INTERNATIONAL STANDARD

ISO 11760

First edition
2005-02-15

Classification of coals

Classification des charbons

Reference number
ISO 11760:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11760 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*.

Introduction

Coals occur worldwide and vary significantly in their physical and chemical characteristics for a variety of reasons, both with respect to the organic coal substance and to the associated mineral matter that is always present to varying extents. Coals are an important source of energy, as well as being essential for the production of metallurgical cokes, and are widely used as feedstock for other industrial processes such as in the production of gaseous fuels and synthesis gas. Hence, a wide range of procedures has been developed by the International Organization for Standardization (ISO) for the analysis and testing of coals. These ISO procedures are variously designated as being applicable to "hard coals", "brown coals" and "lignite", "bituminous coals" and "anthracite". There are, however, no ISO definitions that specify the boundaries that apply to these descriptive terms, which all relate to the geological maturity (rank) of the coals. Further, there is no simple system for the classification of coals that can provide, on a comparative basis, an indication of coal characteristics on a worldwide basis. This ISO standard provides a basis for addressing both these issues.

The classification is not intended to be used for commercial purposes because the assessment and selection of coals for a specific purpose require detailed information that enables the likely performance of a coal in a particular application to be anticipated. The wide-ranging list of ISO analyses and tests provides that information.

The development of this ISO standard has been guided by the recently published "*International Classification of in-Seam Coals*"[14]. The ISO standard, however, represents a simplified version that incorporates some significant modifications made for reasons given in the classification details that follow.

Classification of coals

1 Scope

This International Standard describes a simple classification system for coals providing

— guidance on the selection of the appropriate ISO standard procedures for the analyses and testing of coals,

— international comparison of coals in terms of some key characteristics,

— descriptive categorization of coals.

The system is applicable to coals of all ranks, but care is required in relation to the classification of some types of coal.

The system may be applied to a wide range of representative coal samples, provided their exact nature is stated. Such samples include bore-core seam sections and composite samples, raw (as-mined) coal, washed coal, blends of coals of similar rank and selected, specified size fractions.

The system provides a broad framework within which coals can be assessed. The selection of coals for a specific use requires detailed information that enables the likely performance of a coal in a particular application to be anticipated. The wide-ranging list of ISO analyses and test procedures for coals serve this purpose. The selection of the appropriate procedures to be used in assessing a coal depends on the intended use.

2 Normative references

The following referenced documents are indispensable for the application 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 1213-2, *Solid mineral fuels — Vocabulary — Part 2: Terms relating to sampling, testing and analysis*

ISO 7404-1, *Methods for the petrographic analysis of bituminous coal and anthracite — Part 1: Vocabulary*

ISO 7404-5, *Methods for the petrographic analysis of bituminous coal and anthracite — Part 5: Method of determining microscopically the reflectance of vitrinite*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1213-2, ISO 7404-1 and the following apply.

3.1
coal
carbonaceous sedimentary rock largely derived from plant remains with an associated mineral content corresponding to an ash yield less than, or equal to, 50 % by mass (dry basis)

NOTE In the geological coalification sequence, the transformation from peat to coal is defined as occurring when the total *in-situ* moisture content has decreased to 75 % by mass. The upper limit for undisturbed coal seams in the normal coalification process leading to semi-graphite is defined as corresponding to a mean random vitrinite reflectance, $\bar{R}_r$, of 6,0 % or, preferably, a mean maximum vitrinite reflectance, $\bar{R}_{v,max}$, of 8 %, determined in accordance with ISO 7404-5. The upper limit, $\bar{R}_{v,max}$, for disturbed, contact altered, coals can exceed 10 %; see Table 1, Note 2.

3.2
vitrinite
group of macerals with a grey colour (as observed with reflected light under a microscope) and with a reflectance generally between that of the associated darker liptinite and lighter inertinite over the rank range in which the three respective maceral groups can be readily recognized

NOTE 1 In the upper range of medium rank, vitrinite reflectance can be less than that of liptinite (where liptinite is recognizable) whilst at very high rank ($\bar{R}_r > 4{,}0$ %), the maximum reflectance of both liptinite and vitrinite may exceed that of inertinite.

NOTE 2 In medium and high rank coals, vitrinite reflectance measurements should preferably be taken on telovitrinite or, in its absence, on the whole of the vitrinite population. Within low-rank coals, vitrinite reflectance measurements must be measured on the submaceral ulminite B, or preferably on Eu-ulminite, if present. Eu-ulminite consists of gelified plant tissues with the cell structures weakly visible in reflected white light. Ulminite B is the more highly reflecting part of ulminite; see [9].

3.3
inertinite
maceral group that is composed of particles having a reflectance in low and medium-rank coals that is higher than that of the macerals of the vitrinite and liptinite groups, but is lower than that of the corresponding vitrinite in very high-rank coals

NOTE The reflectance of inertinite macerals begins to be exceeded by that of the macerals of the vitrinite group when the vitrinite and inertinite reflectance, $\bar{R}_r$, has reached about 4 %; see [8].

3.4
liptinite

maceral group that includes sporinite, cutinite, suberinite, resinite, liptodetrinite and alginite

NOTE At low ranks, the reflectance of liptinite macerals is lower than that of vitrinite but converges with that of vitrinite at medium rank B to A. Liptinite macerals show stronger primary autofluorescence relative to that of macerals from the other maceral groups up to medium rank B.

3.5
lignite
brown coal
coal having a mean random vitrinite reflectance, $\bar{R}_r$, less than 0,4 %

NOTE The terms “brown coal” and “lignite” are frequently used as alternatives but the latter is the term now preferred by the International Commission for Coal and Organic Petrology; see [10].

3.6
sub-bituminous coal
coal having a mean random vitrinite reflectance, $\bar{R}_r$, equal to or greater than 0,4 % but less than 0,5 %

3.7
bituminous coal
coal, synonymous with medium-rank coal, having a mean random vitrinite reflectance, $\bar{R}_r$, equal to or greater than 0,5 %, but less than 2,0 %

3.8
anthracite
coal, synonymous with high-rank coal, having a mean random vitrinite reflectance, $\bar{R}_r$, equal to or greater than 2,0 % but less than 6,0 %, or, preferably, a mean maximum reflectance, $\bar{R}_{v,max}$, less than 8,0 % for geologically unaltered coal

3.9
hard coal
coal, comprising the medium-rank (bituminous) and high-rank (anthracite) coals, having a mean random vitrinite reflectance, $\overline{R}_r$, equal to or greater than 0,5 % and less than 6 % or, preferably, a mean maximum vitrinite reflectance, $\overline{R}_{v,max}$, less than 8,0 %

3.10
bed-moisture
natural moisture content of the coal *in situ* in the seam

NOTE It is necessary to take care to ensure that samples for this determination are free of open fissures, voids or other features that might entrain free water, and that there is no loss of moisture during sampling and sample preparation.

4 Classification

4.1 General

The physical and chemical properties of a coal are virtually all determined by its geological maturity (rank), petrographic composition and the amount (as well as the nature and mode of association) of the mineral matter present. Thus, for simplicity, this classification for coals is based on the following coal properties:

— vitrinite reflectance, expressed in percent: mean random reflectance, $\overline{R}_r$, to designate rank, where $\overline{R}_r$ is determined directly or calculated from $\overline{R}_{v,max}$; see ISO 7404-5;

— vitrinite content, expressed as percent by volume on a mineral-free basis: designation of the petrographic composition; see ISO 7404-3; see footnote to Table 5;

— ash yield, expressed as a percent on a basis: designation of the amount of inorganic material present; see ISO 1171.

NOTE For medium-rank coals, $\overline{R}_{v,max} = 1{,}07\ \overline{R}_r$ [6].

4.2 Rank — Primary categories

Three broad rank categories, low rank, medium rank and high rank, are defined in Table 1.

Table 1 — Definition of broad rank categories: low, medium and high rank

Rank	Definition
Low rank [a] (lignite and sub-bituminous coals)	bed moisture $\leqslant$ 75 % and $\overline{R}_r < 0{,}5$ %; see AS 2434-1[5]
Medium rank [a] (bituminous coals)	0,5 % $\leqslant \overline{R}_r <$ 2,0 %
High rank [b] (anthracites)	2,0 % $\leqslant \overline{R}_r <$ 6,0 % (or $\overline{R}_{v,max} <$ 8,0 %) [c]

[a] The boundary between low-rank and medium-rank coals is set at $\overline{R}_r = 0{,}5$ % since coals with $\overline{R}_r$ between 0,5 % and 0,6 % (the latter being the threshold value set for medium-rank coals in [14]) are texturally similar to coals with $\overline{R}_r$ greater than 0,6 %. The degree of gelification is high and shrinkage cracks are not observed when fresh coal is exposed to the atmosphere.

[b] $\overline{R}_{v,max} = 8{,}0$ % is just beyond the rank where $\overline{R}_{v,min}$ (~2,5 %) is falling rapidly from its maximum of $\overline{R}_{v,min}$ = ~3,5 % at $\overline{R}_{v,max} = 6$ % and marks the transition to increasing graphitization; see [16], [15]. (Contact-altered coals with $\overline{R}_{v,max}$ as high as 10,5 % are classified as anthracite in China.)

[c] $\overline{R}_{v,max}$ is preferred at this rank since $\overline{R}_r$ is difficult to measure reliably.