

METHODS FOR THE DETERMINATION OF THE CALORIFIC VALUE OF FUEL GASES

Part 1. Non-Recording Methods

B.S. 3804 : Part 1 : 1964

THIS BRITISH STANDARD, having been approved by the Solid Fuel Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 1st October, 1964.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 4000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, price 15s. The B.S. Yearbook may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- B.S. 526. Definitions of the calorific value of fuels.
- B.S. 791. Bomb calorimeter thermometers.
- B.S. 970. Wrought steels in the form of bars, billets and forgings, up to 6 in ruling section, for automobile and general engineering purposes. (En series.)
- B.S. 1041. Code for temperature measurement.
- B.S. 1501–6. Steels for use in the chemical, petroleum and allied industries.
- B.S. 1780. Bourdon tube pressure and vacuum gauges.
- B.S. 2032. Aluminium bronze rods, sections and forgings for general engineering purposes.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:
Committee references SFE/17 and SFE/17/5
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Methods for the determination of the calorific value
of fuel gases

Part 1. Non-recording methods

Revision

Clause 7. Calorific values between 600 Btu/ft³ and 3500 Btu/ft³. Sub-clause a. General. Delete '630A/9' and '614/35' and substitute '5029/90' and '5445/35' respectively.

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CO-OPERATING ORGANIZATIONS

The Solid Fuel Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- Association of Boiler Setters, Chimney and Furnace Constructors
- *Association of British Chemical Manufacturers
- Association of Consulting Engineers
- British Cast Iron Research Association
- British Chemical Plant Manufacturers' Association
- *British Coal Utilisation Research Association
- *British Coke Research Association
- British Coking Industry Association
- British Electrical and Allied Manufacturers' Association
- *British Iron and Steel Federation
- British Ironfounders' Association
- British Mechanical Engineering Federation
- Chamber of Coal Traders
- Coal Utilisation Council
- *Coke Oven Managers' Association
- Combustion Engineering Association
- Council of Ironfoundry Associations
- *Electricity Council, the Generating Board and Area Boards in England and Wales
- Federation of British Industries
- *Gas Council
- Heating and Ventilating Contractors Association
- Imperial Chemical Industries Limited
- Institute of British Foundrymen
- *Institute of Fuel
- *Institution of Chemical Engineers
- *Institution of Gas Engineers
- Institution of Heating and Ventilating Engineers
- Institution of Mechanical Engineers
- *Iron and Steel Institute
- Low Temperature Coal Distillers' Association of Great Britain, Ltd.
- *Ministry of Housing and Local Government
- *Ministry of Power
- Ministry of Public Building and Works
- National Coal Board
- Society of British Gas Industries
- *Water-tube Boilermakers' Association
- Women's Advisory Council on Solid Fuel

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this standard:

- British Ceramic Research Association
- British Laboratory Ware Association
- D.S.I.R.—Warren Spring Laboratory
- Institute of Petroleum
- Institute of Sewage Purification
- Institution of Civil Engineers
- Institution of Electrical Engineers
- Liquefied Petroleum Gas Industry Technical Committee
- Scientific Instrument Manufacturers' Association
- Society of Chemical Industry
- Society of Glass Technology

BRITISH STANDARD METHODS FOR THE DETERMINATION OF THE CALORIFIC VALUE OF FUEL GASES

Part 1. Non-Recording Methods

FOREWORD

Although methods for the determination of the calorific value of gas have been specified for many years by the Ministry of Power and formerly by the Gas Referees, these methods were intended only for official use with town gas within the range 300–600 Btu/ft³. There are, however, many fuel gases of industrial importance the calorific values of which fall outside this range and the present standard has been developed, at the request of the interests concerned, in order to cover the majority of such gases, i.e. those in the range 80–3500 Btu/ft³, which includes blast-furnace gas, town gas, natural gas, gas from oil refinery operation and liquefied petroleum gases. The requirements of the standard have been specified in accordance with conditions in the United Kingdom and appropriate adjustments or corrections will be necessary in other circumstances.

Part 1 deals with non-recording methods, and for this purpose the apparatus specified to test gases in the greater part of the stated range is the Boys water-flow calorimeter. For gases with calorific values in the upper part of this range the bomb calorimeter is specified as an alternative apparatus for calorific value determination. Calculations are presented by which gross calorific value at constant pressure (or, in the case of the bomb calorimeter, at constant volume) can be obtained, values for other conditions being achieved by the conversions given in B.S. 526*. It will be noted that for readings with the Boys calorimeter, other than the rise in water temperature, the use of thermometers graduated in degrees Fahrenheit has been retained. It is permissible, however, to use thermometers of equivalent accuracy† graduated in degrees Celsius.

Part 1 of the standard is presented in three Sections:

Section One describes the apparatus and procedure, using the Boys calorimeter, whereby the calorific value of gases within the range 250–600 Btu/ft³ may be determined. The procedure specified is based upon that laid down in the General Directions to Gas Examiners, issued by the Ministry of Power.

Section Two describes how this apparatus and procedure should be modified to test gases having calorific values within the ranges 600–3500 Btu/ft³ and 80–250 Btu/ft³.

* B.S. 526, 'Definitions of the calorific value of fuels'.

† See B.S. 1041, 'Code for temperature measurement'.

Section Three describes the use of the bomb calorimeter for gases of calorific value greater than about 2200 Btu/ft³. With a refinement of the method of temperature measurement it is also suitable for gases of lower calorific value, such as town gas.

The bomb calorimeter is particularly suitable for crude gases which would have to be purified before they could be tested in the Boys calorimeter. Such purification and the correction which this renders necessary are not required with the bomb calorimeter.

The use of recording calorimeters to provide a continuous record of the calorific value of gas will be dealt with in Part 2 of this British Standard, which will be published separately.

NOTE. Where metric equivalents are stated the figures in British units are to be regarded as the standard. The metric conversions are approximate. More accurate conversions should be based on Appendix E or the tables in B.S. 350, 'Conversion factors and tables'.

SPECIFICATION

SCOPE

1. This British Standard describes the methods to be used in determining the gross calorific value of fuel gases with non-recording instruments.

SECTION ONE: CALORIFIC VALUES BETWEEN 250 Btu/ft³ AND 600 Btu/ft³

GENERAL

2. The Boys calorimeter and the ancillary apparatus to be used with it are described in Appendix A. All flexible gas connections should be of a material unaffected by the gas, e.g. nylon. The essential requirements for the test room are stated in Appendix B. Details of suitable thermometers are given in Appendix C.

PRELIMINARY ADJUSTMENT

3. *a. Leak test.* The burners of the calorimeter shall be closed by slipping over them the two ends of a piece of well-fitting flexible tubing, or two rubber caps. The gas, governed to a pressure of 2 in w.g., shall be turned on to the meter and if, after the lapse of not less than one minute, it is found that the meter hand moves forward at the rate of as much as one division in four minutes, the leak shall be located and stopped, and the connections again tested for soundness.

b. Meter adjustment. Before making any test or series of tests, the setting of the indicating point of the meter shall be verified by the use of the point-setting gauge. The meter shall then be properly levelled, and the level of the water adjusted by reference to the indicating point (see Appendix A5b), while the meter is working at the rate at which it will be used during the test (see below).

The water in the meter should be in equilibrium with the type of gas being tested.

METHOD OF TEST

4. *a.* The gas shall be turned on and ignited. The two flames shall be symmetrical, parallel, similar in size and exactly opposite each other.

The flow of gas to the calorimeter shall be adjusted so that the time for one revolution of the meter hand is within the range given in Table 1 for the particular calorific value expected (the time for an intermediate value is found by interpolation). An exploratory test may be necessary for this purpose.

The rate of gas flow shall be checked by observing the time of one revolution of the meter hand with the aid of a stop-watch, shortly before the thermometer readings are made.

TABLE 1. RELATIONSHIP OF FLOW RATES TO CALORIFIC VALUE

Calorific value (Btu/ft ³)	Time for one revolution of meter drum (1/12 ft ³) (seconds)	Water collected during four revolutions of meter drum (grammes)
250	30.0 to 35.0	1000 to 1100
275	33.0 to 38.5	1100 to 1210
300	36.0 to 42.0	1200 to 1320
325	39.0 to 45.5	1300 to 1430
350	42.0 to 49.0	1400 to 1540
375	45.0 to 52.5	1500 to 1650
400	48.0 to 56.0	1600 to 1760
425	51.0 to 59.5	1700 to 1870
450	54.0 to 63.0	1800 to 1980
475	57.0 to 66.5	1900 to 2090
500	60.0 to 70.0	2000 to 2200
525	63.0 to 73.5	2100 to 2310
550	66.0 to 77.0	2200 to 2420
575	69.0 to 80.5	2300 to 2530
600	72.0 to 84.0	2400 to 2640

b. The calorimeter is placed on its base, the water is turned on and the rate of flow of water through the calorimeter is adjusted so that the amount collected during four revolutions of the meter hand is within the range indicated for the particular calorific value in Table 1. Care should be taken to ensure that no air bubble is retained under either the inlet or the outlet closures, e.g. by momentarily loosening the corks.

c. Water is poured through one of the effluent gas holes in the wooden top until it begins to run out from the condensate spout.

d. During the course of the test the water entering the calorimeter shall be lower in temperature than the surrounding air by 3 ± 0.5 degC.

e. The water collecting vessel (see Appendix A3) is placed in position and the change-over funnel (Fig. 5) is adjusted so that the outlet water is led to waste. The outlet water tube of the calorimeter should not touch the change-over funnel.

f. Not less than 45 minutes after the preceding operations have been completed, the water level in the meter is verified and the following observations are made by means of thermometer viewers:

- (i) When the meter hand is at 75, the inlet thermometer is read. At the instant when the meter hand reaches 100 the change-over funnel is moved so as to direct the outlet water into the collecting vessel.
- (ii) When the meter hand reaches 25 the first reading of the outlet thermometer is made and this thermometer is read at every succeeding quarter turn until 15 readings have been taken. The meter hand will then be at 75.
- (iii) At every revolution of the meter hand, except the last, a reading of the inlet thermometer is made when the meter hand is between 75 and 100. At the instant when the meter hand reaches 100 after the last reading of the outlet thermometer, the funnel is moved so as to redirect the outlet water to waste.

g. The foregoing thermometer readings are estimated to the nearest one-hundredth of a degree. Since the viewers, when in position on the thermometers, may obscure the figures on the side of the scale, they should, after the readings have been completed, be moved clear of the meniscus and a check reading should be made with the naked eye to ensure that the whole and tenth-degree readings recorded are correct. If any reading of the inlet thermometer differs by more than 0.05 degC or of the outlet thermometer by more than 0.1 degC from the mean of the complete series of readings made with that thermometer, the test shall be discarded.

h. Additional readings shall be taken as follows:

Barometric pressure, to the nearest 0.01 inch

Meter temperature

Effluent gas temperature

Wet and dry bulb temperatures

of the combustion air (see Clause 5c)

} to the nearest 0.5 degF

j. During a test of calorific value, the water manometer at the inlet of the meter shall be read to the nearest fifth of an inch. The observed inlet pressure is converted into its equivalent on the mercury scale by reference to Table 2 and added to the barometer reading for the purpose of extracting the gas volume factor.

k. If the temperature of the effluent gases exceeds that of the inlet water by more than 5 degC, the test shall be discarded.

l. The water in the water collecting vessel is weighed to the nearest gramme (see Appendix A3).

m. During the test, the amount of water condensed from the products of combustion of the gas is measured. Not less than 15 minutes after the calorimeter has been placed in position, the condensed water is directed into a receiver. If the water collected in not less than 20 minutes shows a rate in excess of 175 ml/h, a significant leak in the unions or coils is indicated and the test shall be discarded.

TABLE 2. PRESSURE CONVERSION TABLE

Inches of water	Inches of mercury
0.4	0.03
0.6	0.04
0.8	0.06
1.0	0.07

METHOD OF CALCULATION

5. *a.* The mean of the four readings of the inlet thermometer shall be subtracted from the mean of the 15 readings of the outlet thermometer, the appropriate corrections having been made to the mean reading in each case*. The difference shall be multiplied by the number of kilogrammes of water collected, by the gas volume factor (see Appendix A5) and by a conversion factor, $3(3.968 + x)$, where x is the percentage addition for the exposed mercury columns of the inlet and outlet thermometers and is generally between 0.009 and 0.015 (see Appendix D).

b. The error in the meter capacity shall have been determined by reference to a suitable standard of volume†. Provided that this error does not exceed ± 0.5 per cent, an equivalent correction shall be applied to the result obtained in Clause 5*a* above by a percentage increase in the result if the meter capacity is small or by a percentage decrease in the result if the meter capacity is large.

c. The correction to be applied for augmentation or depletion of the heat of combustion, resulting from a difference between the total heat content of the entering air and gas and that of the effluent gases, involves additionally a knowledge of the degree of saturation with water vapour of the combustion air entering the calorimeter. This is obtained by means of a ventilated air hygrometer, of which a suitable type is described in Appendix A4 and illustrated in Fig. 3. The correction shall be determined by reference to the Correction Table (Table 6) given in Appendix F, as follows:

Find in Column 1 the temperature readings of the dry bulb, wet bulb, effluent gas and meter thermometers and extract in turn from:

Column 2, the number opposite the dry bulb temperature

Column 3, the number opposite the wet bulb temperature

Column 4, the number opposite the effluent gas temperature

Column 5, the number opposite the meter temperature

The four numbers thus extracted, each with its proper sign, must be added together algebraically. The sum will be the correction, in Btu, which

* See B.S. 1041, 'Code for temperature measurement'.

† The official standard of reference for calorimetric meters in Great Britain is the Hyde meter-prover; this apparatus is based on a water-jacketed measuring bottle of one cubic foot capacity and is fully described in 'Gas Calorimetry' (Hyde and Jones), p. 76.

must be added algebraically to the calorimeter result already corrected for meter error.

d. The test result, worked out to the nearest one-tenth of a unit, is the number of British thermal units (gross) produced by the combustion of one cubic foot of gas measured at 60° Fahrenheit under a pressure of 30 inches of mercury and saturated with water vapour.

EXAMPLE OF CALCULATION

6. An example of the calculation of a calorific value determined with the Boys calorimeter is given below. The expected C.V. was 480 Btu/ft³.

Water temperatures, °C.		Calorimeter started: 9.35 a.m. Test started: 10.30 a.m. Interval: 55 minutes (not less than 45 min)*
Inlet Thermometer No. XY 1234	Outlet Thermometer No. AB 9876	Time for one revolution: 65 seconds (57.5 – 67.0s)*
12.93	33.42	Water collected: 1989 grammes
.94	.43	Buoyancy correction (+1.08 × 1989): +2 grammes
.94	.44	(1920 – 2110g)* 1991
.95	.45	
	.45	Condensate: 40 ml in 30 minutes = 80 ml per hour (not more than 175 ml/h)*
	.44	
	.45	Meter error: +0.2 per cent (not more than ±0.5 per cent)*
	.45	Inlet gauge pressure: 0.8 in w.g.†
	.46	Barometer reading: 29.83 inches of mercury
	.47	Inlet gauge pressure (0.8 ÷ 13.6): +0.06 inches of mercury
	.48	Total: 29.89 inches of mercury
	.47	Meter temperature: 59.0°F
	.47	Effluent gas temperature: 61.5°F (16.4°C)
	.48	Dry bulb (room) temperature: 60.0°F (15.6°C)
	.48	Wet bulb temperature: 51.5°F
Mean 12.94	33.46	Room temperature – Inlet water temperature: 2.6 degC (3 ± 0.5 degC)* Effluent gas temperature – Inlet water temperature: 3.4 degC (not more than 5 degC)*
Correction +0.08 degC	–0.09 degC	
Corrected 13.02	33.37 13.02	
Corrected tem- perature rise	20.35 degC	

* The figures within brackets are the permitted limits.

† The inlet gauge pressure (expressed as inches of mercury) must be added to the barometer reading.

Log 11·940 ($3 \times (3·968 + 0·012)$)	1·0770
Log gas volume factor (29·89 inches of mercury and 59°F)	0·0005
Log water weight (1·991 kg)	0·2991
Log temperature rise (20·35 degC)	1·3086

 2·6852

	484·5
Meter correction (— 0·2 per cent)	— 1·0

 483·5

Humidity correction: Dry bulb	— 0·2
Wet bulb	+ 4·6
Effluent	— 2·4
Meter	+ 0·2

 + 2·2

 485·7 British thermal units
 (gross) per cubic foot

SECTION TWO: MODIFICATIONS REQUIRED FOR OTHER CALORIFIC VALUES

CALORIFIC VALUES BETWEEN 600 BTU/FT³ AND 3500 BTU/FT³

7. a. General. The determination of the calorific value of gases having calorific values between 600 Btu/ft³ and 3500 Btu/ft³ shall be made with a Boys calorimeter which has been modified to burn these gases. It is necessary also to modify the testing procedure.

The Bray No. 3 burners used in the standard Boys calorimeter are replaced by Bray burners of the following types for each sub-range of calorific value:

600–900 Btu/ft³ Bray 630A/90 burners

900–3500 Btu/ft³ Bray 614/35 burners

The tops of these burners should be four inches above the base-plate.

In all determinations where the calorific value exceeds 1000 Btu/ft³, the normal 1/12 ft³ Hyde meter is replaced by a properly constructed meter of the same pattern but having a capacity per revolution of 1/50 ft³. It is essential that the capacity of this size of meter should have been verified strictly at the rate of operation at which it is used. Alternatively, a 1/12 ft³ meter may be retained and fitted with a 4/1 gearing between meter axle and meter hand, so that the hand makes four revolutions over the dial during one revolution of the meter drum.

The flow of gas to the calorimeter is adjusted to give a steady heat input of about 40 Btu/min; that is to say, the time for one revolution of the meter hand for any calorific value shall be within the range given in Table 4, Columns 2 and 3.

The rate of flow of water through the calorimeter is adjusted to give a temperature rise of about 20 degC in all cases. This rate of flow is approximately 500 g/min. Since the collection of a very large quantity of water is inconvenient, involving either the use of a very large collecting vessel or the change-over from one vessel to another in the middle of test (with additional likelihood of error), the duration of the test is limited to restrict the amount of water collected to a maximum of about 3500 grammes. In order to achieve this the test is carried out during three revolutions only of the meter hand (instead of the usual four revolutions) in the case of calorific values between 600–1000 Btu/ft³ (inclusive) (when a 1/12 ft³ meter is used) and between 2600–3500 Btu/ft³ (inclusive) (when a 1/50 ft³ meter is used). However, a 1/12 ft³ meter with gearing requires four revolutions of the meter hand on all occasions (see Table 4, Columns 4, 5 and 6.)

The rate of flow of water shall be such that the amount of water collected during three or four revolutions of the meter hand, as the case may be, is within 100 grammes of that indicated for the particular calorific value in Column 7 of Table 4.

b. Leak test. This test is made as described in Section One except that in this case the heads of the Bray burners are removed so that the burner stems may be sealed in the manner described.

c. Method of test. After the gas has been turned on and ignited the two flames are examined to ensure that the gas is burning at the burner heads and not at the orifices. The flows of gas and water are adjusted to the values defined above.

Where only three revolutions of the meter hand are required during the test the method described in Section One is modified as follows:

- (i) When the meter hand is at 75, the inlet thermometer is read. At the instant when the meter hand reaches 100 the change-over funnel is moved so as to direct the outlet water into the collecting vessel; the time when this is done is entered as 'time of starting test'.
- (ii) When the meter hand reaches 25 the first reading of the outlet thermometer is made and this thermometer is read at every succeeding quarter turn until 11 readings have been taken. The meter hand will then be at 75.
- (iii) At every revolution of the meter hand, except the last, a reading of the inlet thermometer is made when the meter hand is between 75 and 100. At the instant when the meter hand reaches 100 after the last reading of the outlet thermometer, the funnel is moved so as to redirect the outlet water to waste.

d. Method of calculation. (i) Where only three revolutions of the meter hand are taken the mean of the three readings of the inlet thermometer is subtracted from the mean of the 11 readings of the outlet thermometer. The factor which is used in calculating the calorific value from the rise in water temperature, the weight of water collected and the gas volume factor depends, inter alia, upon the volume of gas used in the test, i.e. upon the size of meter used and the number of revolutions of its drum during the test.

Table 3 gives the appropriate figure, for each set of circumstances, to replace '3' in the formula given in Clause 5a.

TABLE 3. FACTOR FOR VARYING METER REVOLUTIONS

Size of meter	Number of drum revolutions during test	Figure to be used
1/12 ft ³	3	4
1/12 ft ³ (with gearing)	1	12
1/50 ft ³	3	50/3
1/50 ft ³	4	50/4

(ii) It is necessary also to modify the correction which is applied for augmentation or depletion of the heat of combustion resulting from a difference between the total heat content of the entering air and gas, and that of the effluent gases, since with gases of higher calorific value the air/gas ratio and the effluent gases/gas ratio are significantly different from those used in the formula which gives the correction to be applied in the lower range of calorific values.

Since the heat input into the Boys calorimeter is maintained at about 40 Btu/min, whatever the calorific value, it can reasonably be assumed that the volume of inlet air drawn into the calorimeter will remain constant. In this case, therefore, the air/gas ratio will increase in direct proportion to the calorific value. Thus, taking the figure of 7.0 as the air/gas ratio for a gas of 500 Btu/ft³, the ratio for other gases up the range will be increased proportionately, e.g. 14.0 for 1000 Btu/ft³ gas, 21.0 for 1500 Btu/ft³ gas.

Accurate values of the effluent gases/gas ratio are more difficult to obtain since the variation, with the composition of the gas, of the volume contraction which takes place on combustion assumes substantial significance.

The connection between these two ratios is:

$$\text{Air/gas} = \text{Effluent gases/gas} + \text{Contraction/gas} - 1$$

An average contraction figure for high calorific value gases can be obtained by plotting the theoretical contraction of all common hydrocarbon gases against calorific value (see Fig. 10). This graph enables a mean value to be taken for the contraction corresponding to any calorific value and thus a figure for the effluent gas/gas ratio for that calorific value is obtained.

Tables 7-12 (to be used in the manner described in Clause 5c for Table 6 are given in Appendix F for calorific values of 1000-3500 Btu/ft³ at intervals of 500 Btu. If the nearest table is used for intermediate values the errors incurred will be small.

CALORIFIC VALUES BETWEEN 80 BTU/FT³ AND 250 BTU/FT³

8. The determination of the calorific value of gases having calorific values between 80 Btu/ft³ and 250 Btu/ft³ may be made with the Boys calorimeter provided that the basic requirements relating to rate of heat input and water temperature rise are adhered to; that is to say, the gas rate must be adjusted to maintain a heat input of 40 Btu/min and the water rate to give a temperature rise of approximately 20 degC.

The satisfactory burning of a gas having a calorific value in the lower part of the range may present some difficulty and for this purpose a gauze-topped burner may be used, the gas being premixed with either air or, if necessary, oxygen to ensure stable combustion.

The correction which is applied to counteract the difference between the total heat content of the entering air and gas and that of the effluent gases will need modification to take into account the changed air/gas and effluent gases/gas ratios.

**TABLE 4. RELATIONSHIP OF FLOW RATES TO CALORIFIC VALUE
FOR HIGH C.V. GASES**

1	2	3	4	5	6	7
Calorific value	Time for one revolution of the meter hand		Number of revolutions of meter hand during test			Water collected during test
	1/12 ft ³ meter	1/50 ft ³ meter or 1/12 ft ³ meter with 4/1 gearing	1/12 ft ³ meter	1/50 ft ³ meter	1/12 ft ³ meter with 4/1 gearing	
Btu/ft ³	s	s				g
600	70-80	—	3	—	—	1890
800	92-108	—	3	—	—	2520
1000	115-135	—	3	—	—	3150
1200	—	33-39	—	4	4	1200
1400	—	39-45	—	4	4	1400
1600	—	45-51	—	4	4	1600
1800	—	50-58	—	4	4	1800
2000	—	55-65	—	4	4	2000
2200	—	61-71	—	4	4	2200
2400	—	66-78	—	4	4	2400
2600	—	72-84	—	3	4	1940 (2580)*
2800	—	77-91	—	3	4	2100 (2800)
3000	—	83-97	—	3	4	2260 (3010)
3200	—	88-104	—	3	4	2420 (3230)
3400	—	94-110	—	3	4	2580 (3440)
3500	—	97-113	—	3	4	2660 (3550)

* The figures in brackets give the water to be collected where a 1/12 ft³ meter with 4/1 gearing is used with calorific values of 2600 Btu/ft³ and above.