
Methods for

Analysis and testing of coal and coke

Part 16. Methods for reporting results

Méthodes d'analyse et d'essai du charbon et du coke
Partie 16. Méthodes de présentation des résultats

Verfahren für die Analyse und Prüfung von Kohle und Koks
Teil 16. Verfahren zur Berichterstattung

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Foreword

This British Standard is Part 16 of a series issued under the same number, BS 1016, dealing with methods for the analysis and testing of coal and coke; the other Parts are as follows:

- Part 1 Total moisture of coal
- Part 2 Total moisture of coke
- Part 3 Proximate analysis of coal
- Part 4 Moisture, volatile matter and ash in the analysis sample of coke
- Part 5 Gross calorific value of coal and coke
- Part 6 Ultimate analysis of coal
- Part 7 Ultimate analysis of coke
- Part 8 Chlorine in coal and coke
- Part 9 Phosphorus in coal and coke
- Part 10 Arsenic in coal and coke
- Part 11 Forms of sulphur in coal
- Part 11 Caking and swelling properties of coal

- Part 13 Tests special to coke
- Part 14 Analysis of coal ash and coke ash
- Part 15 Fusibility of coal ash and coke ash
- Part 17 Size analysis of coal
- Part 18 Size analysis of coke
- Part 19 Determination of the index of abrasion of coal
- Part 20 Determination of the Hardgrove grindability index of hard coal
- Part 21 Determination of moisture-holding capacity of hard coal

This revision of Part 16 brings its presentation into line with that adopted in the revision of other Parts. The technical content is similar to that of the 1971 edition, but various minor changes have been made to take into account the revisions of the other Parts of BS 1016.

This Part of BS 1016 supersedes BS 1016 : Part 16 : 1971, which is therefore withdrawn.

Amendment No. 1
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Methods for analysis and testing of
coal and coke
Part 16. Methods for reporting results

Revised text

AMD 4155
February 1983

Clause 5.4 'Dry, ash free' basis

In paragraph 3, delete formula for $C_{o,daf}$, and substitute the following:

$$'C_{o,daf} = (C_{ad} - 0.273CO_{2,ad}) \times \frac{100}{100 - (M_{ad} + A_{ad})}'$$

NOTE. This amendment inserts a minus sign in the denominator of the second term between '100' and ' $(M_{ad} + A_{ad})$ '.

AMD 4155
February 1983

Clause 5.5.4.2 Hydrogen

Delete the formula and substitute the following:

$$'H_{dmmf} = (H_{ad} - 0.014 A_{ad} + 0.02S_{p,ad} + 0.02CO_{2,ad}) \times \frac{100}{100 - (M_{ad} + M_{ad})}'$$

NOTE. This amendment inserts a parenthesis after ' $0.02 CO_{2,ad}$ '.

AMD 4155
February 1983

Table 2. Repeatability and reproducibility of test methods

In column 6 headed 'Reproducibility between laboratories', in the entry against Part 12, positive dilation, delete ' $5\left(1 + \frac{d}{100}\right)$ ' and substitute ' $5\left(2 + \frac{d}{100}\right)$ '.

AMD 4155
February 1983

Clause A.7.1 Sulphur: Eschka method

In line 16, delete the second derived formula for S_{ad} and substitute the following:

$$' = \frac{100}{m_1} \times \frac{32.06}{233.386} \{m_2 - (m_3 - 0.03348m_4)\}'$$

NOTE. This amendment alters the number in the denominator of the second part of the formula from 233.398 to 233.386.

AMD 4155
February 1983

Clause A.10 Phosphorus: colorimetric method

In line 8, delete ' D ' and substitute ' D_3 '.

British Standard Methods for

Analysis and testing of coal and coke

Part 16. Methods for reporting results

1. Scope

This Part of BS 1016 gives information and formulae dealing with the conversion of analytical data for coal and coke to the various different bases in common use. Procedures for the interpretation of analytical results are also given.

2. References

The titles of the standards publications referred to in this Part of BS 1016 are listed on the inside back cover.

NOTE. Where, in the text, a Part is quoted without the BS number, this indicates a Part of BS 1016.

3. Definitions

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

3.1 coke. The solid product of the carbonization, generally at a temperature in excess of 900 °C, of a charge consisting predominantly of bituminous coal.

3.2 analysis sample. The sample of coal or coke used for general analysis, ground to pass a 212 µm aperture sieve complying with the requirements of BS 410, and taken and prepared in accordance with:

- (a) BS 1017 : Part 1, for coal;
- (b) BS 1017 : Part 2, for coke.

3.3 proximate analysis of coal. The analysis of coal expressed in terms of moisture, volatile matter, ash and fixed carbon.

3.4 total moisture. The moisture in the coal or coke as sampled.

3.5 moisture in the analysis sample

3.5.1 moisture in the analysis sample of coal. The moisture in the analysis sample of coal after it has been exposed to the laboratory atmosphere and has attained approximate equilibrium with it.

3.5.2 moisture in the analysis sample of coke. The moisture in the coke sample as analysed.

3.6 volatile matter. The loss in mass, less that due to moisture, that occurs when coal or coke is heated out of contact with air under standard conditions.

3.7 ash. The inorganic matter remaining after the coal or coke has been incinerated to constant mass under standard conditions.

3.8 fixed carbon (as applied to the proximate analysis of coal). A calculated figure obtained by subtracting the sum of the percentages of moisture, volatile matter and ash from 100 %.

3.9 calorific value

3.9.1 gross calorific value at constant volume. The number of heat units measured as being liberated when unit mass of solid fuel is burned in oxygen in a bomb under standard conditions, the materials after combustion (suitable corrections having been made) being taken as the gases, oxygen, carbon dioxide, sulphur dioxide and nitrogen, liquid water in equilibrium with its vapour and saturated with carbon dioxide, hydrochloric acid in solution and solid ash.

3.9.2 gross calorific value at constant pressure. The number of heat units that would be liberated if unit mass of fuel was burned in oxygen at constant pressure in such a way that the heat release was equal to the sum of the gross calorific value at constant volume and the heat equivalent of the work that would have been done by the atmosphere under isothermal conditions had the pressure remained constant.

3.9.3 net calorific value at constant volume. The number of heat units that would be liberated if unit mass of fuel was burned in oxygen at constant volume in such a way that the heat release was equal to the gross calorific value of the fuel at constant volume, less the latent heat of evaporation at a temperature of 25 °C and constant volume of the water both originally contained in the fuel and formed by its combustion.

3.9.4 net calorific value at constant pressure. The number of heat units that would be liberated if unit mass of fuel was burned in oxygen at constant pressure in such a way that the heat release was equal to the gross calorific value of the fuel at constant pressure, less the latent heat of evaporation at 25 °C and constant pressure of the water both originally contained in the fuel and formed by its combustion.

3.10 ultimate analysis. The analysis of coal or coke in terms of its carbon, hydrogen, nitrogen, sulphur and oxygen contents.

3.11 organic carbon in coal. The total carbon in the coal less that present as mineral carbonates.

3.12 mineral matter in coal. The inorganic material in coal, including water of constitution (e.g. as combined in silicates) and the carbon dioxide of mineral carbonates, but moisture as defined in 3.4 or 3.5.

3.13 forms of sulphur in coal

3.13.1 pyritic sulphur. The part of the sulphur in coal which is in the form of pyrites or marcasite.

3.13.2 sulphate sulphur. The part of the sulphur which is present in the coal as sulphate.



3.13.3 organic sulphur. Sulphur combined in the coal substance.

NOTE. The amount is calculated as the difference between the total sulphur in coal and the sum of the pyritic and sulphate sulphur.

3.14 crucible swelling number. The number that, by reference to a series of standard profiles, defines the size and shape of the residue produced when a standard mass of coal is heated under specified conditions.

3.15 Gray-King coke type. The letter or the letter and number that defines, by reference to a series of standard profiles, the size and texture of the coke residue produced when a standard mass of coal is heated in a retort tube to a temperature of 600 °C under standard conditions. For certain coals, subscripts applied to the letter G represent the proportion of electrode carbon or specially prepared anthracite required in admixture to produce a coke residue of profile G.

3.16 shatter index. The percentage of a specially prepared sample of coke remaining on a test sieve of stated aperture after the sample has been subjected to a specified dropping procedure.

3.17 Micum indices. The percentages of a specially prepared sample of coke remaining on a 40 mm aperture test sieve and passing a 10 mm aperture test sieve, denoted by M_{40} and M_{10} respectively, after the sample has been subjected to 100 revolutions by a specified procedure in a rotating drum.

NOTE. Other indices, e.g. M_{60} , M_{20} , may be reported if required. The subscript indicates the lower size of the test sample.

3.18 Isrid indices. The percentages of a specially prepared sample of coke remaining on a 40 mm aperture test sieve and passing a 10 mm aperture test sieve, denoted by I_{40} and I_{10} respectively, after the sample has been subjected to 500 revolutions by a specified procedure in a rotating drum.

NOTE. Other indices, e.g. I_{20} , may be reported if required. The subscript indicates the lower size of the test sample.

3.19 maximum contraction. The maximum downward movement of the piston of a dilatometer measured from the zero point when a standardized pencil of compressed powdered coal is heated. The value is expressed as a percentage of the initial coal pencil length.

3.20 maximum dilation. The maximum upward movement of the piston of a dilatometer measured from the zero point when a standardized pencil of powdered coal is heated. The value is expressed as a percentage of the initial coal pencil length and can be either positive or negative.

3.21 density

3.21.1 bulk density. The mass, in kg, of 1 m³ of dry coke, measured in a container of specified dimensions.

3.21.2 true relative density. The ratio of the mass of a given volume of a representative sample of dry coke, ground to pass a 212 µm aperture sieve complying with the requirements of BS 410, to the mass of an equal volume of water at the same temperature.

3.21.3 apparent relative density. The ratio of the mass of a given volume of dry coke, prepared specifically for the test, to the mass of an equal volume of water.

3.22 porosity. The proportion by volume of voids within a piece of coke, calculated from the true and apparent relative densities of the coke.

3.23 critical air blast. The minimum flow rate of air that will maintain combustion of a closely graded sample of coke in an ignited bed of specified dimensions.

3.24 index of abrasion. The total mass lost by abrasion of four carbon steel blades when rotated in a specified mass of coal under specified conditions, expressed in milligrams of metal loss per kilogram of coal.

3.25 fusibility of coal ash and coke ash. The properties of an ash prepared and tested under specified oxidizing or reducing conditions as defined by the following characteristics.

(a) **deformation temperature.** The temperature at which the first sign of rounding of the tip or of the edges of the specimen occurs.

(b) **hemisphere temperature.** The temperature at which the height of the specimen is equal to half the base, its shape being approximately hemispherical.

(c) **flow temperature.** The temperature at which the height of the specimen is equal to one-third of that at the hemisphere temperature.

3.26 repeatability (within laboratory). 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.

NOTE 1. Differences greater than the stated tolerance may be accepted after further replicate testing (see 6.4).

NOTE 2. See note 2 to 3.27.

3.27 reproducibility (between laboratory). The maximum acceptable difference between the mean of acceptable replicate determinations, carried out in one laboratory, and the mean of acceptable replicate determinations carried out in any other laboratory on representative samples taken from the same bulk sample after the last stage of the reduction process.

NOTE 1. See 3.26 and clause 6.

NOTE 2. The repeatability and reproducibility of determinations of total moisture in coal and in coke, and for the tests special to coke, are defined differently from the foregoing (see BS 1016 : Parts 1, 2 and 13).

4. Symbols

The majority of symbols used in this Part of this standard are listed below in alphabetical order. The basis on which a result is reported is defined by a literal subscript to the symbol; numerical subscripts are used to distinguish between different values of similar identities, e.g. mass or volume.

NOTE. Some of the symbols in the following list differ from those used for the same quantity in appendix A and other Parts of BS 1016, and some symbols in other Parts of BS 1016 have different quantities from those defined here; reference should be made to the usage in each Part.

It should be noted that the use of italic type of chemical symbols is deprecated. This method of denoting percentage content has, however, been retained to align with content and style of other Parts of BS 1016.

Symbol	Quantity
<i>A</i>	percentage of ash
<i>Al₂O₃</i>	percentage of alumina in ash
<i>As₂O₃</i>	percentage of arsenic oxide
<i>C</i>	percentage of carbon
<i>C_o</i>	percentage of organic carbon
<i>CaO</i>	percentage of calcium oxide in ash
<i>Cl</i>	percentage of chlorine
<i>Cl_o</i>	percentage of organic chlorine
<i>CAB</i>	critical air blast