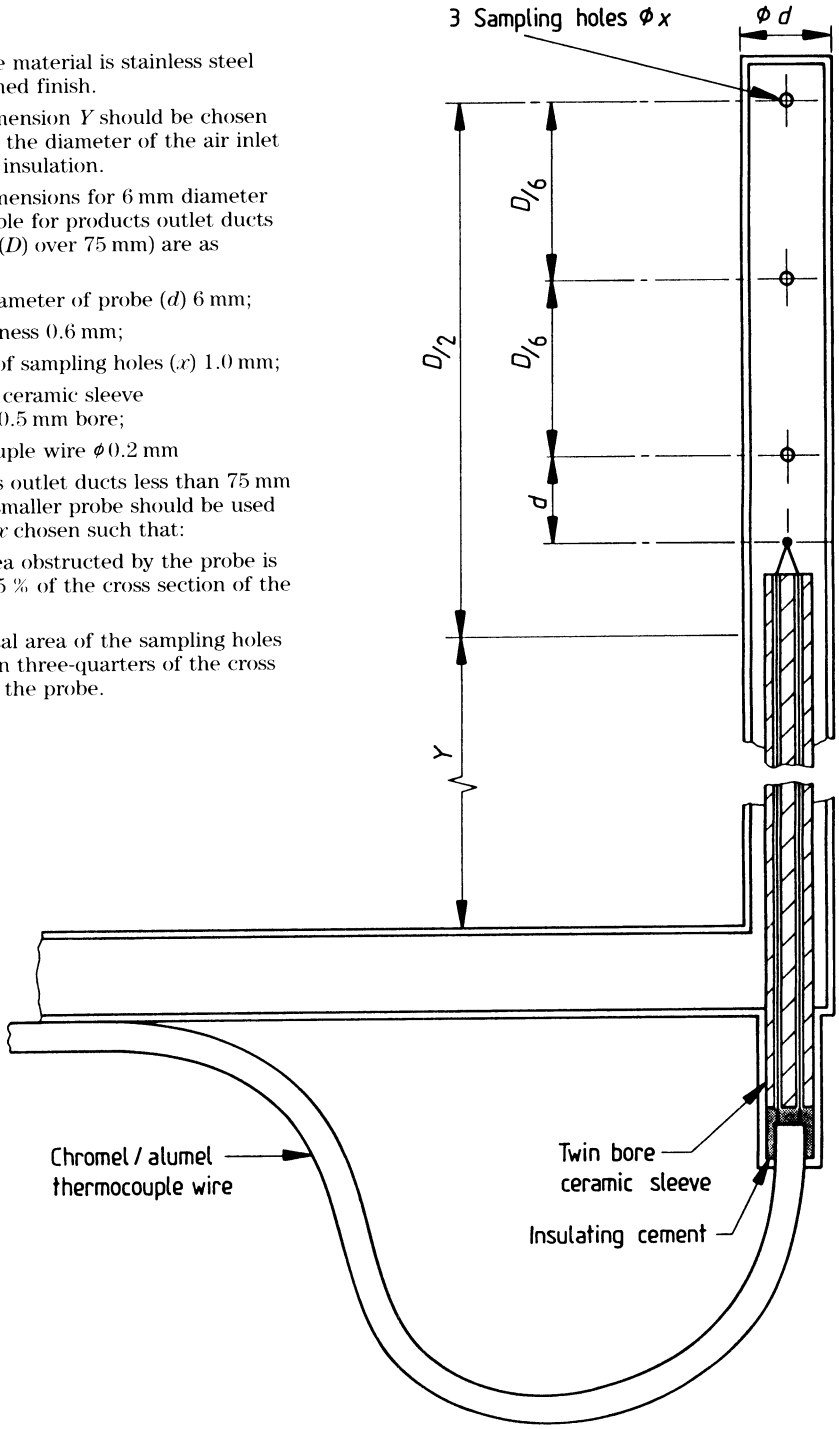
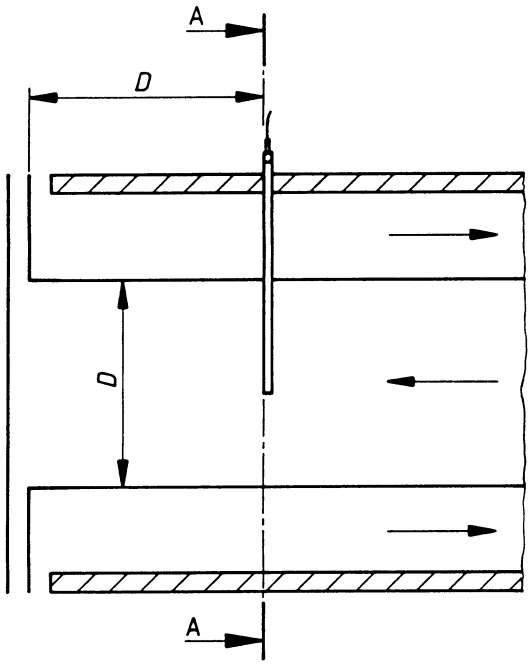


Figure 3 — Sampling probe for type C air heaters



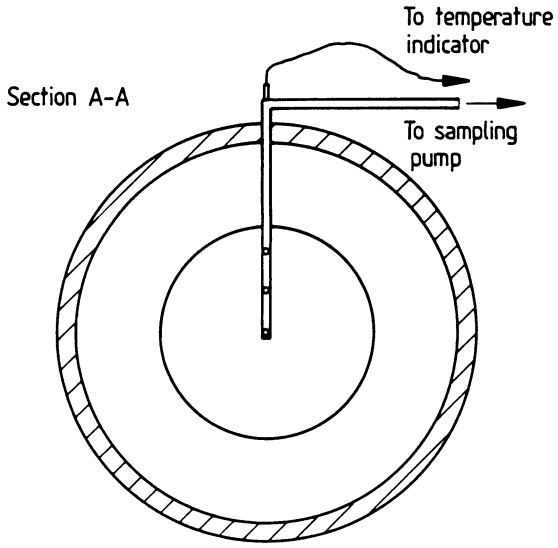


Figure 4 — Sampling position for type C_1 air heaters

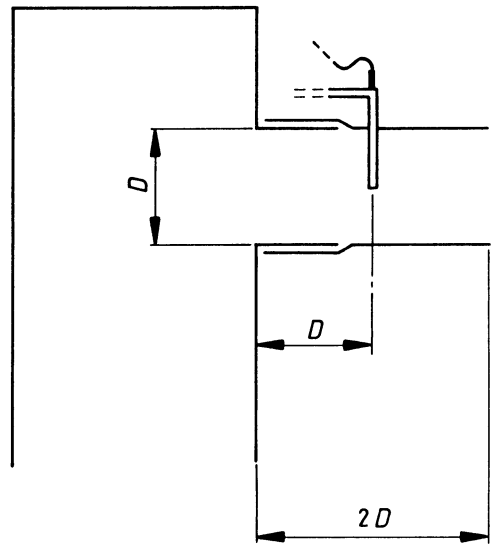


Figure 5 — Sampling position for type C_2 air heaters

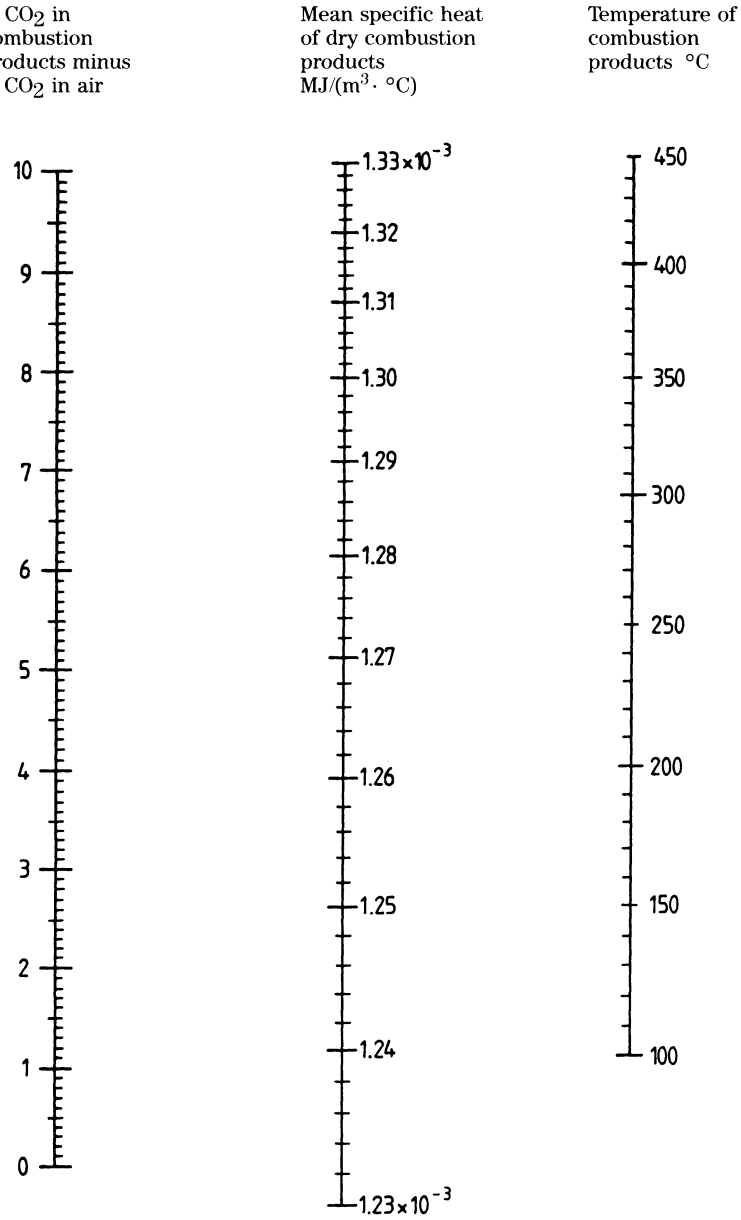
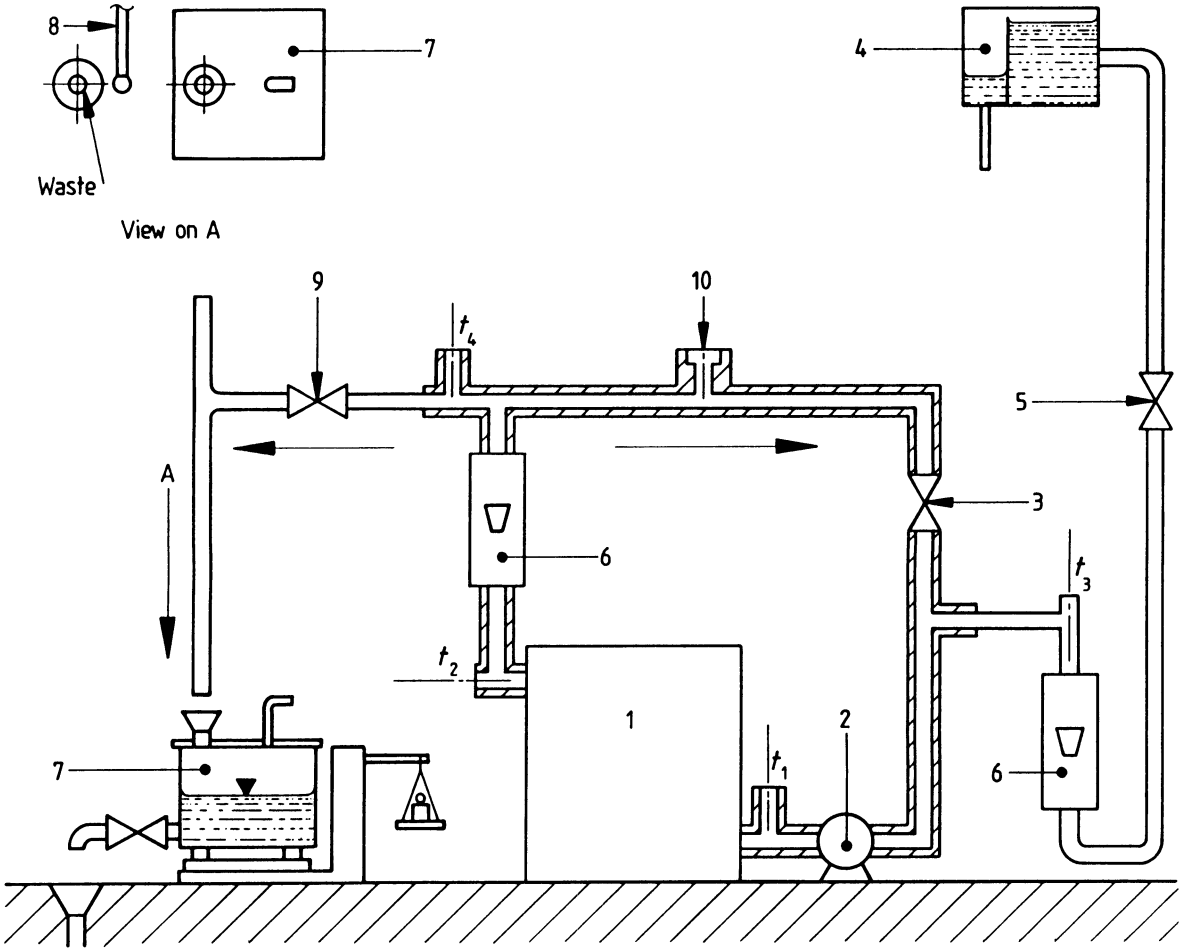


Figure 6 — Nomogram for the calculation of mean specific heat of dry combustion products



1 Appliance under test
2 Circulating pump
3 Control valve I
4 Constant head tank
5 Stop valve
6 Flowmeter
7 Weighing tank
8 Swinging arm
9 Control valve II
10 Air vent

Figure 7 — Test rig (circulator)

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Publications referred to

BS 1179, *Glossary of terms used in the gas industry*.
BS 1179-6, *Combustion and utilization including installation at consumer's premises*.
BS 4947, *Specification for test gases for gas appliances*.
BS 5258, *Safety of domestic gas appliances*.
BS 5258-9, *Specification for combined appliances: fanned-circulation ducted-air heaters/circulators*.
BS 6332, *Thermal performance of domestic gas appliances*.
BS 6332-1, *Specification for thermal performance of central heating boilers and circulators*.
BS 6332-5, *Specification for thermal performance of fanned-circulation ducted-air heaters*[2)].

[2)] Referred to in the foreword only.

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