INTERNATIONAL STANDARD

ISO 1182

Fourth edition
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Reaction to fire tests for building products — Non-combustibility test

Essais de réaction au feu des produits de construction — Essai d'incombustibilité

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 1182 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

This fourth edition cancels and replaces the third edition (ISO 1182:1990), which has been technically revised.

Annex C forms a normative part of this International Standard. Annexes A, B and D are for information only.

Contents

Foreword

The text of EN ISO 1182:2002 has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, the secretariat of which is held by BSI in collaboration with Technical Committee ISO/TC 92 “Fire safety”.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2002, and conflicting national standards shall be withdrawn at the latest by December 2003.

Annexes A, B and D are informative. Annex C is normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This fire test has been developed for use by those responsible for selection of construction products which, whilst not completely inert, produce only a very limited amount of heat and flame when exposed to temperatures of approximately 750 °C.

The limitation of the field of application to testing homogeneous products and substantial components of non-homogeneous products was introduced because of problems in defining specifications for the specimens. The design of the specimen of non-homogeneous products strongly influences the test results, which is the reason why non-homogenous products cannot be tested to this standard.

Safety warning

The attention of all persons concerned with managing and carrying out this test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful smoke and gases may be evolved during the test. Operational hazards may also arise during the testing of specimens and the disposal of test residues.

An assessment of all potential hazards and risks to health should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written safety instructions at all times.

1 Scope

This European Standard specifies a method of test for determining the non-combustibility performance, under specified conditions, of homogeneous building products and substantial components of non-homogeneous building products.

Information on the precision of the test method is given in annex A.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at appropriate places in the text, and the publications are listed hereafter. For dated references subsequent amendments to or revisions of, any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates.*

EN ISO 13943, *Fire safety — Vocabulary* (ISO 13943:1999).

EN 60584-2, *Thermocouples — Part 2: Tolerances* (IEC 60584-2:1982+A1:1989).

3 Terms and definitions

For the purpose of this European Standard, the terms and definitions given in EN ISO 13943, together with the following, apply:

3.1
product
material, element or component about which information is required

3.2
material
a single basic substance or uniformly dispersed mixture of substances e.g. metal, stone, timber, concrete, mineral wool with uniformly dispersed binder, polymers

3.3
loose fill material
material without any physical shape

3.4
homogeneous product
a product, consisting of a single material, having uniform density and composition throughout the product

3.5
non-homogeneous product
a product that does not satisfy the requirements of a homogeneous product. It is a product composed of more than one component, substantial and/or non-substantial

3.6
substantial component
a material that constitutes a significant part of a non-homogeneous product. A layer with a mass/unit area ≥ 1,0 kg/m^2 or a thickness ≥ 1,0 mm is considered to be a substantial component

4 Test apparatus

4.1 General

4.1.1 The test apparatus shall be capable of creating the conditions specified in 7.1. A typical design of furnace is given in annex B; other designs of furnace may be used.

4.1.2 All dimensions given in the description of the test apparatus are nominal values, unless tolerances are specified.

4.1.3 The apparatus shall consist of a furnace comprising essentially a refractory tube surrounded by a heating coil and enclosed in an insulated surround. A cone-shaped airflow stabilizer shall be attached to the base of the furnace and a draught shield to its top.

4.1.4 The furnace shall be mounted on a stand and shall be equipped with a specimen holder and a device for inserting the specimen-holder into the furnace tube.

4.1.5 Thermocouples, as specified in 4.4, shall be provided for measuring the furnace temperature and the furnace wall temperature. annex C gives details of additional thermocouples to be used if the specimen surface temperature and the specimen centre temperature are required. The thermal sensor, as specified in 4.5, shall be provided for measuring the furnace temperature along its central axis.

4.2 Furnace, stand and draught shield

4.2.1 The furnace tube shall be made of an alumina refractory material as specified in Table 1, of density (2 800 ± 300) kg/m^3 and shall be (150 ± 1) mm high with an internal diameter of (75 ± 1) mm and a wall thickness of (10 ± 1) mm.

Table 1 — Composition of the furnace tube refractory material

Material	Composition % (kg/kg mass)
Alumina (Al_2O_3)	> 89
Silica and alumina (SiO_2, Al_2O_3)	> 98
Ferric oxide (Fe_2O)	< 0,45
Titanium dioxide (TiO_2)	< 0,25
Manganese oxide (Mn_3O_4)	< 0,1
Other trace oxides (sodium, potassium, calcium and magnesium oxides)	The balance

4.2.2 The furnace tube shall be fitted in the centre of a surround made of insulating material 150 mm in height and of 10 mm wall thickness, and fitted with top and bottom plates recessed internally to locate the ends of the furnace tube. The annular space between the tubes shall be filled with a suitable insulating material. A typical example is given in annex B.

4.2.3 To the underside of the furnace shall be attached an open-ended cone-shaped air flow stabilizer 500 mm in length, and reducing uniformly from (75 ± 1) mm internal diameter at the top to (10 ± 0,5) mm internal diameter at the bottom. The stabilizer shall be manufactured from 1 mm thick sheet steel, with a smooth finish on the inside. The joint between the stabilizer and the furnace shall be a close, airtight fit, with a smooth finish internally. The upper half of the stabilizer shall be insulated externally with a suitable insulating material. A typical example is given in annex B.

4.2.4 A draught shield made of the same material as the stabilizer cone shall be provided at the top of the furnace. It shall be 50 mm high and have an internal diameter of (75 ± 1) mm. The draught shield and its joint with the top of the furnace shall have a smooth finish internally, and the exterior shall be insulated with a suitable insulating material. A typical example is given in annex B.

4.2.5 The assembly of the furnace, stabilizer cone and draught shield shall be mounted on a firm horizontal stand which shall be provided with a base and draught screen attached to the stand to reduce draughts around the bottom of the stabilizer cone. The draught screen shall be 550 mm high and the bottom of the stabilizer cone shall be 250 mm above the base plate.

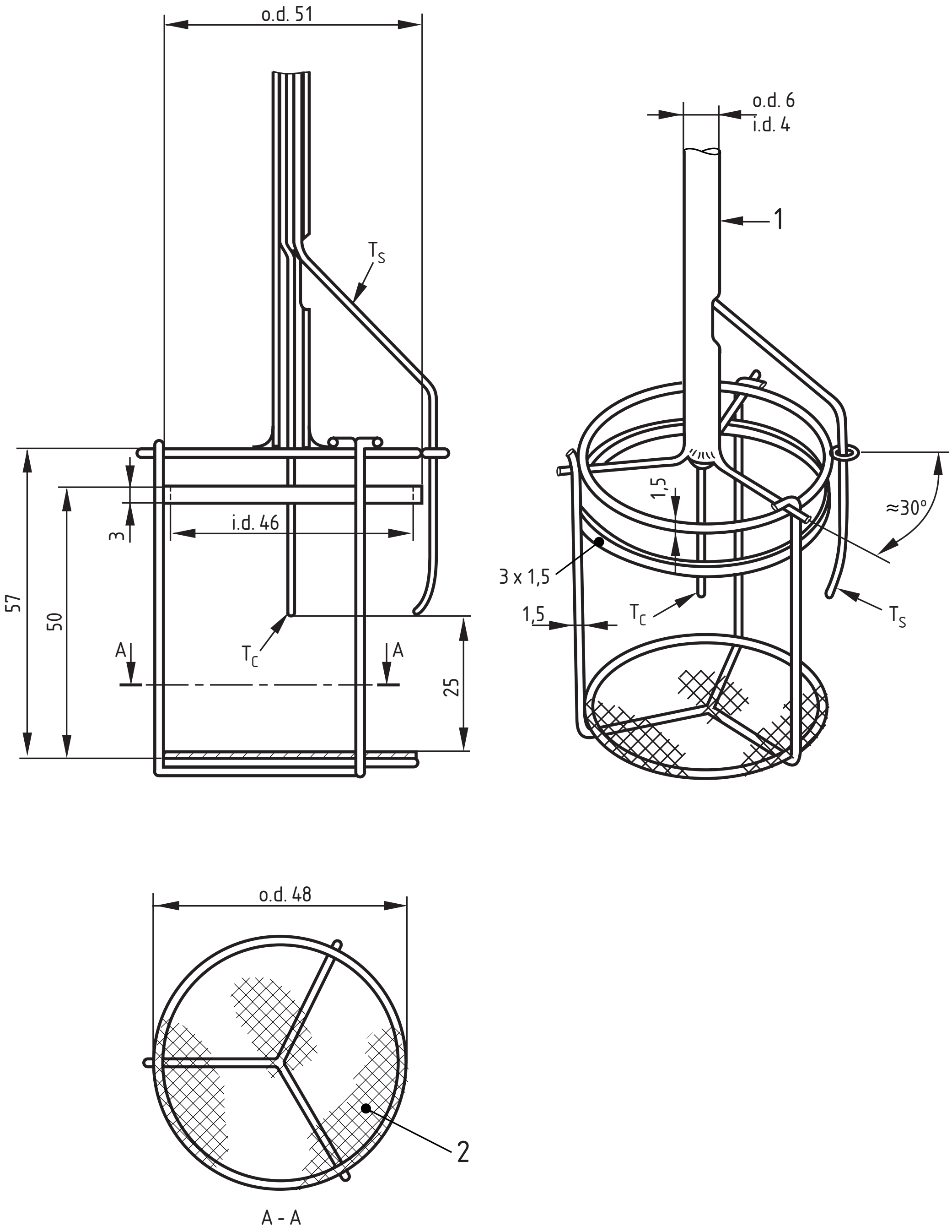
4.3 Specimen holder and insertion device

4.3.1 The specimen holder shall be as specified in Figure 1, and shall be made of nickel/chromium or heat-resisting steel wire. A fine metal gauze tray of heat-resisting steel shall be placed in the bottom of the holder. The mass of the holder shall be (15 ± 2) g.

4.3.2 The specimen holder shall be capable of being suspended from the lower end of a tube of stainless steel having an outside diameter of 6 mm and a bore of 4 mm.

4.3.3 The specimen holder shall be provided with a suitable insertion device for lowering it precisely down the axis of the furnace tube without shock, so that the geometric centre of the specimen is located rigidly at the geometric centre of the furnace during the test. The insertion device shall consist of a metallic sliding rod moving freely within a vertical guide fitted to the side of the furnace.

Dimensions in millimetres



Key

1 Stainless steel tube

2 Aperture mesh 0,9 mm diameter of wire 0,4 mm

T_c Specimen centre thermocouple

T_s Specimen surface thermocouple

Note - use of T_c and T_s is optional

Figure 1 — Specimen holder

4.3.4 The specimen holder for loose fill materials shall be cylindrical and of the same outer dimensions as the specimen (see 5.1) and made of a fine metal wire gauze of heat resisting steel similar to the wire gauze used at the bottom of the normal holder specified in 4.3.1. The specimen holder shall have an open end at the top. The mass of the holder shall not exceed 30 g.

4.4 Thermocouples

4.4.1 Thermocouples with a wire diameter of 0,3 mm and an outer diameter of 1,5 mm shall be used. The hot junction shall be insulated and not earthed. The thermocouples shall be of either type K or type N. They shall be of tolerance class 1 in accordance with EN 60584-2. The sheathing material shall be either stainless steel or a nickel based alloy.

4.4.2 All new thermocouples shall be artificially aged before use to reduce reflectivity.

4.4.3 The furnace thermocouple shall be located with its hot junction (10 ± 0,5) mm from the tube wall and at a height corresponding to the geometric centre of the furnace tube (see Figure 2). The position of the thermocouple may be set using the locating guide illustrated in Figure 3, and the correct position shall be maintained with the help of a guide attached to the draught shield.

4.4.4 Details of any additional thermocouples required and their positioning are given in annex C.

4.5 Thermal sensor

The thermal sensor shall be made of a thermocouple of the type specified in 4.4.1 and 4.4.2, brazed to a copper cylinder of diameter (10 ± 0,2) mm and height (15 ± 0,2) mm.

4.6 Mirror

To facilitate observation of sustained flaming and for the safety of the operators, it is advisable to provide a mirror above the apparatus, positioned so that it will not affect the test.

A mirror 300 mm square, at an angle of 30° to the horizontal, 1 m above the furnace has been found suitable.

4.7 Balance

A balance with an accuracy of 0,01 g is required.

4.8 Voltage stabilizer

This shall be a single-phase automatic voltage stabilizer with a rating of not less than 1,5 kVA.

It shall be capable of maintaining the accuracy of the output voltage within ± 1 % of the rated value from zero to full load.

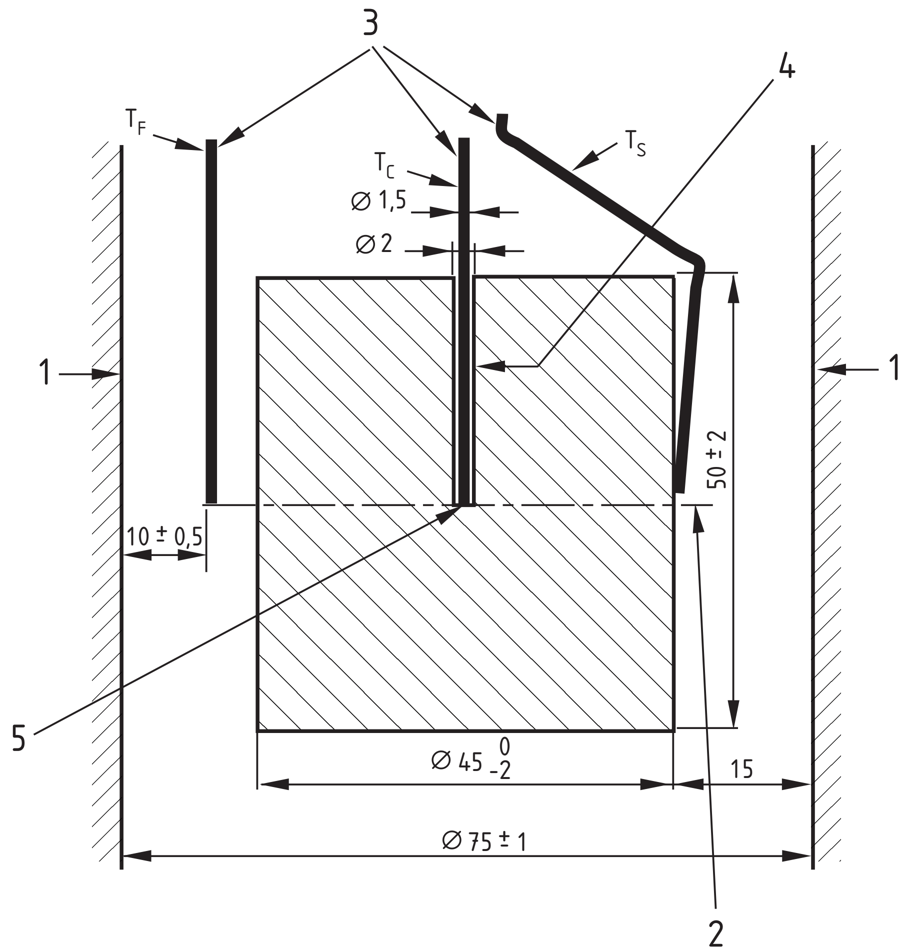
4.9 Variable transformer

This shall be capable of handling at least 1,5 kVA and of regulating the voltage output from zero to a maximum value equal to that of the input voltage. The voltage output shall vary linearly over the range.

4.10 Electrical input monitor

An ammeter, and voltmeter or wattmeter, shall be provided to enable rapid setting of the furnace to approximately the operating temperature. Any of these instruments shall be capable of measuring the levels of electrical power specified in 7.2.3.

Dimensions in millimetres



Key

1 Furnace wall

2 Mid-height of constant temperature zone

3 Sheathed thermocouples

4 2 mm diameter hole

5 Contact between thermocouple and material

T_F Furnace thermocouple

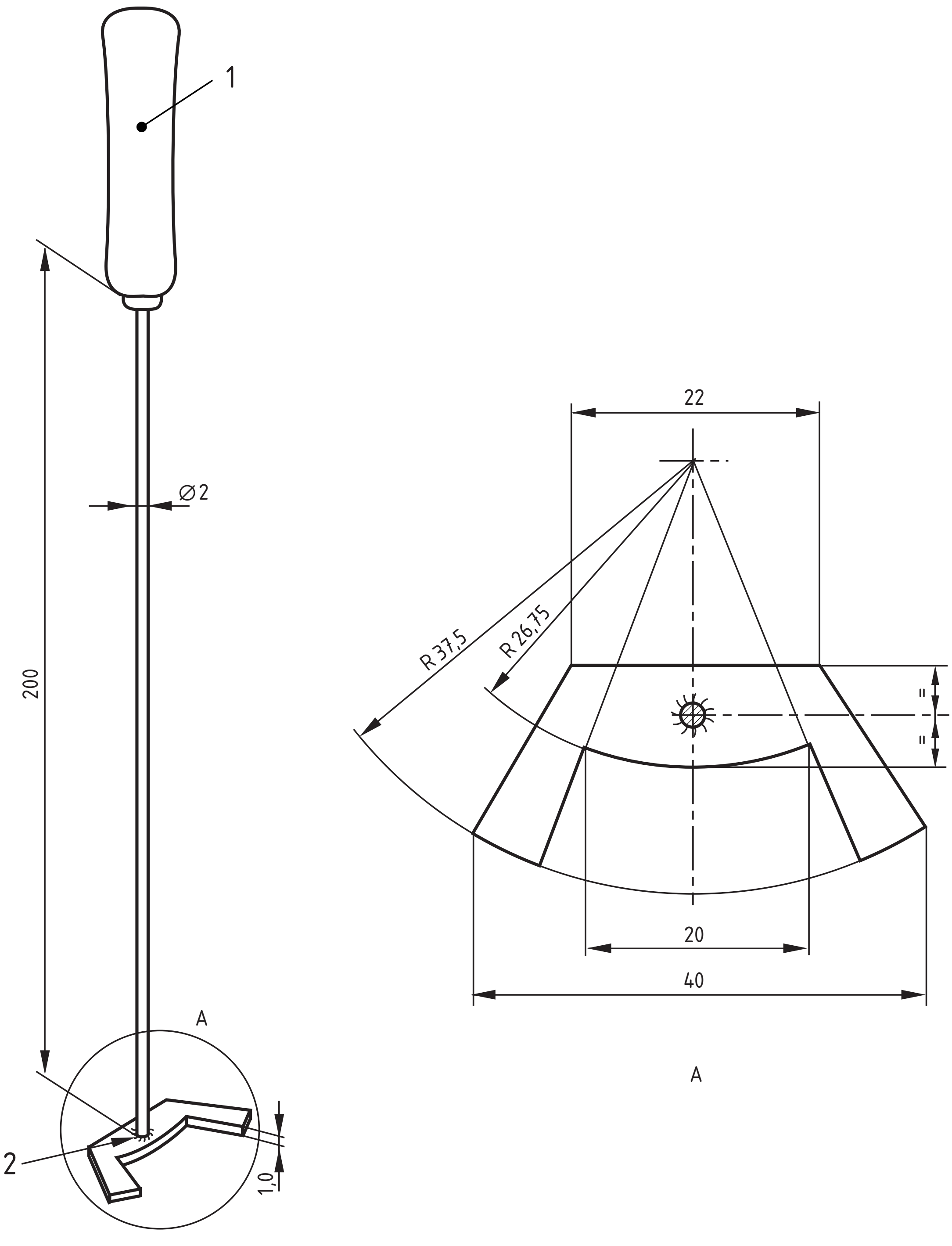
T_C Specimen centre thermocouple

T_S Specimen surface thermocouple

NOTE Use of T_C and T_S is optional.

Figure 2 — Relative position of furnace, specimen and thermocouple

Dimensions in millimetres



Key

1 Wooden handle

2 Weld

Figure 3 — A typical locating guide

4.11 Power controller

This can be used as an alternative to the voltage stabilizer, variable transformer and electrical input monitor specified in 4.8, 4.9 and 4.10. It shall be of the type which incorporates phase-angle firing and shall be linked to a thyristor unit capable of supplying 1,5 kVA. The maximum voltage shall not be greater than 100 V and the current limit shall be adjusted to give "100 % power" equivalent to the maximum rating of the heater coil. The stability of the power controller shall be approximately 1,0 % and the setpoint repeatability shall be ± 1,0 %. The power output shall be linear over the setpoint range.

4.12 Temperature indicator and recorder

The temperature indicator shall be capable of measuring the output from the thermocouple to the nearest 1 °C or the millivolt equivalent. It shall be capable of producing a permanent record of this at intervals of not greater than 1 s.

NOTE A suitable instrument is either a digital device or a multirange chart recorder with an operating range of 10 mV full scale deflection with a "zero" of approximately 700 °C.

4.13 Timing device

The timing device shall be capable of recording elapsed time to the nearest second and shall be accurate to within 1 s in 1 h.

4.14 Desiccator

This is used for storing the conditioned specimens (see clause 6).

5 Test specimen

5.1 General

The test specimen shall be taken from a sample which is sufficiently large to be representative of the product.

The test specimens shall be cylindrical and each shall have a volume of (76 ± 8) cm^3, a diameter of (45^{+0}_{-2}) mm and a height of (50 ± 3) mm.

5.2 Preparation

5.2.1 If the thickness of the material is different from (50 ± 3) mm, specimens of the height of (50 ± 3) mm shall be made by using a sufficient number of layers of the material and/or by adjustment of the material thickness.

5.2.2 The layers shall occupy a horizontal position in the specimen holder and shall be held together firmly, without significant compression, by means of two fine steel wires, of maximum diameter 0,5 mm, to prevent air gaps between layers. The specimens of loose fill materials shall be representative in appearance, density etc. as in use.

NOTE When a specimen is composed of a number of layers, the overall density should be as close as possible to that of the product provided by the manufacturer.

5.3 Number

Five specimens shall be tested following the procedure given in 7.4.

NOTE More specimens may be tested as required for any classification system.

6 Conditioning

The test specimens shall be conditioned as specified in EN 13238. Afterwards, they shall be dried in a ventilated oven maintained at (60 ± 5) °C, for between 20 h and 24 h, and cooled to ambient temperature in a desiccator prior to testing. The mass of each specimen shall be determined to an accuracy of 0,01 g prior to test.

7 Test procedure

7.1 Test environment

The apparatus shall not be exposed to draughts or any form of strong direct sunlight or artificial illumination which would adversely affect the observation of flaming inside the furnace.

The room temperature shall not change by more than 5 °C during a test.

7.2 Setting up procedure

7.2.1 Specimen holder

Remove the specimen holder (see 4.3) and its support from the furnace.

7.2.2 Thermocouple

The furnace thermocouple shall be positioned as specified in 4.4.3, and if additional thermocouples are required they shall be positioned as specified in 4.4.4 and annex C. All thermocouples shall be connected to the temperature indicator (see 4.12), using compensating cables.

7.2.3 Electricity supply

Connect the heating element of the furnace either to the voltage stabilizer (see 4.8), variable transformer (see 4.9) and the electrical input monitor (see 4.10) or the power controller (see 4.11) as shown in Figure 4. Automatic thermostatic control of the furnace shall not be used during testing.

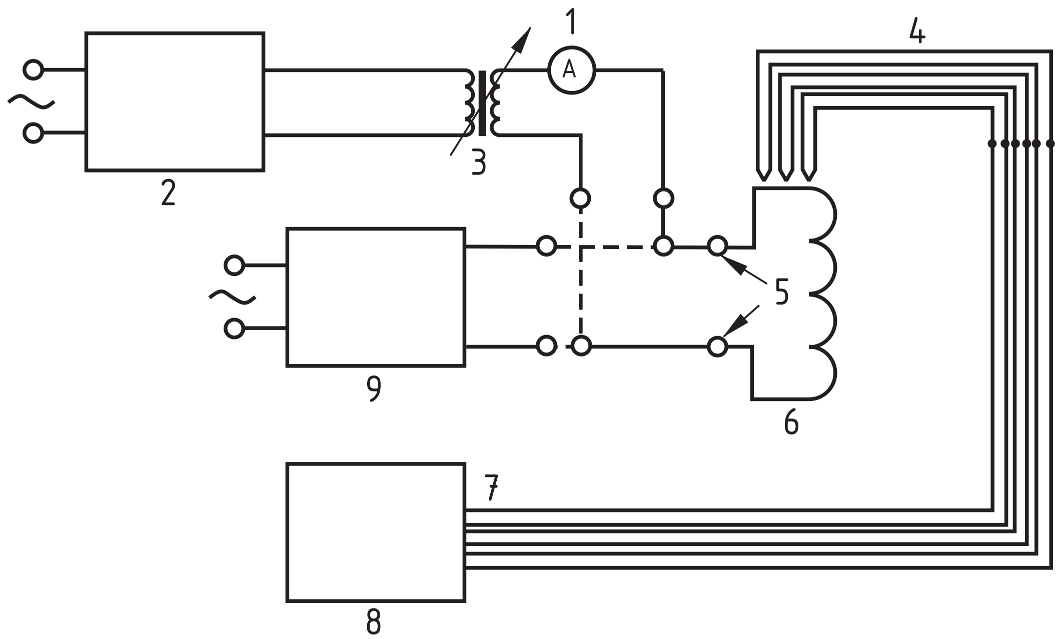
NOTE 1 The heating element should normally draw a current of between 9 A and 10 A at approximately 100 V under steady state conditions. In order not to overload the winding, it is recommended that the maximum current does not exceed 11 A.

NOTE 2 A new furnace tube should be subjected to slow heating initially. A suitable procedure has been found to be to increase the furnace temperature in steps of approximately 200 °C, allowing 2 h heating at each temperature.

7.2.4 Furnace stabilization

Adjust the power input to the furnace so that the average furnace temperature, as indicated by the furnace thermocouple (see 4.4), is stabilized for at least 10 minutes at (750 ± 5) °C. The drift (linear regression) shall be not more than 2 °C during these 10 minutes and there shall be a maximum deviation from the average temperature of not more than 10 °C in 10 minutes (see annex D).

Take a continuous record of the temperature.



Key

1 Ammeter
2 Voltage stabilizer
3 Variable transformer
4 Thermocouples
5 Terminal blocks
6 Furnace winding
7 Compensating cable
8 Temperature indicator
9 Power controller

Figure 4 — Layout of apparatus and additional equipment

7.3 Calibration procedure

7.3.1 Furnace wall temperature

7.3.1.1 When the furnace temperature is stabilized as given in 7.2.4, measure the temperature of the furnace wall using a contact thermocouple of the type specified in 4.5 and the temperature indicator specified in 4.12. Make measurements on three vertical axes of the furnace wall such that the distances separating each of the axes are the same. Record the temperatures on each axis at a position corresponding to the mid-height point of the furnace tube and at positions both 30 mm above and 30 mm below the mid-height point.

This procedure may be conveniently achieved using a suitable thermocouple scanning device with the thermocouple and insulating tubes in the positions specified above. Particular attention should be paid to the contact between thermocouple and furnace wall which, if poor, will lead to low temperature readings. At each measurement point the temperature recorded by the thermocouple shall be stable before a temperature reading is taken.

Nine temperature readings are obtained $T_{i;j}$ (i = axis 1 to 3; j = level a to c for +30 mm; 0 mm and –30 mm) as indicated in Table 2.

Table 2 — Position of furnace wall temperature readings

		Level	
Vertical axis	**a at 30 mm**	**b at 0 mm**	**c at – 30 mm**
1 (at 0 0)	$T_{1;a}$	$T_{1;b}$	$T_{1;c}$
2 (at 120 0)	$T_{2;a}$	$T_{2;b}$	$T_{2;c}$
3 (at 240 0)	$T_{3;c}$	$T_{3;b}$	$T_{3;c}$

7.3.1.2 Calculate and record the arithmetic mean of the nine temperature readings recorded in 7.3.1.1 as the average furnace wall temperature, T_{avg} .

$$T_{avg} = \frac{T_{1;a} + T_{1;b} + T_{1;c} + T_{2;a} + T_{2;b} + T_{2;c} + T_{3;a} + T_{3;b} + T_{3;c}}{9} \quad (1)$$

Calculate the arithmetic means of the temperature readings on the three axes recorded in 7.3.1.1 as the three vertical axes average furnace wall temperatures.

$$T_{avg.axis1} = \frac{T_{1;a} + T_{1;b} + T_{1;c}}{3} \quad (2a)$$

$$T_{avg.axis2} = \frac{T_{2;a} + T_{2;b} + T_{2;c}}{3} \quad (2b)$$

$$T_{avg.axis3} = \frac{T_{3;a} + T_{3;b} + T_{3;c}}{3} \quad (2c)$$

Calculate the absolute percentage value of the deviations of the temperature on the three axes from the average furnace wall temperature.

$$T_{dev.axis1} = 100 \times \frac{\left| T_{avg} - T_{avg.axis1} \right|}{T_{avg}} \tag{3a}$$

$$T_{dev.axis2} = 100 \times \frac{\left| T_{avg} - T_{avg.axis2} \right|}{T_{avg}} \tag{3b}$$

$$T_{dev.axis3} = 100 \times \frac{\left| T_{avg} - T_{avg.axis3} \right|}{T_{avg}} \tag{3c}$$

Calculate and record the average deviation (arithmetic mean) of the average temperature on each the three axes and the average furnace wall temperature.

$$T_{avg.dev.axis} = \frac{T_{dev.axis1} + T_{dev.axis2} + T_{dev.axis3}}{3} \tag{4}$$

Calculate the arithmetic means of the temperature readings on the three levels recorded in 7.1.6.1 as the three level average furnace wall temperatures.

$$T_{avg.level\,a} = \frac{T_{1;a} + T_{2;a} + T_{3;a}}{3} \tag{5a}$$

$$T_{avg.levelb} = \frac{T_{1;b} + T_{2;b} + T_{3;b}}{3} \tag{5b}$$

$$T_{avg.level\,c} = \frac{T_{1;c} + T_{2;c} + T_{3;c}}{3} \tag{5c}$$

Calculate the absolute percentage value of the deviations of the temperature on the three levels from the average furnace wall temperature.

$$T_{dev.level\ a} = 100 \times \frac{\left| T_{avg} - T_{avg.level\ a} \right|}{T_{avg}} \quad (6a)$$

$$T_{dev.level\ b} = 100 \times \frac{\left| T_{avg} - T_{avg.level\ b} \right|}{T_{avg}} \quad (6b)$$

$$T_{dev.level\ c} = 100 \times \frac{\left| T_{avg} - T_{avg.level\ c} \right|}{T_{avg}} \quad (6c)$$

Calculate and record the average deviation (arithmetic mean) of the average temperature on each of the three levels and the average furnace wall temperature.

$$T_{avg.level\ c} = \frac{T_{dev.level\ a} + T_{dev.level\ b} + T_{dev.level\ c}}{3} \quad (7)$$

The average deviation of the temperature on the three vertical axes from the average furnace wall temperature $T_{\text{avg.dev.axis}}$ (4) shall be less than 0,5 %.

The average deviation of the temperature on the three levels from the average furnace wall temperature $T_{\text{avg.dev.level}}$ (7) shall be less than 1,5 %.

7.3.1.3 Check that the average wall temperature at level (+30 mm) $T_{\text{avg.level}\ a}$ (5a) is less than the the average wall temperature at level (-30 mm), $T_{\text{avg.level}\ c}$ (5c).

7.3.2 Furnace temperature

When the furnace temperature is stabilized as given in 7.2.4 and when the furnace wall temperature is checked as given in 7.3.1, measure the temperature of the furnace along its central axis using the thermal sensor specified in 4.5 and the temperature indicator specified in 4.12. The following procedure shall be achieved using a suitable positioning device to locate precisely the thermal sensor. The reference for the vertical positioning shall be the top surface of the copper cylinder of the thermal sensor.

Record the temperature of the furnace along its central axis at a position corresponding to the mid height point of the furnace tube.

From this position, move the thermal sensor downwards in steps of maximum 10 mm until the bottom of the furnace tube is reached and record the temperature at each position once it has stabilized.

Move the thermal sensor from the lowest position upwards in steps of maximum 10 mm until the top of the furnace is reached and record the temperature in each position once it has stabilized.

From the top of the furnace move the thermal sensor downwards in 10 mm steps until the mid point of the furnace is reached and record the temperature in each position once it has stabilized.

For each position, two temperatures are recorded, one going upwards and one downwards. Report the arithmetic mean of these temperature records with distance.

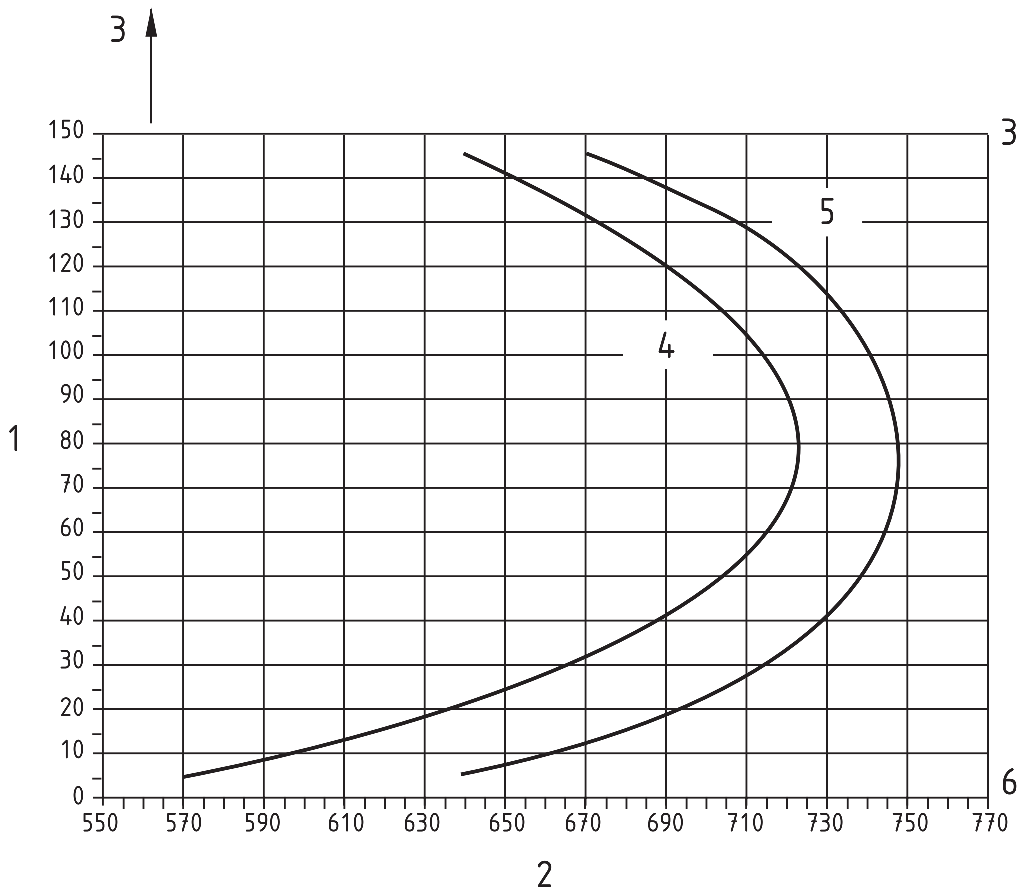
The calculated mean temperature at each level used shall be inside the limits specified as follows (see Figure 5):

$$T_{min} = 541{,}653 + (5{,}901 \times x) - (0{,}067 \times x^2) + (3{,}375 \times 10^{-4} \times x^3) - (8{,}553 \times 10^{-7} \times x^4)$$

$$T_{max} = 613{,}906 + (5{,}333 \times x) - (0{,}081 \times x^2) + (5{,}779 \times 10^{-4} \times x^3) - (1{,}767 \times 10^{-6} \times x^4)$$

where x is the furnace height in mm and x =0 mm corresponds to the bottom of the furnace

The values in Figure 5 are given in Table 3.



Key

1 Furnace height (mm)
2 Temperature (°C)
3 Top of the furnace
4 Lower limit (*T* min)
5 Upper limit (*T* max)
6 Bottom of the furnace

Figure 5 — Furnace temperature profile along its central axis measured with the thermal sensor

Table 3 — Furnace temperature profile values

furnace height (mm)	T_{min} (°C)	T_{max} (°C)
145	639,4	671,0
135	663,5	697,5
125	682,8	716,1
115	697,9	728,9
105	709,3	737,4
95	717,3	742,8
85	721,8	745,9
75	722,7	747,0
65	719,6	746,0
55	711,9	742,5
45	698,8	735,5
35	679,3	723,5
25	652,2	705,0
15	616,2	677,5
5	569,5	638,6

7.3.3 Procedure frequency

The procedures given in 7.3.1 and 7.3.2 shall be carried out for a new furnace and whenever the furnace tube, winding, insulation or power supply is replaced.

7.4 Standard test procedure

7.4.1 Stabilize the furnace as described in 7.2.4.

If the recorder used does not allow a real-time calculation, the temperature stabilization shall be checked afterwards. If the conditions specified in 7.2.4 were not satisfied, the test shall be repeated.

7.4.2 Before starting the test, ascertain that the whole equipment is in good working order, for example, that the stabilizer is clean, the specimen insertion device is working smoothly and the specimen holder exactly occupies the required position in the furnace.

7.4.3 Insert one specimen prepared and conditioned as specified in clause 6 into the specimen holder (4.3) suspended on its support.

7.4.4 Place the specimen holder in the furnace in the position specified in 4.3.3 taking not more than 5 s for this operation.

7.4.5 Start the timing device (4.13) immediately following the insertion of the specimen into the furnace.

7.4.6 Record throughout the test the temperature measured by the furnace thermocouple (4.4.3) and, if required (see annex C), the temperature measured by the surface thermocouple (4.4.4) and centre thermocouple (4.4.4).

7.4.7 Carry out the test for a period of 30 min.

If final temperature equilibrium, which is achieved when the temperature drift (linear regression) as measured by the furnace thermocouple does not exceed 2 °C over a period of 10 min, has been reached by the thermocouple at this time (30 min), the test shall be stopped. If final temperature equilibrium has not been reached by the thermocouple at 30 min, continue the test, checking for final temperature equilibrium at 5 min intervals thereafter. Stop the test once equilibrium is established by the thermocouple or after 60 min and note the duration of the test. Then remove the specimen from the furnace. The end of the test is the end of the final 5 min interval or 60 min (see annex D).

If the recorder used does not allow real-time calculation, the end recordings shall be checked after the test. If the requirements set out above are not satisfied, the test shall be repeated.

If additional thermocouples are used the test shall be stopped when final temperature equilibrium is achieved for all thermocouples used, or after 60 min.

7.4.8 After cooling to ambient temperature in a desiccator, weigh the specimen. Recover any char, ash or other debris which breaks off the specimen and falls down the tube, either during or following the test, and include this as a part of the unconsumed specimen.

7.4.9 Test all five specimens as given in 7.4.1 to 7.4.8.

7.5 Observations during test

7.5.1 Record the mass, in g, before and after the test for each specimen tested according to 7.4, and note any observations relating to the behaviour of the specimen during the test.

7.5.2 Note the occurrence of any sustained flaming and record the duration of such flaming in seconds. Sustained flaming shall be taken as the persistence of flames on or over any part of the visible part of the specimen lasting 5 s or longer.

NOTE Flaming is sometimes difficult to identify. Some specimens exhibit only a steady blue-coloured luminous gas zone; this should not be timed but should nevertheless be noted under 'observations during test' in the test report.

7.5.3 Record the following temperatures, in °C, as measured by the furnace thermocouple:

a) the initial temperature, T_I which is the average temperature over the final 10 min of the stabilisation period as defined in 7.2.4;

b) the maximum temperature, T_m which is the discrete value at maximum temperature anywhere over the entire test period;

c) the final temperature, T_f which is the average temperature over the final 1 min of the test period as defined in 7.4.7.

Examples of temperature recording are given in annex D.

If additional thermocouples are used record the temperatures as described in annex C.

8 Expression of results

8.1 Mass loss

Calculate and record the mass loss in % for each of the five specimens, expressed as a percentage of the initial mass of the specimen, measured as specified in 7.5.1.

8.2 Flaming

Calculate and record the total duration of sustained flaming, in s, for each of the five specimens measured as specified in 7.5.2.

8.3 Temperature rise

Calculate and record the temperature rise, $\Delta T = T_m - T_f$, in ^{0}C, for each of the five specimens recorded by the thermocouple as specified in 7.5.3.

9 Test report

The test report shall include the following information as a minimum. A clear distinction shall be made between the data provided by the sponsor and data determined by the test.

a) reference that the test was carried out in accordance with EN ISO 1182 (but see b));

b) any deviations from the test method;

c) name and address of the testing laboratory;

d) date and identification number of the report;

e) name and address of the sponsor;

f) name and address of the manufacturer/supplier, if known;

g) date of sample arrival;

h) identification of the product;

i) description of the sampling procedure, where relevant;

j) a general description of the product tested including density, mass per unit area and thickness, together with details of the construction of the product;

k) details of conditioning;

l) date of test;

m) calibration results expressed in accordance with 7.3.1 and 7.3.2;

n) test results expressed in accordance with clause 8, and C.5 if additional thermocouples are used;

o) observations made during the test;

p) the statement ‘The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use’.

Annex A
(informative)

Precision of test method

A round robin exercise was conducted by CEN/TC 127. The protocol used was functionally the same as described in this standard.

The products tested in this round robin were as described in Table A.1.

Table A.1 — Products included in the round robin exercise

Product	Density (kg/m^3)	thickness (mm)
Glass wool	10,9	100
Stone wool	145	50
Calcium silicate board with cellulose	460	50,8
Wood fibre board	50	-
Gypsum fibre board (10wt%- paper fibre)	1100	25
FR cellulose loose fill	30	-
Mineral wool loose fill	30	-
Vermiculux	190	50,1
Polystyrene concrete board	-	-

Values of statistical means (m), standard deviation (S_r and S_R), repeatability (r) and reproducibility (R) at 95 % confidence level were calculated according to ISO 5725-2[1)] (Table A.2) for the three parameters: temperature increase (ΔT in ((°C)), mass loss (Δm in %) and flaming time (t_f in s). Such values for r and R are equal to 2,8 times the appropriate standard deviation. The values include results identified as “stragglers” but exclude results identified as “outliers”.

1) ISO 5725-2:1994 Accuracy (trueness and precision) of measured methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method.

Table A.2 — Statistical results of the round robin exercise

	Statistical mean M	Standard Deviation S_r	Standard Deviation S_R	r	R	S_r/m %	S_R/m %
ΔT °C	from 1,60 to 144,17	From 1,13 to 20,17	from 1,13 to 54,26	from 3,15 to 56,47	from 3,15 to 151,94	from 9,37 to 70,36	From ,64 To 0,36
Δm (%)	from 2,12 to 90,13	from 0,25 to 1,68	from ,33 to 3,06	from 0,71 to 4,70	from 0,93 to 8,57	from 0,55 to 30,64	from 1,34 to 30,64
t_f (s)	from 0 to 251,22	from 0 to 37,05	from 0 to 61,75	from 0,00 to 103,73	from 0 to 172,90	from 9,19 to 43,37	from 23,94 to 136,19

It was possible for all the parameters to obtain linear models for S_r, S_R, r and R. The coefficients are presented in Table A.3. The graphic for ΔT is presented as an example in Figure A.1. For mass loss in % and flaming time in s, the results lead to models which are more or less meaningless even if they are statistically correct. More complicated models than simple linear models could better fit to these parameters but this was not considered in the round robin exercise.

Table A.3 — Statistical models of the round robin exercise

Parameters	S_r	S_R	r	R
ΔT °C	= 1,26 + 0,10 x ΔT	= 0,96 + 0,26 x ΔT	= 3,53 + 0,29 x ΔT	= 2,68 + 0,73 x ΔT
Δm °C	= 0,00 + 0,09 x Δm	= 0,00 + 0,11 x Δm	= 0,00 + 0,24 x Δm	= 0,00 + 0,30 x Δm
t_f (s)	= 0,00 + 0,14 x t_f	= 0,00 + 0,32 x t_f	= 0,00 + 0,38 x t_f	= 0,00 + 0,89 x t_f

When the models correctly fit to the parameters, they may be a tool to “predict” a result. This can be illustrated by means of an example. Suppose a laboratory tests a single specimen of a given product and determines that the temperature increase ΔT is 25 °C. If the same laboratory conducts a second test on the same product, the value of r is evaluated as:

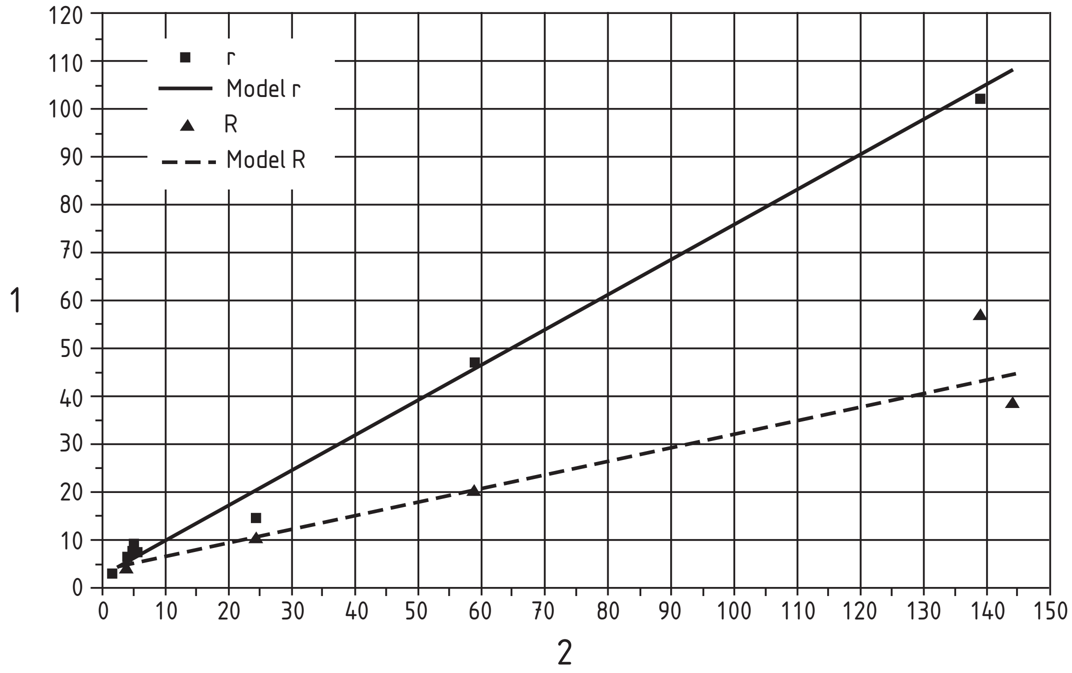
$r = 3{,}53 + 0{,}29 \times 25 \approx 11\ ^{0}\mathrm{C}$

Then the probability is 95 % that the result of the second test will fall between 14 °C and 36 °C.

Suppose now that the same product is tested by a different laboratory. The value of R is evaluated as:

$R = 2{,}68 + 0{,}73 \times 25 \approx 21\ ^{0}\mathrm{C}$

Then the probability is 95% that the results from the test at that laboratory will fall between 4 °C and 46 °C.



Key

1   ΔT

2   Estimated mean *m*

▲   R

–   Model r

■   R

---   Model R

Figure A.1 — Statistical model for ΔT in °C

Annex B
(informative)

Typical designs of test apparatus

B.1 General

A typical arrangement of the test apparatus is shown in Figure B.1.

B.2 Furnace tube

The furnace tube may be provided with a single winding of 80/20 nickel/chromium electrical resistance tape 3 mm wide and 0,2 mm thick, and may be wound as specified in Figure B.2. Grooves may be cut into the tube to allow accurate winding of the tape, at the discretion of the manufacturer.

The annular space between the tube and the external insulating wall may be filled with magnesium oxide powder of bulk density of (170 ± 30) kg/m^3.

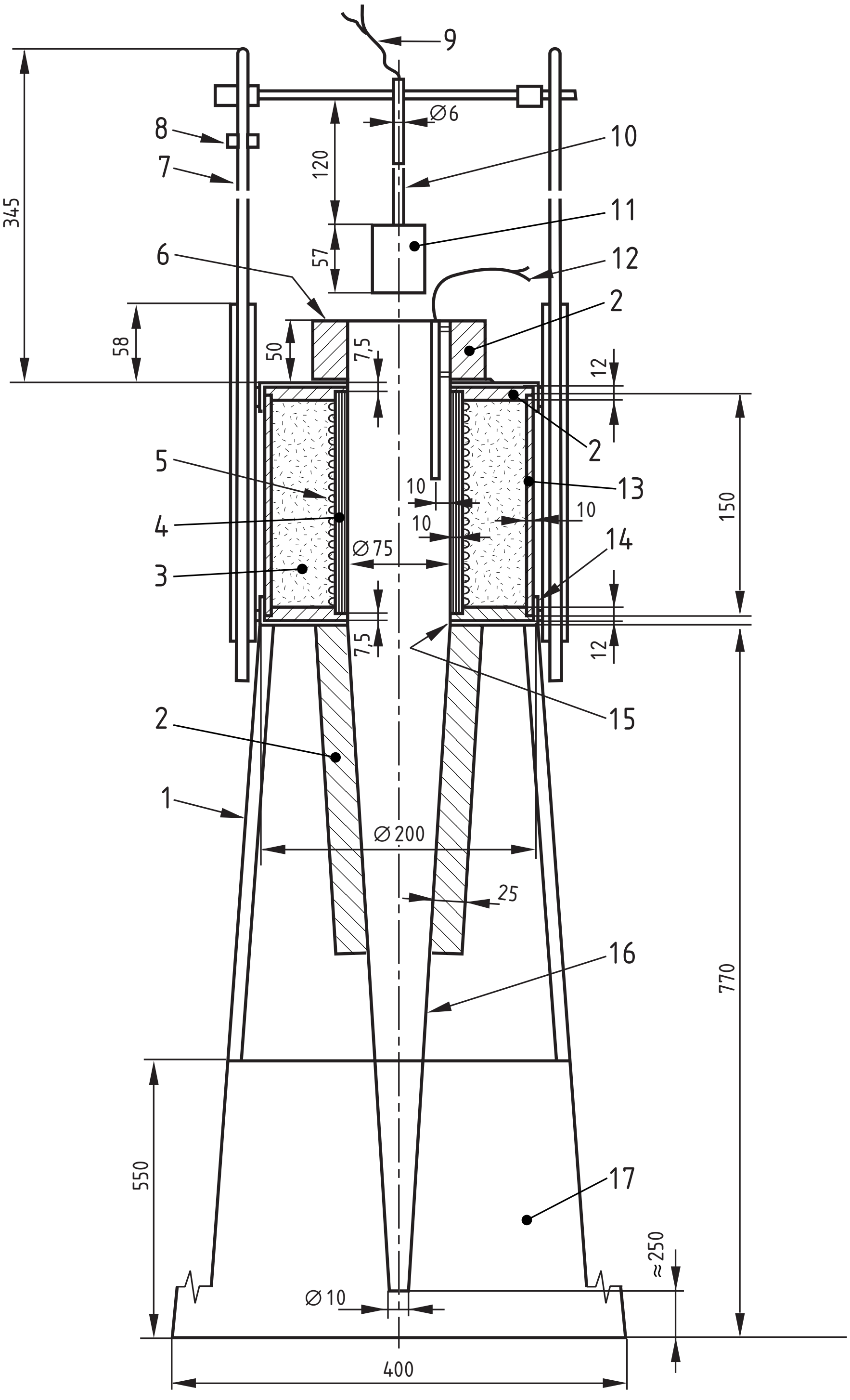
B.3 Air flow stabilizer

The upper half of the stabilizer may be insulated externally with a 25 mm thick layer of mineral fibre insulating material having a thermal conductivity of (0,04 ± 0,01) W/(m K) at a mean temperature of 20 °C.

B.4 Draught shield

The exterior of the draft shield may be insulated with a 25 mm layer of mineral fibre insulation having a thermal conductivity of (0,04 ± 0,01) W/(m · K) at a mean temperature of 20 °C.

Dimensions in millimetres

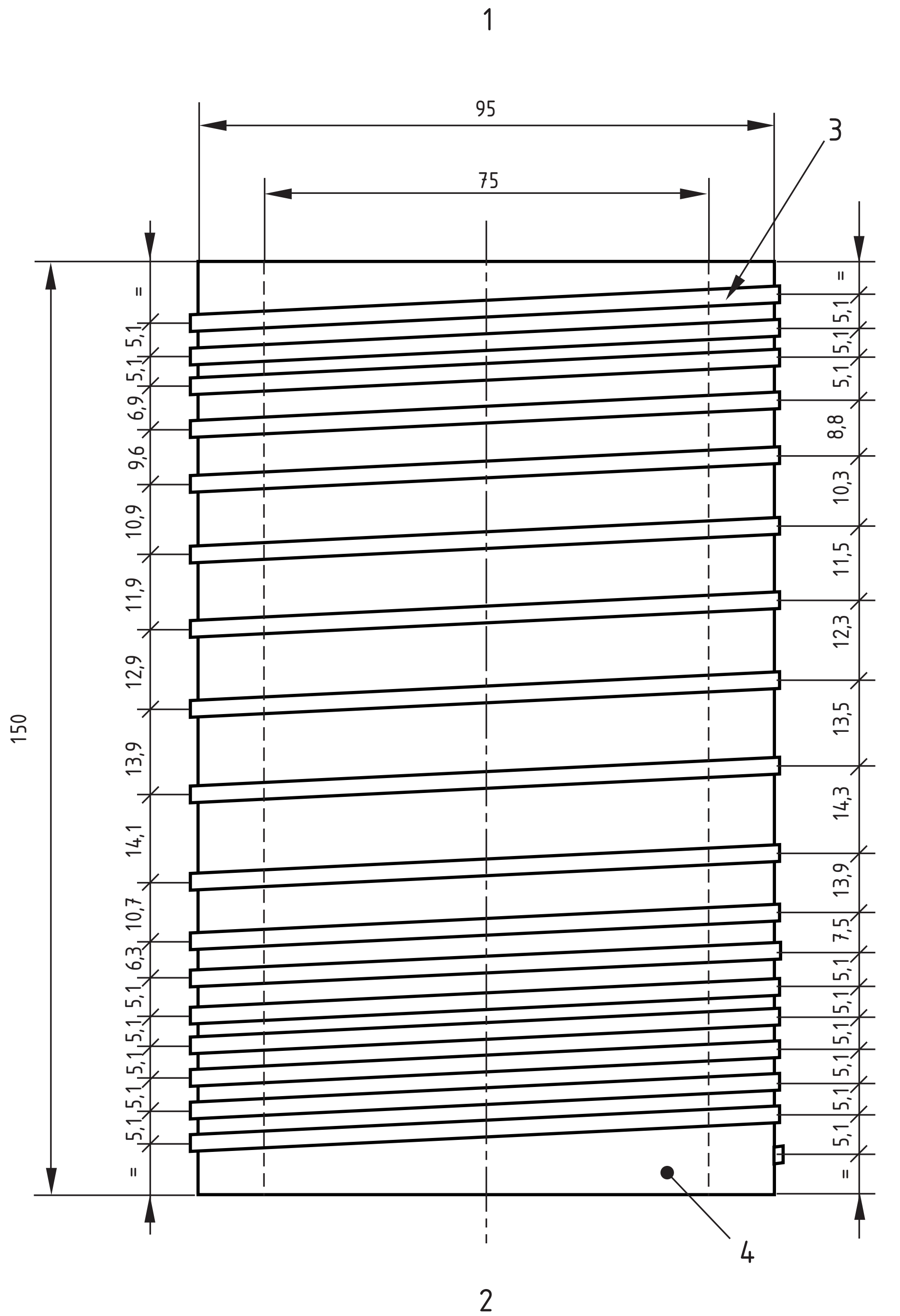


Key

1	Stand	7	Heat resisting steel rod for insertion device	13	External insulating wall
2	Insulation	8	Stop	14	Mineral fibre cement
3	Magnesium oxide powder	9	Specimen thermocouples (optional)	15	Seal
4	Furnace tube	10	Stainless steel tube	16	Stabilizer cone
5	Heating coils	11	Specimen holder	17	Draught screen (metal sheet)
6	Draught shield	12	Furnace thermocouple		

Figure B.1 — Typical arrangement of test apparatus

Dimensions in millimetres



Key

1 Top

2 Bottom

3 Electrical resistance tape

4 Furnace tube

Figure B.2 — Furnace windings

Annex C
(normative)

Thermocouples for additional measurements

C.1 General

In addition to the thermocouple for the measurement of furnace temperature and furnace wall temperature (4.1.5), if required, thermocouples shall also be provided for measurement of the temperature in the geometric centre of the specimen and on the surface of the specimen. Details of these two additional thermocouples and their use are given in C.2 to C.4.

C.2 Location of thermocouples

C.2.1 Specimen centre thermocouple

The specimen centre thermocouple shall be positioned so that its hot junction is located at the geometric centre of the specimen (see Figure 1 and 2). This shall be achieved by means of a 2 mm diameter hole made axially in the top of the test specimen.

C.2.2 Specimen surface thermocouple

The specimen surface thermocouple shall be positioned so that its hot junction is in contact with the specimen at mid-height of the specimen at the start of the test and shall be located diametrically opposite the furnace thermocouple (see Figure 1 and 2).

C.3 Test procedure

Carry out the test as described in clause 7 and record the temperatures measured by both thermocouples throughout the test.

NOTE In some cases the specimen centre thermocouple provides no additional information and in such cases it need not be used. This may apply to materials which are thermally unstable.

C.4 Observations during the test

In addition to the observations required in 7.5, the following shall be recorded:

a) the maximum specimen centre thermocouple temperature, T_C (max);

b) the final specimen centre thermocouple temperature T_C (final);

c) the maximum specimen surface thermocouple temperature T_S (max);

d) the final specimen surface thermocouple temperature T_S (final).

The maximum and final temperatures for the centre and surface thermocouples are defined in 7.5.3 for T_{max} and T_f respectively.

C.5 Expression of results

The temperature rise, in °C, shall be calculated from the temperatures recorded by the two thermocouples for each specimen as follows:

a) specimen centre thermocouple

$$\Delta T_C = T_C\ (\text{max}) - T_c\ (\text{final})$$

b) specimen surface thermocouple

$$\Delta T_S = T_S\ (\text{max}) - T_S\ (\text{final})$$

Annex D
(informative)

Temperature recording

D.1 Initial temperature stabilisation

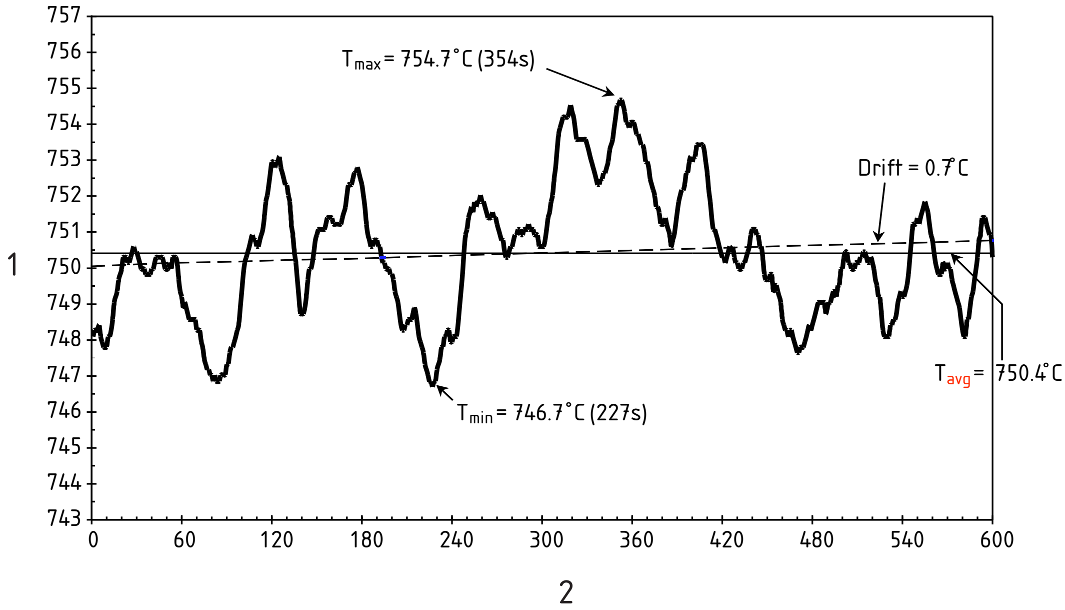
The criteria defining the initial temperature stabilisation are given in 7.2.4. The conditions, over 10 min are:

- an average temperature T_{avg}, °C = (750 ± 5) °C and
- $|T - T_{avg}| \leq 10$ °C and
- a drift (linear regression) ≤ 2 °C

This is illustrated by the example presented in Figure D.1:

- Average temperature: 750,4 °C
- Maximum deviation of the temperature = 4,3 °C
- Drift = 0,7 °C

According to the definition of the initial temperature given in 7.5.3 is T_i °C is equal to T_{avg}. This is illustrated by the example presented in Figure D.1: T_i = 750,4 °C.



Key

1 Temperature °C

2 Time (s)

Figure D.1 — Example of initial temperature stabilisation

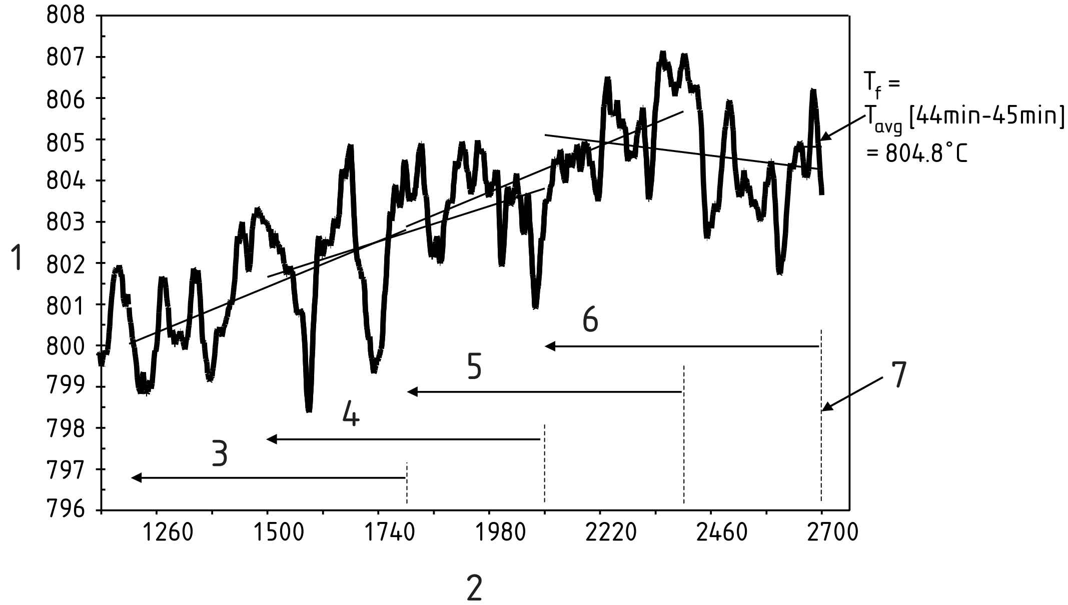
D.2 Final temperature stabilisation

If the stabilisation criterion is reached within 30 min, the end of the test shall be at 30 min. If the stabilisation criterion is reached between 30 min and 60 min, then that time shall be the end of the test. If no stabilisation criterion is reached, the test will be terminated at 60 min.

The stabilisation criterion is reached when the drift (linear regression) of the temperature is within 2 °C for a period of 10 min, calculated at 5 min intervals.

This is illustrated by the example presented in Figure D.2 and Table D.1.

The drift (linear regression) of the temperature is lower than 2 °C between 35 min and 45 min (period of 10 min). The final temperature stabilisation criterion is therefore reached at 45 min and so the end of the test is 45 min.



Key

1 Temperature (°C)
2 Time (s)
3 Drift [20 min – 30 min] = 2,76 °C
4 Drift [25 min – 35 min] = 2,15 °C
5 Drift [30 min – 40 min] = 2,80 °C
6 Drift [35 min – 45 min] = 0,84 °C
7 End of test = 45 min

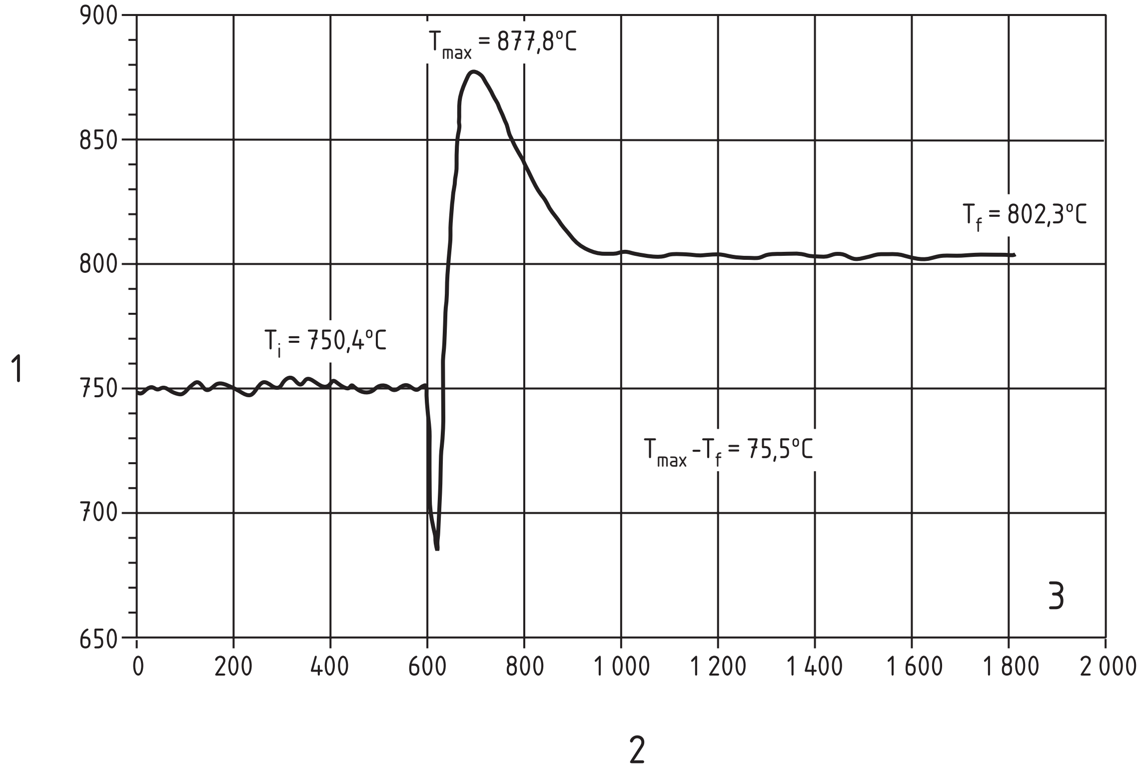
Figure D.2 — Example of final temperature stabilisation

D.3 Determination of temperature rise

The temperature increase is specified in 8.3, calculated from T_m °C and T_f °C. This is illustrated by the two typical examples of temperature recording presented in Figures D.3 and D.4 for which the results are summarised in Table D.1.

Table D.1 — Test results

Example	end of test	T_i	T_m	T_f	T_m - T_f
Figure D.3	30 min	750,4 °C	877,8 °C	802,3 °C	75,5 °C
Figure D.4	45 min	748,4 °C	807,4 °C	804,8 °C	2,6 °C



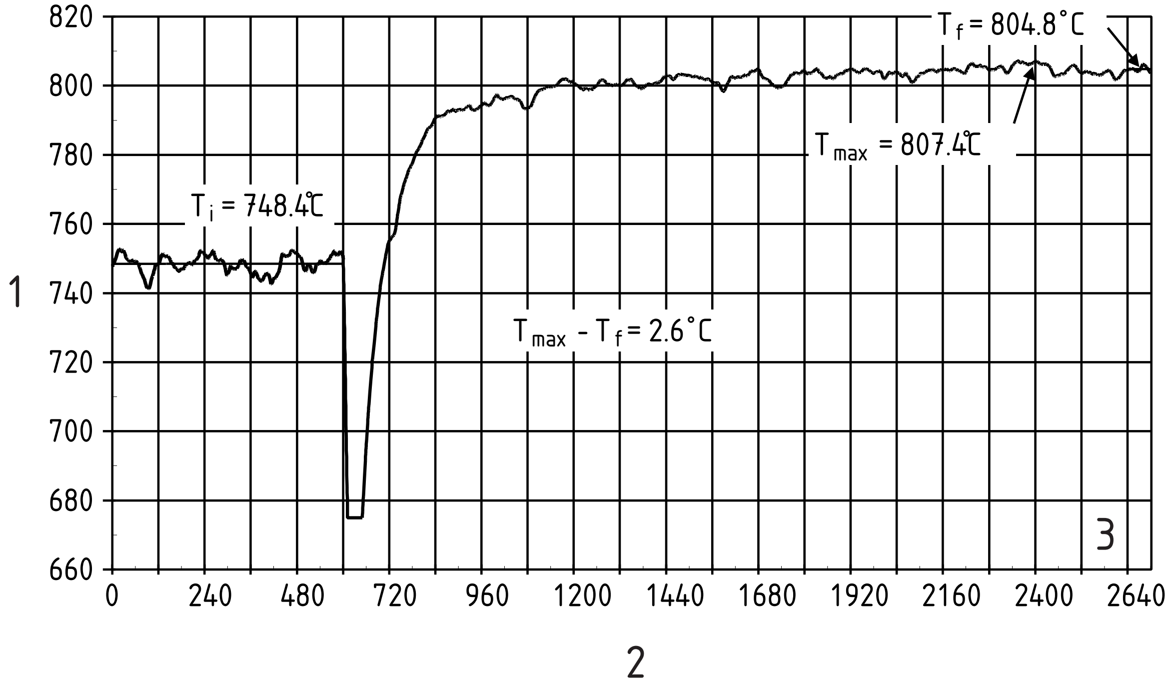
Key

1 Temperature (°C)

2 Time (s)

3 End of test = 30 min

Figure D.3 — Example of temperature recording during one test A



Key

1 Temperature (°C)

2 Time (s)

3 End of test = 45 min

Figure D.4 — Example of temperature recording during one test B

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