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Solid recovered fuels — Determination of content of volatile matter

*Combustibles solides de récupération — Détermination de la teneur
en composés volatils*

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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 300, *Solid recovered fuels*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 343, *Solid recovered fuels*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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.

Introduction

The volatile matter is determined as the loss in mass of the analysed sample, after moisture removal, when material is heated up under specific conditions of temperature, time and in a reduced atmosphere (anoxic conditions). The test is empirical and, in order to ensure reproducible results, it is essential that the rate of heating, the final temperature and the overall duration of the test are carefully controlled. It is also essential to exclude air from the solid recovered fuel during heating to prevent oxidation.

The moisture content of the sample is determined at the same time as the volatile matter so that the appropriate correction can be made. Mineral matter associated with the sample can also lose mass under the conditions of the test, the magnitude of the loss being dependent on both the nature and the quantity of the minerals present.

This document is primarily geared toward laboratories, producers, suppliers and purchasers of solid recovered fuels, but is also useful for the authorities and inspection organizations.

The method specified in this document is based on EN 15402^[3] as well as ISO 562.

For information about environmental aspect, see [Annex B](#).

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Solid recovered fuels — Determination of content of volatile matter

1 Scope

This document specifies the requirements and a method for the determination of volatile matter of solid recovered fuels.

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 21637, *Solid recovered fuels — Vocabulary*

ISO 21645¹⁾, *Solid recovered fuels — Methods for sampling*

ISO 21646²⁾, *Solid recovered fuels — Sample preparation*

ISO 21660-3³⁾, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 3: Moisture in general analysis sample*

3 Terms and definitions

ISO/FDIS 22167

For the purposes of this document, the terms and definitions given in ISO 21637 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

ash

ash content on dry basis

total ash

A

mass of inorganic residue remaining after combustion of a fuel under specified conditions, typically expressed as a percentage of the mass of dry matter in fuel

Note 1 to entry: Depending on the combustion efficiency the ash may contain combustibles.

Note 2 to entry: If a complete combustion is realized, ash contains only inorganic, non-combustible components.

[SOURCE: ISO 16559:2014, 4.13, modified — “Note 1 to entry” was removed and the following ones renumbered, and symbol “A” was italicized.]

- 1) Under preparation. Stage at the time of publication: ISO/FDIS 21645:2020.)
- 2) Under preparation. Stage at the time of publication: ISO/DIS 21646:2020.)
- 3) Under preparation. Stage at the time of publication: ISO/FDIS 21660-3:2020.)

3.2

removed ash contributors

rac

coarse inert material (i.e. metals, glass, stones, tiles etc.) removed from the pre-dried sample before preparation, in order to avoid damage to the preparation equipment

Note 1 to entry: Removed ash contributors are included in the ash content calculations.

[SOURCE: ISO 21637:2020, 3.62, modified – Note 1 to entry was added.]

3.3

total organic matter

combustible part of solid recovered fuels, which consists of the sum of volatile matter and fixed carbon

Note 1 to entry: It is calculated as: 100 - moisture content - ash content.

Note 2 to entry: It is the mass fraction of the matter lost by ignition, also known as “Loss Of Ignition” (LOI).

3.4

volatile matter

relative part of the analysed sample, after moisture removal, that is lost when material is heated up under specific conditions of temperature, time and in a reduced atmosphere (anoxic conditions)

3.5

fixed carbon

relative part of carbon contained in a material that can only be degraded in oxic conditions and high temperature

Note 1 to entry: It is calculated as: 100 - moisture content - volatile matter content - ash content.

3.6

pre-drying

drying process to minimise moisture loss in the subsequent sample division processes, to facilitate the sample preparation processes, and to minimise biological activity

4 Principle

A test portion of the general analysis sample is heated out of contact with ambient air at (900 ± 10) °C for 7 min. The percentage of volatile matter is calculated from the loss in mass of the test portion after deducting the loss in mass due to moisture. The test is empirical and, in order to ensure reproducible results, it is essential that the rate of heating, the final temperature and the overall duration of the test are carefully controlled.

Automatic equipment (such as thermogravimetric analysers) may be used as long as the equipment is validated by parallel measurements to the reference method. The automatic equipment shall fulfil all the requirements regarding sample size, heating procedure, temperature, atmosphere and weighing accuracy. Deviations from this paragraph shall be reported and justified.

5 Apparatus

5.1 Furnace

The furnace shall be heated electrically and capable of maintaining a temperature of (900 ± 10) °C. It may be of the stop-ended type or fitted at the back with a flue with a diameter of about 25 mm and a length of about 150 mm (see [Figure 1](#)).

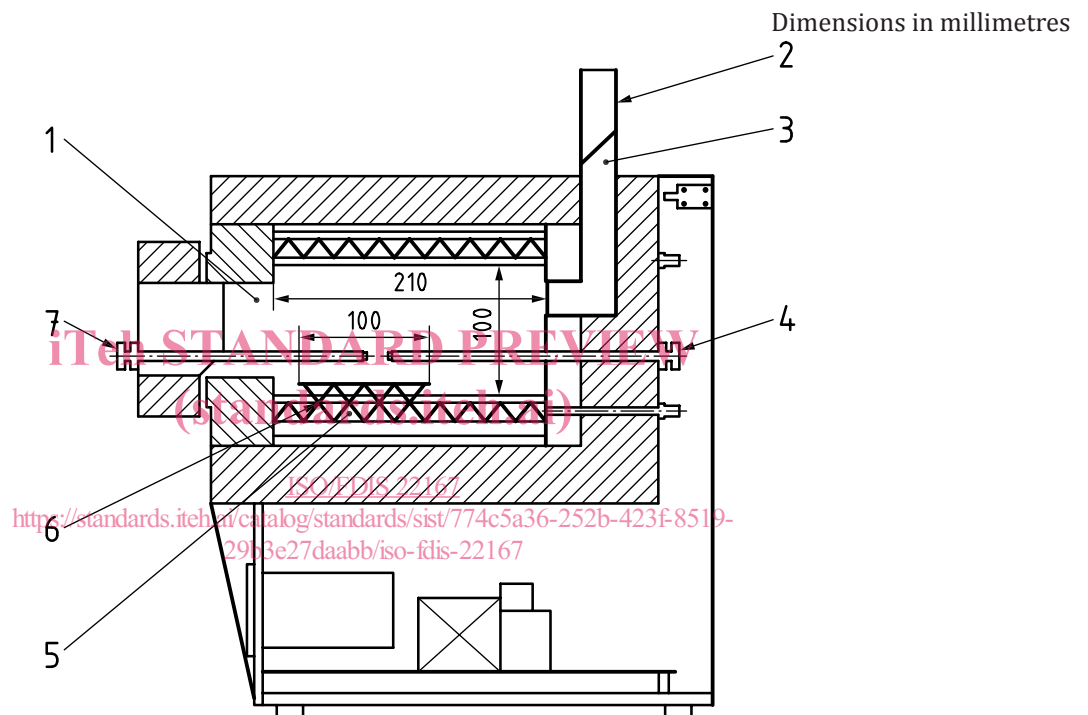
It is important for furnaces with flues that the furnace door seals well. The flue should not reach far out of the furnace and should be fitted with a butterfly valve to restrict airflow through the furnace.

The heat capacity of the furnace shall be such that, with an initial temperature of $(900 \pm 10) ^\circ\text{C}$, the temperature is regained within about 4 min after insertion of a cold stand and its crucibles. The temperature shall be measured with a thermocouple, as specified in 5.2.

NOTE Observing the temperature is very important in order to compensate for inherent deviations of the temperature measurement and lack of uniformity regarding the temperature distribution.

Usually the furnace will be designed specifically either for multiple determinations using a number of crucibles in one stand or for receiving one crucible and its stand. In the first case, the zone of uniform temperature shall be at least $160 \text{ mm} \times 100 \text{ mm}$; in the latter case, a zone of diameter about 40 mm is sufficient.

A position for the crucible stand shall be chosen within the zone of uniform temperature and this position shall be used for all determinations.



Key

1	chamber, 200 mm width	5	heating system
2	flue	6	zone of uniform temperature
3	valve	7	check thermocouple
4	thermocouple		

Note No design tolerances given, because it is an example of design. Standard practices can be followed.

Figure 1 — Example of suitable furnace

5.2 Thermocouple

The thermocouple shall be an unsheathed wire with a thickness $\leq 1 \text{ mm}$. It shall be long enough to reach the centre of the underside of each crucible when placed into the zone of uniform temperature on being inserted through the front or rear of the furnace. The thermo junction shall be placed midway between the base of the crucible in its stand and the floor of the furnace. If the stand holds more than one crucible, the temperature under each crucible shall be checked in the same manner.

If desired, a sheathed thermocouple may be permanently installed in the furnace (5.1) (see Figure 1) with its thermo junction as close as possible to the centre of the zone of uniform temperature; in

this case furnace temperature readings shall be correlated at frequent intervals with those of the unsheathed thermocouple which is thus inserted only if necessary.

NOTE The temperature/electromotive force relationship of a thermo junction maintained at elevated temperatures gradually changes with time.

5.3 Crucible

The crucible shall be cylindrical, with a well-fitting lid, both of fused silica, porcelain or other suitable material. The crucible with lid shall have a mass from 10 g to 14 g and dimensions approximating to those shown in Figure 2. The lid shall be selected to match the crucible such that the horizontal clearance between them is not more than 0,5 mm. After selection it is good practice to label the lid and crucibles so it is easy to identify the matching lid and crucible.

Dimensions in millimetres

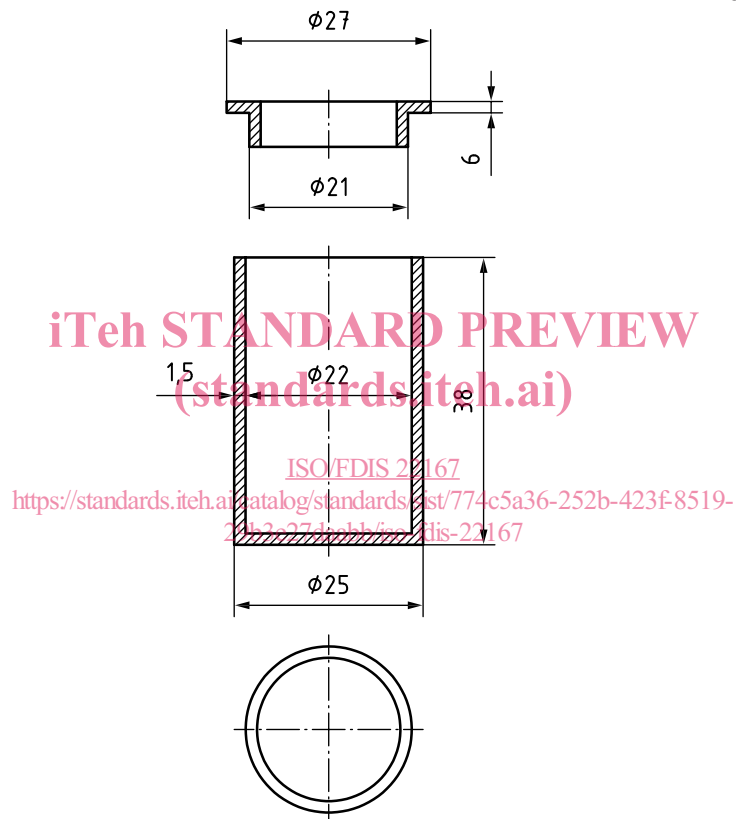


Figure 2 — Crucible and lid

If performing multiple determinations of expanding solid recovered fuels, it can be necessary to use taller crucibles; these may be up to 45 mm in height without affecting the determined volatile matter, provided that the specified rate of temperature recovery is maintained.

5.4 Crucible stand

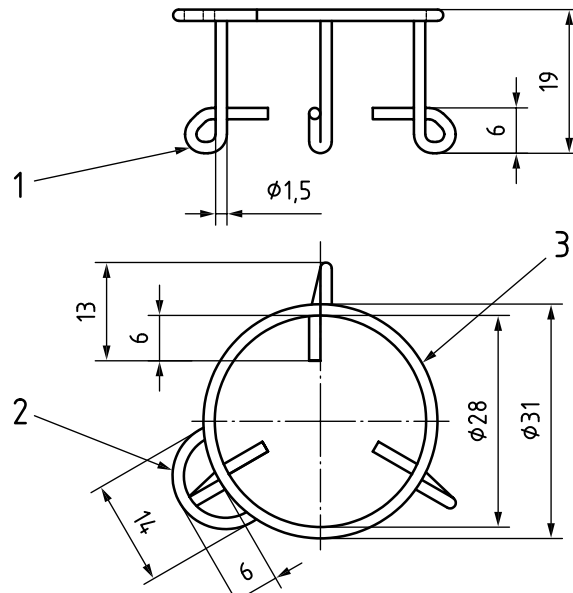
The crucible stand which the crucible (5.3) is placed on in the furnace (5.1), shall be such that the appropriate rate of heating is achievable. For example, it may consist of the following:

- a) for single determinations, a ring of heat-resistant steel wire as shown in Figure 3 a), with ceramic discs with a diameter of about 25 mm and a thickness of about 2 mm, resting on the inner projection of its legs

or

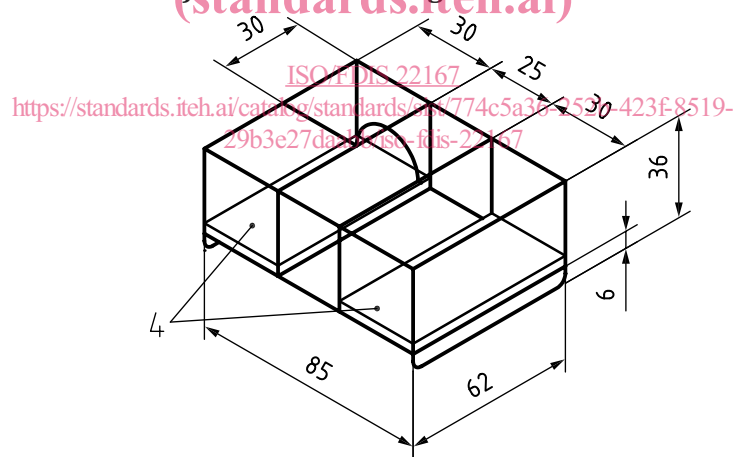
- b) for multiple determinations, a tray of heat-resistant steel wire as shown in Figure 3 b), of appropriate size, with ceramic plates with a thickness of about 2 mm supporting the crucibles.

Dimensions in millimetres



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a) Suitable for a single determination



b) Suitable for multiple determinations

Key

- 1 three legs spaced 120° apart
- 2 handle
- 3 ring
- 4 ceramic plates

Figure 3 — Crucible stand

5.5 Balance

The balance shall be readable to the nearest 0,1 mg.