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Hard coal and coke — Determination of ash fusibility

Houille et coke — Détermination de la fusibilité des cendres

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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 540 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 540:1995), which has been technically revised.

Introduction

The method for determination of the fusibility temperatures of coal ash and coke ash described in this International Standard provides information about the fusion and melting behaviour of the composite inorganic constituents of the ash at high temperatures. The standard method is based on the “Seger Cone” method, which is well known in the ceramic industry, the use of which predates the year 1900. The conditions of the test, as well as basic studies on the influence of ash chemistry and of gas composition on ash fusibility temperatures (which have led to the standardization of the method), arose from the pioneering work of Fieldner, Hall and Field [1].

In the laboratory, the ash used for the test is a homogeneous mixture prepared from a representative sample of the coal or coke, and the determination is performed at a controlled rate of heating in either a reducing or an oxidizing atmosphere. In contrast, under industrial conditions, the complex processes of combustion and fusion involve heterogeneous mixtures of particles, heating rates (that can be several orders of magnitude greater than those used in the standard test) and variable gas composition.

During the first quarter of the 20th century, laboratory, pilot-scale and field studies were undertaken to establish that the ash fusibility test can provide a reasonable indication of the propensity of ash to form fused deposits (referred to as “clinker”) in stoker and other fuel-bed type furnaces (Nicholls and Selvig [2]). Subsequently, the test has been used as a general indicator of the tendency for ash to fuse on heating and of ash slagging propensity in pulverized coal-fired furnaces.

Hard coal and coke — Determination of ash fusibility

1 Scope

This International Standard specifies a method of determining the characteristic fusion temperatures of ash from coal and coke.

NOTE Descriptors: fossil fuels, solid fuels, ash, ashes, tests, high temperature tests, determination, and fusibility.

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 1171, *Solid mineral fuels — Determination of ash*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
deformation temperature
DT
temperature at which the first signs of rounding, due to melting, of the tip or edges of the test piece occur

NOTE Shrinkage or distortion of the test piece, or rounding of cracks and fins, are not criteria for deformation and should be ignored if the tip and edges remain sharp. However, for some solid mineral fuels, the temperature at which the test piece shrinkage begins can be of interest and should be reported as a feature noted during the determination.

3.2
sphere temperature
ST
in the case of pyramidal and truncated-cone test pieces, the temperature at which the height is equal to the width of the base, and in the case of cubical or cylindrical test pieces, the temperature at which the edges of the test pieces become completely round with the height remaining unchanged

3.3
hemisphere temperature
HT
temperature at which the test piece forms approximately a hemisphere, i.e. when the height becomes equal to half the base diameter

3.4
flow temperature
FT
temperature at which the ash melt is spread out over the supporting tile in a layer, the height of which is one-third of the height of the test piece at the hemisphere temperature

4 Principle

A test piece made from the ash is heated under standard conditions and continuously observed. The temperatures at which characteristic changes of shape occur are recorded. The characteristic temperatures are defined in Clause 3. (See also Figures 2, 3 and 4.)

Although the determination is usually performed in a reducing atmosphere, additional information can sometimes be obtained by performing a further determination in an oxidizing atmosphere. In general, the reducing atmosphere in 7.1 gives the lowest characteristic temperatures.

5 Reagents

5.1 Dextrin, 100 g/l solution.

Dissolve 10 g of dextrin in 100 ml of water.

5.2 Petroleum jelly.

5.3 Gold wire, of diameter 0,5 mm or larger, or **gold plate**, of thickness 0,5 mm to 1,0 mm, with a purity of 99,99 % and a melting point of 1 064 °C.

5.4 Nickel wire, of diameter 0,5 mm or larger, or **nickel plate**, of thickness 0,5 mm to 1,0 mm, with a purity of 99,9 % and a melting point of 1 455 °C.

5.5 Palladium wire, of diameter 0,5 mm or larger, or **palladium plate**, of thickness 0,5 mm to 1,0 mm with a purity of 99,9 % and a melting point of 1 554 °C.

5.6 Carbon dioxide.

5.7 Hydrogen or **carbon monoxide**.

6 Apparatus

6.1 Furnace, electrically heated, which satisfies the following conditions.

a) It shall be capable of reaching the maximum temperature at which the properties of the ash are determined (a temperature of 1 500 °C or more can be required).

NOTE Some furnaces can have a practical upper operating temperature, e.g. 1 480 or 1 540 °C, due to the type of heating elements used in their manufacture.

b) It shall provide an adequate zone of uniform temperature in which to heat the test piece(s).

c) It shall provide means of heating the test piece(s) at a uniform rate from 815 °C upwards.

d) It shall be capable of maintaining the required test atmosphere (see 7.1) around the test piece(s).

e) It shall provide a means of observing the change of shape of the test piece(s) during heating.

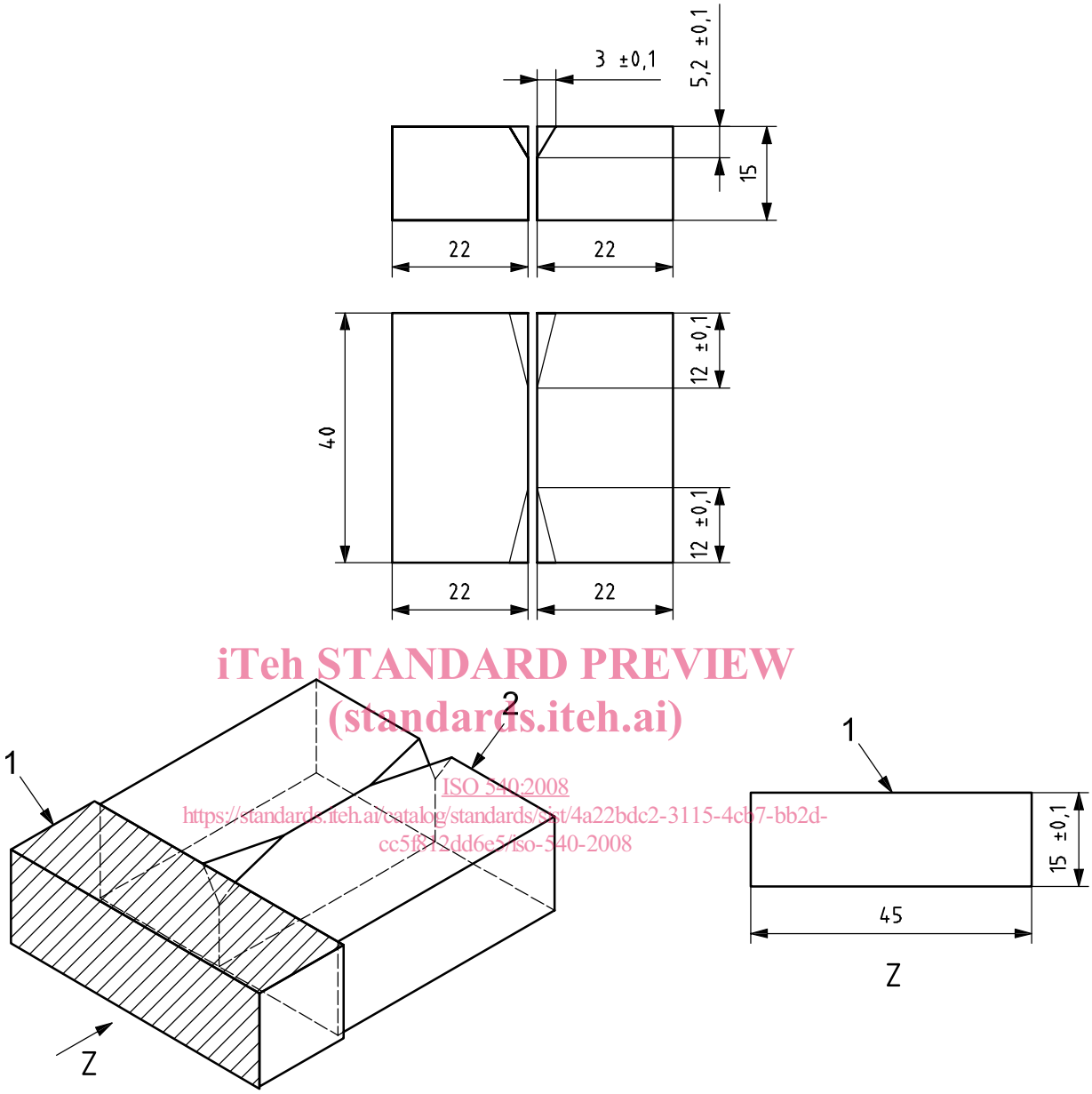
It is recommended to provide a facility for inserting, between the end window of the furnace and the optical viewing instrument, a piece of cobalt-blue or similar glass to protect the retina of the operator from radiation emitted at elevated temperatures.

6.2 Pyrometer, comprised of a platinum/platinum-rhodium thermocouple.

The thermocouple is positioned so that the thermo-junction is on the longitudinal axis in the centre of the zone of uniform temperature.

6.3 Mould, of brass, stainless steel, or other suitable material, for preparing the test piece. (See example in Figure 1.)

Dimensions in millimetres



Key

1 base plate
2 mould(s)

Figure 1 — An example of a mould that is suitable for making a pyramidal specimen