INTERNATIONAL STANDARD

ISO 17247

Third edition
2020-08

Coal and coke — Ultimate analysis

Charbon et coke — Analyse élémentaire

Reference number
ISO 17247:2020(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 27, *Coal and coke*, Subcommittee SC 5, *Methods of analysis.*

This third edition cancels and replaces the second edition (ISO 17247:2013), of which it constitutes a minor revision. This edition includes the following changes compared to the previous edition:

— amending the title and the scope;

— updating of referenced documents;

— updating of the standard test methods used for ultimate analysis in Table 1;

— defining of constants in Table 2.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Coal and coke — Ultimate analysis

1 Scope

This document establishes a practice for the ultimate analysis of coal and coke and is intended for general utilization by the coal and coke industries to provide a basis for comparison of coals and cokes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 334, *Solid mineral fuels — Determination of total sulfur — Eschka method*

ISO 579, *Coke — Determination of total moisture*

ISO 589, *Hard coal — Determination of total moisture*

ISO 609, *Solid mineral fuels — Determination of carbon and hydrogen — High temperature combustion method*

ISO 625, *Solid mineral fuels — Determination of carbon and hydrogen — Liebig method*

ISO 687, *Solid mineral fuels — Coke — Determination of moisture in the general analysis test sample*

ISO 1171, *Solid mineral fuels — Determination of ash*

ISO 1213-2, *Solid mineral fuels — Vocabulary — Part 2: Terms relating to sampling, testing and analysis*

ISO 5068-1, *Brown coals and lignites — Determination of moisture content — Part 1: Indirect gravimetric method for total moisture*

ISO 5068-2, *Brown coals and lignites — Determination of moisture content — Part 2: Indirect gravimetric method for moisture in the analysis sample*

ISO 11722, *Solid mineral fuels — Hard coal — Determination of moisture in the general analysis test sample by drying in nitrogen*

ISO 19579, *Solid mineral fuels — Determination of sulfur by IR spectrometry*

ISO 20336, *Solid mineral fuels — Determination of total sulfur by Coulomb titration method*

ISO 29541, *Solid mineral fuels — Determination of total carbon, hydrogen and nitrogen content — Instrumental method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1213-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
ultimate analysis
analysis of a solid mineral fuel reported in terms of its carbon, hydrogen, nitrogen, sulfur, ash, moisture, and oxygen by difference

Note 1 to entry: This definition includes hydrogen and oxygen present in the water of constitution of the mineral matter associated with the coal substance and carbon and oxygen present in mineral carbonates.

[SOURCE: ISO 1213-2:2016, 3.237, modified — In the definition "on an air-dried basis" has been deleted and "moisture, and oxygen by difference" was added. Notes 1 and 3 to entry have been deleted and Note 2 to entry renumbered as Note 1 to entry.]

3.2
oxygen by difference
sum of carbon, hydrogen, nitrogen, sulfur, ash, and moisture of a solid mineral fuel, expressed as percent mass fraction, subtracted from 100

4 Principle

Coal and coke are analysed for carbon, hydrogen, nitrogen, sulfur, ash, and moisture. The oxygen by difference is calculated and the results are reported, to the preferred basis, as an ultimate analysis.

5 Preparation of sample

Prepare the sample so that it satisfies the requirements of the various test methods (see Table 1).

6 Test methods

Carry out the determination in accordance with the test methods specified in Table 1.

Table 1 — Standard test methods used for ultimate analysis

Component	Classical test method	Instrumental test method
Carbon and hydrogen	ISO 609 or ISO 625	ISO 29541
Nitrogen	—	ISO 29541
Total sulfur	ISO 334	ISO 19579 ISO 20336
Ash	ISO 1171	—
Moisture in the air-dried sample	ISO 687 ISO 5068-2 ISO 11722	—
Total moisture (if an “as received” reporting basis is required)	ISO 579 ISO 589 ISO 5068-1	—

7 Expression of results

The parameters as analysed in the sample or calculated by difference, expressed as percentage mass fraction, may be calculated to different bases using the formulae in Table 2.

See Annex A for an example of ultimate data reported to different bases.

Table 2 — Formulae for calculation of results to different bases

Reporting basis				
As analysed[a]	**Excluding hydrogen and oxygen from moisture**		**Dry**	**Including hydrogen and oxygen from moisture**
	Air dried (ad)	**As received** (ar)	(d)	**As received** (ar,m)
Parameter (ash, carbon, nitrogen or sulfur)				
P	$P_{ad} = P$	$P_{ar} = P_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right)$	$P_d = P_{ad} \times \left(\frac{100}{100 - M_{ad}} \right)$	$P_{ar,m} = P_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right)$
Hydrogen				
H	$H_{ad} = H - 0{,}111\,9 M_{ad}$	$H_{ar} = H_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right)$	$H_d = H_{ad} \times \left(\frac{100}{100 - M_{ad}} \right)$	$H_{ar,m} = H_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right) + 0{,}111\,9 M_{ar}$
Oxygen (by difference)				
$O = 100 - (C + H + N + S + A)$	$O_{ad} = O - 0{,}888\,1 M_{ad}$ or $O_{ad} = 100 - (C_{ad} + H_{ad} + N_{ad} + S_{ad} + A_{ad} + M_{ad})$	$O_{ar} = O_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right)$ or $O_{ar} = 100 - (C_{ar} + H_{ar} + N_{ar} + S_{ar} + A_{ar} + M_{ar})$	$O_d = O_{ad} \times \left(\frac{100}{100 - M_{ad}} \right)$ or $O_d = 100 - (C_d + H_d + N_d + S_d + A_d)$	$O_{ar,m} = O_{ad} \times \left(\frac{100 - M_{ar}}{100 - M_{ad}} \right) + 0{,}888\,1 M_{ar}$ or $O_{ar,m} = 100 - (C_{ar} + H_{ar} + N_{ar} + S_{ar} + A_{ar})$

[a] Including hydrogen and oxygen from moisture.

where

C, H, N, S, A are the percentage mass fractions of carbon, hydrogen, nitrogen, sulfur and ash, respectively, expressed on the sample as analysed (i.e. no corrections);

NOTE Hydrogen and oxygen reported on the as-analysed basis include hydrogen and oxygen in the free moisture that is associated with the analysis sample.

M is the moisture content, expressed as a percentage mass fraction;

O is the oxygen by difference;

100 is conversion factor from dimensionless mass fraction to percent, %;

0,111 9 is gravimetric factor for the ratio of the relative atomic mass of H (2H) to the relative molecular mass of H_2O, dimensionless;

0,888 1 is gravimetric factor for the ratio of the relative atomic mass of O to the relative molecular mass of H_2O, dimensionless.

8 Test report

The test report shall include the following information:

a) identification of the sample tested;

b) the method used by reference to this document, i.e. ISO 17247:2020;

c) the date of the determination;

d) the results and the method of expression used.

Annex A
(informative)

Ultimate analysis example

Parameter mass fraction in %	**As analysed**	**Excluding hydrogen and oxygen from moisture Air dried** (ad)	**Excluding hydrogen and oxygen from moisture As received** (ar)	**Dry** (d)	**As received** (ar,m)
Carbon	70,0	70,0	66,4	72,2	66,4
Hydrogen	4,34	4,00	3,79	4,12	4,69
Nitrogen	1,50	1,50	1,42	1,55	1,42
Sulfur	0,50	0,50	0,47	0,52	0,47
Ash	10,0	10,0	9,5	10,3	9,5
Oxygen by difference	13,7	11,0	10,4	11,3	17,5
Moisture in air-dried sample	—	3,0	—	—	—
Total moisture	—	—	8,0	—	—
Total	100,0	100,0	100,0	100,0	100,0