

CONFIRMED
September 1997

Methods for

Analysis and testing of coal and coke —

Part 6: Ultimate analysis of coal

UDC [662.66 + 662.74]:543.84

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- British Carbonization Research Association*
- British Cast Iron Research Association
- British Ironfounders' Association
- British Mechanical Engineering Confederation
- Central Electricity Generating Board*
- Chamber of Coal Traders
- Coke Oven Managers' Association*
- Combustion Engineering Association*
- Council of Ironfoundry Associations
- Department of Energy
- Domestic Solid Fuel Appliances Approval Scheme
- Greater London Council
- Health and Safety Executive
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- National Coal Board*
- Society of British Gas Industries
- Solid Fuel Advisory Service
- Water-tube Boilermakers' Association
- Women's Solid Fuel Council

The 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 Coal Exporters' Federation
- British Gas Corporation
- British Steel Corporation
- Cement Makers' Federation
- Chemical Industries Association
- Electricity Supply industry in England and Wales
- Institute of Trading Standards Administration
- London Coal Exporters' Association
- Scientific Instruments Manufacturers' Association of Great Britain
- Society of Chemical Industry
- Solid Smokeless Fuels Federation
- Independent experts

This British Standard, having been prepared under the direction of the Solid Fuel Standards Committee, was published under the authority of the Executive Board on 29 April 1977

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First published March 1942
First revision December 1958
Second revision April 1969
Third revision April 1977

The following BSI references relate to the work on this standard:
Committee references SFC/45 and SFC/45/8
Draft for comment 73/42187DC

ISBN 0 580 09173 2

Amendments issued since publication

Amd. No.	Date of issue	Comments
6982	May 1992	
7689	May 1993	Indicated by a sideline in the margin

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Foreword

BS 1016 comprises a series of Parts dealing with methods for the analysis and testing of coal and coke. It is gradually being restructured and Parts in the new series have been allocated numbers from 100 onwards. The current Parts are as follows, with new Part numbers (which will be given to revisions when they are published) in parentheses where appropriate.

- *Part 1: Total moisture of coal (Part 101);*
- *Part 2: Total moisture of coke (Part 102);*
- *Part 6: Ultimate analysis of coal (Part 106);*
- *Part 7: Ultimate analysis of coke (Part 106);*
- *Part 8: Chlorine in coal and coke (Part 106);*
- *Part 9: Phosphorus in coal and coke (Part 106);*
- *Part 10: Arsenic in coal and coke (Part 106);*
- *Part 11: Forms of sulphur in coal (Part 106);*
- *Part 14: Analysis of coal ash and coke ash (Part 114);*
- *Part 15: Fusibility of coal ash and coke ash (Part 113);*
- *Part 16: Methods for reporting results (Part 100);*
- *Part 17: Size analysis of coal (Part 109);*
- *Part 18: Size analysis of coke (Part 110);*
- *Part 20: Determination of Hardgrove grindability index of hard coal (Part 112);*
- *Part 21: Determination of moisture-holding capacity of hard coal (Part 103);*
- *Part 104: Proximate analysis;*
- *Part 105: Determination of gross calorific value;*
- *Part 107: Caking and swelling properties of coal;*
- *Part 108: Tests special to coke;*
- *Part 111: Determination of abrasion index of coal.*

The methods given in BS 1016 are specified for the analysis of coal or of coke or, in some instances, for the analysis of both coal and coke. Experience has shown that, in general, the methods may also be used for the analysis of manufactured smokeless fuels other than coke made by a conventional process. However, as no systematic survey has been made of their applicability to all such fuels, it is not possible to state whether the ultimate analysis methods for coal or those for coke (see Part 7) will be more appropriate for a particular fuel; usually the former are likely to be satisfactory for fuels prepared at temperatures below 800 °C.

The revision of Part 6 has been undertaken in order to complete the introduction of metric units and to adopt a uniform presentation. No technical changes have been made to the methods retained from the previous edition of this Part, but the Liebig method has been deleted as it is now little used for the determination of carbon and hydrogen in coal.

The high temperature method for the determination of carbon and hydrogen is technically equivalent to ISO 609. Similarly, the method for nitrogen, the method for sulphur and the gravimetric method for carbon dioxide correspond technically with those specified in ISO 333, ISO 351 and ISO 925 respectively. There is no ISO titrimetric method for the determination of carbon dioxide.

In the foreword to the last revision of Part 6 it was stated that it might shortly be possible to specify a satisfactory procedure for the direct determination of oxygen in coal. Since then, ISO 1994 has been published on the basis of international collaborative work in which a number of UK laboratories took part. It has been decided that it is unnecessary to issue a British Standard on this subject but that, where a direct oxygen determination is needed, a reference should be made to ISO 1994. The definition of ultimate analysis of a coal consequently includes oxygen as one of its chemical constituents, this being identical with the ISO definition.

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 14, 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 1016 describes methods of determining carbon, hydrogen, nitrogen, sulphur and carbon dioxide in the analysis sample of coal. In order to quote the ultimate analysis of coal a value for oxygen is required; this may be determined by the method specified in ISO 1994 or estimated as a difference figure and reported as “oxygen plus errors”.

2 References

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

3 Definitions

For the purposes of this Part of BS 1016 the following definitions apply.

3.1

ultimate analysis

the analysis of coal expressed in terms of its carbon, hydrogen, nitrogen, sulphur and oxygen contents

3.2

moisture in the analysis sample

the moisture in the analysis sample of coal after it has attained approximate equilibrium with the laboratory atmosphere to which it has been exposed

3.3

ash

the inorganic matter remaining after the coal has been incinerated to constant mass under standardized conditions

3.4

repeatability

the maximum acceptable difference between duplicate determinations carried out at different times in the same laboratory on the same analysis sample by the same operator using the same apparatus

3.5

reproducibility

the maximum acceptable difference between the mean of duplicate determinations carried out in one laboratory and the mean of duplicate determinations carried out in any other laboratory on representative samples taken from the same gross sample after the last stage of the reduction process

4 Introduction

The determination of the total amounts of carbon, hydrogen, nitrogen and sulphur, regardless of their origin, is described. The carbon includes that present in the mineral carbonates and the hydrogen includes that present both in the moisture and in the water of constitution of the argillaceous constituents of the mineral matter.

All the nitrogen is assumed to be present in the coal substance. Sulphur is normally present in three forms: as iron pyrites (FeS_2), as inorganic sulphates associated with the mineral matter, and as organic sulphur compounds in the coal substance.

Oxygen in the coal substance may be determined by one of the procedures given in ISO 1994.

Alternatively, an estimate of the percentage of oxygen can be obtained on the air-dried basis by subtracting the sum of the determined percentages of moisture, ash, carbon, hydrogen, nitrogen and sulphur from 100. The value so obtained for oxygen may be inaccurate because it includes the cumulative errors of all the determinations made, and it should therefore be reported as “oxygen (plus errors)”. A more satisfactory value for oxygen is obtained when the ultimate analysis is expressed on the dry, mineral matter free basis (see Part 16 of this standard).

The value for oxygen (d.m.m.f.) so calculated, can be checked by comparing the determined calorific value of the coal (corrected to the d.m.m.f. basis) with the calorific value calculated from the formula:

$$Q - 80.3 C + 339 H - 36.6 O + 0.172 O^2$$

where

C represents the determined value of carbon

H represents the determined value of hydrogen

O represents the value of oxygen calculated from the following formula:

$$O = 100 - (C + H + N) \text{ d.m.m.f. basis}$$

If the calculated and determined values of the calorific value agree within 125 J/g, then it can be considered that the determined values of C , H and N and therefore the calculated value of the oxygen content lie within the range of experimental error.

5 Sample

The coal used for the ultimate analysis shall be the analysis sample having a top size not greater than 0.2 mm (ground to pass a 212 μm test sieve complying with the requirements of BS 410), taken and prepared according to BS 1017-1.