

Schedule of

Tests for coke ovens

Co-operating organizations

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

- Association of Heating, Ventilating and Domestic Engineering Employers
- Gas Council*
- Institution of Gas Engineers*
- Ministry of Power*
- Society of British Gas Industries*

The Government department 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 British Standard:

- British Coke Research Association
- British Coking Industry Association
- British Iron and Steel Federation
- Coke Oven Managers' Association
- Institute of Petroleum
- National Coal Board
- Individual manufacturers and users

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Foreword

This standard makes reference to the following British Standards:

BS 135, *Benzoles*.

BS 410, *Test sieves*.

BS 616, *Sampling of coal tar and its products*.

BS 995, *Test code for gas producers*.

BS 1016, *Methods for the analysis and testing of coal and coke*.

BS 1017, *The sampling of coal and coke*.

BS 1041, *Code for temperature measurement*.

BS 1042, *Code for flow measurement*.

BS 1293, *Screen analysis of coal (other than pulverized coal) for performance and efficiency tests on industrial plant*.

BS 1756, *Code for the sampling and analysis of flue gases*.

BS 2082, *Code for disappearing-filament optical pyrometers*.

BS 3142, *Manufactured solid smokeless fuels for household use. Part 1. Cokes for domestic open fires*.

BS 3156, *Methods for the sampling and analysis of fuel gases*.

1. These tests apply to by-product coke ovens.

2. This schedule is deemed to contain all the necessary data for the determination of the performance of the plant, and of the yields and qualities of the saleable products, together with a full explanation of how the necessary observations should be made. Purely scientific data not considered to be of importance to the operation of the plant are omitted.

3. *Preliminary survey.* The preliminary survey is an essential part of any satisfactory plant test. The purpose of the survey is to ascertain the practicability of obtaining those items of information that may be desired, to enable a decision to be reached as to the period for which the test must be run, and to conduct the calibration of measuring apparatus. It is desirable that the quantities of the charge used and of coke produced should be measured correctly to within ± 1 per cent and the tar and the liquor to within $\pm 2\frac{1}{2}$ per cent. In modern plants where the charge is weighed in the charging machine and the coke can be weighed within a few hours of production there is no difficulty in measuring correctly over a short period of test, and a test period of not less than five days is considered sufficient. For plants in which the charge cannot be directly measured the minimum length of test must depend upon the period within which it is found possible to measure the charge and products with the required degree of accuracy.

Before commencing a test all weighing machines should be calibrated and a second calibration should be made immediately after the test, the mean of the two calibration corrections being adopted if they agree within 2 per cent; if the disagreement between the two calibrations exceeds this figure the test should be rejected. Where it is necessary to use belt weighing machines, the equipment should only be used by agreement between the parties concerned and particular attention should be paid to maintenance. The machines should not be tested merely by static tests, but the actual discharge of coal or coke should be weighed. Gas meters, barometers, gas calorimeters and other measuring apparatus should be checked both immediately before and after the test. If a Connersville-type meter is used and a temperature and pressure integrating device is attached to the record, the accuracy of this device should also be checked similarly. The calibration of tar, liquor and benzole measuring tanks should be verified and their dimensions should not be assumed to be necessarily the same as the dimensions marked on a drawing of the tanks.

4. *The plant test.* a. The plant shall be regulated on the test charge prior to testing. When regulation is completed the plant shall be run for not less than seven days under these conditions before the test proper is commenced.

b. If the conditions are not deemed satisfactory during this period a further adjustment may be made and the plant run under these conditions for another seven days, and so on.

c. When the adjustments are considered satisfactory and the seven days running has been completed, the test shall commence without further adjustment and shall continue for not less than five days, during which regular readings are taken. The duration of the test should be such that complete cycles of operations are included.

d. A test shall not be considered to give a satisfactory measure of the fuel consumption if (i) the charges are obviously not uniformly and adequately carbonized, (ii) there is a change in the average of the maximum oven flue temperatures recorded of more than 25 degC between the first day and the last day of the test (see Item 24), or (iii) the maximum variation of moisture in the charges as indicated by the daily samples (see Note 25) exceeds 2 per cent. During the test period, only those adjustments to the heating controls which are necessary to maintain constant flue temperatures shall be made.

e. If semi-direct or direct ammonia recovery is practised, the test should start and finish at the time when the bath is desaturated.

f. It has not been found practicable to recommend a method of determining the evenness of temperature distribution within the oven. If, in a particular installation, it is desired to deal with the evenness of heating of a battery, the test should be negotiated between the contractor and the customer for the particular coke oven battery.

5. This schedule was first published as a test code in 1942 and has now been completely revised. In general, the changes made are editorial and arise from the publication of other British Standards, although a few minor alterations in technique have been introduced as a result of experience over the past 20 years. In view of the increasing use of mixed charges, the layout has been adjusted to accommodate suitable entries and some of the instructions specific to coal have been modified. The procedures for assessing the quality of the products have been modernized and the derivation of various formulae, including those dealing with the effects of moisture and ash in the charge, is explained in Appendix F.

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 to iv, pages 1 to 34 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.

NOTES

3. The following information should be stated:
 - a. The name of the oven system.
 - b. Any special features incorporated in the design of ovens.
 - c. The number of batteries.
 - d. The number of ovens per battery (the existence of any intermediate buttresses should be noted).
 - e. The rated capacity, e.g. in tons of charge per day under specified conditions.
 - f. The date of commencement of production.
 - g. The type of gas offtake system, e.g. double, single, Beimann main.
 4. The following information should be stated:
 - a. The material of which the oven chambers are constructed.
 - b. The internal dimensions (measured cold); mean width, taper, height and length between doors of the oven chamber.
 - c. The type of doors, e.g. self-sealing or luted.
 5. Information of any conditions which may have affected the carbonizing efficiency should be given, e.g. the previous working history of the plant, such as number of shut-downs, abnormal uses during industrial stoppages or owing to trade fluctuations, etc.
 Notes as to the general condition of the plant should be made, with special reference to the gas-tightness of the ovens, doors, etc.
 Precautions taken to make the plant gas-tight before the test, such as hot patching, spraying, etc., should be stated.
 It should be stated whether the ovens are left empty regularly for burning off carbon.
 The degree of protection of the battery from weather should be described, considered in conjunction with the thermal insulation of the plant. The nature and extent of the insulation should be stated.
 6. As complete a description as possible should be given of the system of heating, e.g. whether underjet or gas-gun, twin flue, horizontal flue, etc.
 The nature of the gas, whether the gas and air are preheated and whether the air and draught are natural or forced, should be stated.
 7. It should be stated whether heat is recovered by regenerator, waste heat boiler and/or dry coke cooler. If the former, the type of filling should be stated.
 8. It should be stated whether the charge is top or stamp-charged; give the charging and pushing sequence.
 9. The mean depth of the free space above the charge should be stated:
 - a. When freshly charged; in the case of top-charging, after levelling.
 - b. Just prior to discharging.
- The appropriate measurements (see Appendix B) should be made on two ovens per day, using all the charge holes in each oven.
 The ovens should be selected so as to be uniformly distributed along the battery but excluding those adjacent to the buttress walls.

SCHEDULE OF TESTS

A. General information and description of plant

1. Place of test.
2. Reason for making test.
3. Type, size and age of plant.
4. Particulars of ovens and equipment.
5. Condition of plant.
6. Method of heating.
7. System of waste heat recovery.
8. Method of charging and discharging the ovens.
9. Free space and shrinkage.

NOTES

10. The following particulars should be briefly stated:

- a. The method of quenching or dry cooling.
- b. The method of coke removal and transport to the screening plant.

11. The type, number and disposition of the governors should be stated.

12. The system of recovery of the by-products, including the type of offtake system, should be stated and a brief summary given regarding the following, referring particularly to any feature of the plant which may influence the volume, calorific value or composition of the gas after leaving the ovens, and before it is metered and tested for calorific value.

- a. Tar and liquor circulation in the gas-collecting main.
- b. Condensation.
- c. Exhausting machinery (type and means for regulating the suction).
- d. Tar fog extraction.
- e. Ammonia removal and the product manufactured.
- f. Method of final gas cooling, e.g. by direct or indirect means, and the cooling medium employed.
- g. The system of benzole recovery, including the extracting medium employed, e.g. creosote oil, gas oil, active carbon or refrigeration.
- h. Purification from H_2S , if practised.
- j. Naphthalene removal, if special means are employed.
- k. Metering.
- l. Method of gas disposal.
- m. Gas dilution, if any.

15. The duration of the test should be from the time of charging one specific oven to the time of charging another oven so as to give in the test period a definite number of oven charges. This applies to a battery working on a regular time schedule. Where this is not the case the time for stopping the test should be chosen so that the plant is in the same position in the cycle of operations as at the beginning of the test. Particulars of any stoppages should be recorded.

18. The total amount of charge carbonized should be obtained by direct weighing (see Item 25). All weighing machines should be tested in an approved manner before and after the test. In the case of machines working in conjunction with conveyors the apparatus should be tested against a known weight of charge immediately before and after the test period. Calculation of the weight of charges carbonized from bulk density measurements is undesirable, but in the event of direct weighing being impracticable agreement should be reached between the parties concerned on the method to be used for determining the weight of charges. Convenient methods of determining bulk density are given in Appendix C.

In arriving at the weight of the charges, due and proper allowance should be made for spillage from the ovens during levelling, depending on the method of handling spillage at the plant under test.

A. General information and description of plant — *continued*

- 10. Treatment of coke.

- 11. Method of governing the pressure in the ovens.
- 12. Treatment of gas.

B. Plant performance

General

- 13. Date and time of commencement of test.
- 14. Throughput expressed as a proportion of the rated capacity..... . per cent
- 15. Duration of test..... .days

- 16. Total number of charges during test.
- 17. Number of ovens in use.
- 18. Total weight of charges during test..... .tons

NOTES

19. Item 18
Item 15

20. Item 18
Item 16

21. Item 19
Item 17

22. Item 15 × Item 17 × 24
Item 16

23. Item 22 minus the average interval between the commencement of pushing and the completion of charging.

24. An optical pyrometer is to be used and the temperature of the hottest part of the flue brickwork observed (see Appendix D).

For regenerative ovens with vertical flue heating, including twin-flued ovens, three flues in each heating wall, two as nearly as possible equidistant from the centre and each end of the heating wall and one at the centre, are to be selected for observation. If the heating system is group-divided along the length of the wall, the centre flue of each group is to be selected.

In vertical flue ovens the pyrometer will generally be sighted on the hottest point at the base of the flue. All practical steps must be taken to avoid the least haziness in the flue and the temperatures are taken in flues in which the gas is not burning. All temperatures are corrected back to the temperature at the moment of reversal and at ten minutes after reversal by means of a cooling curve, both temperatures being recorded. To determine the cooling curve the temperature of selected flues is taken at reversal and at five minute intervals thereafter until the gas is again turned on in the normal heating schedule, the temperatures registered being plotted against time. Care is taken to keep the flue cover off for only the minimum possible time when taking these readings and to replace it immediately a reading has been taken, otherwise the cooling curve will be too steep. The average of the curves for six flues selected from different parts of the battery is taken as the cooling correction curve.

For regenerative ovens with horizontal heating flues, the temperature of each flue in every wall is to be observed both when on the "up draught" and "down draught" circuit, the fuel gas being shut off from each flue whilst actually taking the temperature.

Temperature readings are to be commenced five minutes after the "off gas"¹⁾ reversal and continued to within five minutes of the "on gas"¹⁾ reversal. These readings should be taken on each wall one or two hours before the scheduled pushing time of the adjacent oven. The observed temperatures are to be corrected to the actual temperatures immediately after and ten minutes after reversal, by means of previously constructed curves showing the average rate of cooling per minute of the flues read during an "off gas"¹⁾ period. These temperatures will be respectively the maximum skin temperature and the working temperature of the flues.

For waste heat batteries, the temperature of the flue connecting the heating flues with the waste gas flue in each wall is to be taken one or two hours before the scheduled pushing time of the adjacent oven.

In all cases the overall average of the temperatures obtained throughout the test period is taken as the average combustion flue temperature of the battery.

With vertical flue regenerative ovens, in addition to the temperatures taken along the length of the battery, as described, temperatures of each flue in every heating wall shall also be taken once during the test period, between 2½ and 1½ hours before one of the adjacent ovens is due for discharge. The temperatures obtained shall be corrected to the actual temperatures at reversal and ten minutes after reversal by means of cooling curves.

For the purpose of Clause 4d (ii) of the Foreword, the battery average of the daily maximum temperature for each position (i.e. coke-side, centre, pusher-side) shall be used for comparison and not the overall average temperature.

¹⁾ In the case of horizontal flued ovens having no reversal of fuel gas, these terms refer to air reversal.

B. Plant performance — *continued*

General

- 19. Total weight of charges, per day..... tons
- 20. Average weight of charge per oven..... .tons
- 21. Throughput per oven per day..... .tons
- 22. Average gross carbonizing time per charge..... . h..... . min
- 23. Average net carbonizing time per charge..... . h..... . min
- 24. Maximum flue temperatures:
 - a. Average for day
 - 1..... °C
 - 2..... °C
 - 3..... °C
 - 4..... °C
 - 5..... °C
 - b. Overall average..... °C

NOTES

25. In the case of a battery of coke ovens which is charged from the top by means of a charging car, the charge shall be sampled while the charging car is being filled ²⁾. By means of a suitable scoop 1 lb increments shall be taken to correspond with the charge delivered from each mouthpiece of the bunker; at least four increments each of 1 lb shall be taken. If the charging car has only three hoppers, the fourth increment shall be obtained by following the sequence 1 231, 2 312, 3 123; if there are only two hoppers, increments shall be taken alternately.

In the case of a battery of coke ovens using compressed charges, the charge shall be sampled when filling the stamping box, at least four 1 lb increments being taken.

The number of increments collected during each 24 hour period shall be initially not less than the following (see BS 1017-1, page 40):

Washed charges

Ash, per cent		
Less than 5	5–10	Over 10
32	128	270

It is recommended that the sampling accuracy be checked by the methods of BS 1017-1-2, before the period of the test and the number of increments adjusted (see BS 1017-1-3.3.3).

An air-tight bin shall be kept in a cool place and the increments placed in this bin as they are obtained. Air-tight bins should preferably be of the type having a hinged lid equipped with a rubber seal, when loss of moisture due to change of air when increments are admitted will be very small provided that this operation is completed in the minimum of time. At the end of each 24 hour period the daily gross sample shall be mixed and prepared according to the methods of BS 1017-1, samples for sieve analysis, moisture and proximate analysis being withdrawn (Ref. BS 1016-1 and BS 1016-3). The averages of the daily sieve analysis, moisture and proximate analysis determinations shall be taken as the sieve analysis, moisture content and analysis of the coal charged during the test period. At the end of the complete period of test, the daily samples shall be thoroughly mixed and a laboratory sample prepared in accordance with BS 1017-1. The tests to be made on the final sample shall be ultimate analysis and calorific value, in accordance with BS 1016-5 and BS 1016-6. The reject from the first division shall be used for determinations of bulk density and size analysis. The figure determined for the moisture content of the charge may require correction if an oil of low distillation range has been added to the charge; the correction can be assessed by carrying out blank tests suited to the individual case.

26. The trade description, size, names, rank and the properties of each of the coals constituting the blend should be stated. A detailed description and size distribution (if applicable) of any components of the blend other than coals should be given. The relative proportion of all components of the charge should be stated.

27. The sample of the charge should be sieved in accordance with BS 1293 and BS 410.

²⁾ See BS 1017 “The sampling of coal and coke”.