INTERNATIONAL STANDARD

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Hard coal — Determination of total moisture

Houille — Détermination de l'humidité totale

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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.

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 589 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 5, *Methods of analysis*.

This fourth edition cancels and replaces the third edition (ISO 589:2003), which has been technically revised.

Introduction

Moisture is an important parameter in respect of coal quality.

The moisture content of coal is not an absolute value and conditions for its determination have to be standardized. It is expected that the results given by the different methods specified here should be comparable within the limits of the tolerance quoted.

It is always necessary that the determination of the total moisture content of hard coals be considered in close connection with sampling. Therefore, this International Standard has been prepared in close relationship with the ISO standards for mechanical sampling ISO 13909 (all parts) and manual sampling ISO 18283.

A major problem with the preparation of test samples for the determination of moisture is the risk of bias due to inadvertent loss of moisture. This is dependent on the tightness of the sealing of sampling containers, the level of moisture content in the sample, the ambient conditions, the type of coal and the reduction and division procedures used. This is described in detail in ISO 13909-4 or ISO 18283.

Depending on the mass, the nominal top size and the facilities available where samples are taken, it is possible to dry the sample directly after sampling (air-drying), then to reduce the particle size and prepare a test sample for determination of moisture in the air-dried sample. Alternatively, the whole sample may be transported to the laboratory and the total moisture determined.

Hard coal — Determination of total moisture

1 Scope

This International Standard describes two methods for determination of the total moisture content of hard coals, a two-stage method and a single-stage method. For either method there is a choice between drying in air and drying in a nitrogen atmosphere. Depending on the coal rank, there may be systematic differences between the results obtained by drying in the different atmospheres on subsamples of the same sample. Drying in a nitrogen atmosphere is suitable for all hard coals, while drying in air is only suitable for hard coals not susceptible to oxidation.

NOTE The term “not susceptible to oxidation” cannot be defined easily. Usually, high-rank coals such as anthracites are not oxidized under the conditions described in this International Standard. For all other types of coal, this has to be verified by experiments.

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

ISO 13909-1, *Hard coal and coke — Mechanical sampling — Part 1: General introduction*

ISO 13909-2, *Hard coal and coke — Mechanical sampling — Part 2: Coal — Sampling from moving streams*

ISO 13909-3, *Hard coal and coke — Mechanical sampling — Part 3: Coal — Sampling from stationary lots*

ISO 13909-4:2001, *Hard coal and coke — Mechanical sampling — Part 4: Coal — Preparation of test samples*

ISO 18283:2006, *Hard coal and coke — Manual sampling*

3 Terms and definitions

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

4 Principle

4.1 Method A — Two-stage methods

4.1.1 Method A 1 — Drying under nitrogen in second stage

The sample is dried in air at ambient temperatures or at elevated temperatures not exceeding 40 °C (first or free-moisture stage) and the loss in mass recorded. The air-dried sample is crushed to 2,8 mm nominal top size and subsamples are dried at 105 °C to 110 °C in a nitrogen-flushed oven (second or residual moisture stage).

NOTE Residual moisture is often called moisture in the air-dried sample.

Provided that the result obtained for the determination of moisture in the analysis sample in accordance with ISO 11722 can be shown to give the same result as that for the second-stage moisture determination, the former may be used.

The moisture is calculated from the loss in mass at each of the two stages.

4.1.2 Method A 2 — Drying in air

The sample is dried in air at ambient temperatures or at elevated temperatures not exceeding 40 °C (first or free-moisture stage) and the loss in mass recorded. The air-dried sample is crushed to 2,8 mm nominal top size and subsamples are dried in air at 105 °C to 110 °C (second or residual moisture stage).

The moisture is calculated from the loss in mass at each of the two stages.

NOTE This method is suitable only for hard coals not susceptible to oxidation.

4.2 Method B — Single-stage methods

4.2.1 Method B 1 — Drying under nitrogen

The sample is crushed to a nominal top size of either 11,2 mm or, alternatively, 10 mm. A subsample is dried in a nitrogen-flushed oven at a temperature of 105 °C to 110 °C. The moisture is calculated from the loss in mass.

4.2.2 Method B 2 — Drying in air

The sample is crushed to a nominal top size of either 11,2 mm or, alternatively, 10 mm. A subsample is dried in air at a temperature of 105 °C to 110 °C. The moisture is calculated from the loss in mass.

NOTE This method is suitable only for hard coals not susceptible to oxidation.

5 Reagent

Nitrogen, moisture-free, having an oxygen content of less than 30 µl/l.

NOTE Commercially available nitrogen with a water content of less than 5 µl/l does not require further drying.

6 Apparatus

6.1 Method A

6.1.1 Oven, for first-stage moisture determination, capable of being controlled at a temperature of 30 °C to 40 °C, with a sufficiently rapid rate of atmosphere change (e.g. 5 times per hour). The air velocity shall be such that the sample particles are not dislodged from their tray.

6.1.2 Nitrogen-flushed oven, for second-stage moisture determination, capable of being controlled at a temperature of 105 °C to 110 °C, with the additional provision for passing a current of dry nitrogen through it at a flow rate about 15 times the oven volume per hour. The gas velocity shall be such that the sample particles are not dislodged from their dish.

6.1.3 Oven, for second-stage moisture determination, capable of being controlled at a temperature of 105 °C to 110 °C, with a sufficiently rapid rate of atmosphere change (e.g. 5 times per hour). The air velocity shall be such that the sample particles are not dislodged from their dish.

6.2 Method B

6.2.1 Nitrogen-flushed oven, for method B 1, capable of being controlled at a temperature of 105 °C to 110 °C, with the additional provision for passing a current of dry nitrogen through it at a flow rate about 15 times the oven volume per hour. The nitrogen velocity shall be such that the sample particles are not dislodged from their tray.

6.2.2 Oven, for method B 2, capable of being controlled at a temperature of 105 °C to 110 °C and with a sufficiently rapid rate of atmosphere change (e.g. 5 times per hour). The air velocity shall be such that the sample particles are not dislodged from their tray.

6.3 Methods A and B

6.3.1 Weighing tray, made of heat- and corrosion-resistant material of such dimensions that the loading of the coal layer does not exceed 1 g/cm^2.

6.3.2 Weighing dishes, shallow vessels of glass, silica or corrosion-resistant metal with well-fitting covers of such a size that the loading of the coal layer does not exceed 0,3 g/cm^2.

6.3.3 Apparatus for size reduction (to 11,2 mm or 10,0 mm and 2,8 mm), without significant loss in moisture content.

6.3.4 Balance, capable of weighing to 0,1 g.

6.3.5 Analytical balance, capable of weighing to the nearest 1 mg.

6.3.6 Sample divider, e.g. riffle divider.

7 Sample

7.1 General

Depending on the mass, the nominal top size and the facilities available where samples are taken, it is possible to dry the sample (air-drying) directly after sampling, then to reduce the particle size and prepare a test sample for determination of moisture in the air-dried sample ("on-site treatment"). Alternatively, the whole sample may be transported to the laboratory and the moisture determined.