EOTA®

TECHNICAL REPORT

Technical description and assessment of reactive products effective in case of fire

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Content

Foreword *(not to be copied into the resp. EAD)*

This EOTA Technical Report has been prepared by a Task Group of experts from industry and test laboratories under the direction of the EOTA Working Group "Fire Stopping, Fire Sealing and Fire Protective Products". It is intended to be a source for the assessment of specific products especially for fire sealing and fire stopping or fire protective purposes.

All undated references to standards in this document are to be understood as references to the dated versions listed in section 3 of this document.

0.1 Scope *(not to be copied into the resp. EAD)*

This EOTA Technical Report is intended to specify reactive products in a uniform way, to define a specific terminology, to suggest test methods and to describe essential criteria of reactive materials and products for fire sealing and fire stopping or fire protective purposes.

This Technical Report may cover issues that are not necessarily applicable for all reactive materials or products due to their nature and/or the way they are incorporated in construction products.

Materials and products exposed to specific industrial or polluted/aggressive atmosphere are not considered in this Technical Report. They shall be tested and assessed separately.

0.2 Terminology *(relevant clauses to be implemented in clause 1.3 of the resp. EAD)*

This EOTA Technical Report uses the following specific terminology:

Reactive Material

A reactive material is a substance composed of various ingredients/constituents such as sodium silicate, graphite, fibres, binders and/or other compounds which are mixed together and are then processed to create an integrated form.

"Reactive material" is the generic term for those materials that chemically or physically react to heat e.g. generated by a fire. The term includes both intumescent and ablative materials.

Reactive product[1]

A reactive product is a product containing a reactive material or component and which is supplied directly to works for permanent incorporation.
The ability to react chemically or/and physically to heat generated by a fire is the essential characteristic of such products. The term includes both intumescent and ablative products.
"Reactive product" is also the generic term for materials and products traded on the market for final application in the work for fire sealing and fir stopping or other fire protective purposes.

Intumescent material

The term describes a material which expands and creates foam or char, when exposed to heat e.g. in case of fire. It may restrict the passage of heat, smoke, flames or any combination of them when used in specific construction elements.

<u>Example of the use of the above terminology:</u>

- *An intumescent MATERIAL may be composed of various ingredients/constituents such as sodium silicate, glass fibres and binders. If the material is supplied for direct incorporation into the works without further processing, it shall be regarded as a PRODUCT requiring a CE marking. Where an intumescent material requires further processing or combining with other materials before incorporation into the works, it shall not be regarded as a product but a component.*
- *An intumescent sealant is a MATERIAL which may be integrated into construction products as a part of the finished construction product but when sold for use directly, it shall be regarded as a REACTIVE PRODUCT.*

Ablative material:

The term describes a material which does not expand significantly when exposed to heat but may consume energy through chemical or physical processes and only degrade slowly under the conditions of fire, remaining sufficiently stable to delay the passage of heat, smoke, flames or any combination of them.

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[1] For the purpose of this document the term "reactive product" is used regardless of assessing it as a material, a component or a product.

Expansion ratio

The expansion ratio is the quotient of the thickness of an expanded sample/specimen of an intumescent material and the original thickness of the same sample/specimen.

Expansion pressure

The expansion pressure is the pressure exerted by an intumescent material as a result of intumescent activity.

Thermo-gravimetric analysis (TGA)

In the thermo-gravimetric analysis the changes in the mass of a sample are measured when the sample is subjected to a given temperature-time-regime. The characteristic temperature-dependent change of mass describes the nature of the material/product technically.

Differential Thermal Analysis (DTA)

Differential thermal analysis compares the difference in heat release between the test sample and a reference sample of known characteristics when they are both subjected to an identical heating regime over a period of time.

Limiting Oxygen Index (LOI):

The term describes the tendency of a material to sustain a flame. The procedure is to ignite the top of a sample and to identify the lowest oxygen concentration in a defined flowing mixture of nitrogen and oxygen which normally supports burning. The LOI value is the lowest percentage of oxygen in the mixture which sustains a flame.

Cone Calorimetry

The Cone Calorimetry is a standardized test method showing the specific thermal output (heat release) of a material when subjected to a defined heating regime.

“Fingerprint”

The "Fingerprint" is a method or combination of methods (TG/TGA, DTA, IR-Spectroscopy) to describe qualitatively a specific material on the basis of the chemical phases system without knowing the formulation.

Infrared spectroscopy (IR)

The Infrared spectroscopy is a fundamental method to qualify the inner structure of unknown materials on the basis of specific reflection infra-red spectrum.

1. Description of reactive products *(relevant clauses to be implemented in clause 3.4 of the resp. EAD)*

1.1 Determination of suitable properties

Table 1A: Suitable properties and corresponding test methods[2]

		Reactive material/product			
N°	**Property**	**Liquids**	**Pastes**	**Solids**	**Powder and granules**
1	Appearance (colour/ texture/gloss/packaging)	1.2.1	1.2.1	1.2.1	1.2.1
2	Dimensions / shape	irrelevant	irrelevant	1.2.2	irrelevant
3	Viscosity	1.2.3	1.2.3	irrelevant	irrelevant
4	Density	1.2.4	1.2.4	1.2.4	1.2.4
5	Weight per unit area	irrelevant	irrelevant	1.2.5	irrelevant
6	Particle size distribution	irrelevant	irrelevant	irrelevant	3.1.6
7	Content of non-volatile components	1.2.7	1.2.7	1.2.7	1.2.7
8	Ash content/loss of mass at a certain temperature	1.2.8	1.2.8	1.2.8	1.2.8
9	"Fingerprint"	1.2.9	1.2.9	1.2.9	1.2.9
10	Heat release	1.2.10	1.2.10	1.2.10	1.2.10
11	Expansion ratio [3]	1.2.11	1.2.11	1.2.11	1.2.11
12	Expansion pressure [4]	1.2.12	1.2.12	1.2.12	1.2.12
13	Flexibility [5]	1.2.13	1.2.13	irrelevant	irrelevant
14	LOI	1.2.14	1.2.14	1.2.14	1.2.14
15	Insulation efficiency [6]	1.2.15	1.2.15	1.2.15	irrelevant

NOTE 1
For reactive products which change their properties as a result of drying (e.g. liquids, pastes) it is preferable to measure the properties of the dried material but measurements on wet material under defined conditions are not precluded (e.g. density of a liquid). The thickness of dried films shall be determined according to EN ISO 2808.

NOTE 2
For all selected properties not only the nominal values but also tolerances shall be declared for the product as placed on the market.

1.2 Test methods

1.2.1 Appearance

The delivered reactive material/product shall be examined visually. The colour, texture, gloss, surface finish, protective coatings or casings and the packaging shall be recorded clearly with appropriate terms to facilitate recognition.

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[2] Not all methods mentioned will be suitable at the same level and will deliver comparable results but a combination of at least two methods will allow a profound assessment.
[3] Only for intumescent products
[4] Only for intumescent products which generate sufficient pressure
[5] Only for dried films/coatings
[6] Only for ablative products

1.2.2 Dimensions and shape

1.2.2.1 Thickness

The thickness of sheet material shall be measured on 3 specimens of approximately 10 cm x 10 cm. Strip material shall be measured on 3 specimens each approximately 50 cm in length. Measurements shall be made in 5 symmetrically arranged positions with one reading at the centre of the sheets. If the material is not available in a suitable size to meet this requirement several smaller samples may be used. The measuring equipment shall have an accuracy of 0,1 mm or 0,5 %.

If an appropriate standard exists which is more suitable for the measurement of the specific material, the equipment and tolerances shall be taken from that standard. The following standards are suitable EN 823 (for slabs), EN 1849-1, EN 1849-2 (for membranes, sheets), EN ISO 2808 (for foils and films), EN 1603 or EN 1604. *(select the appropriate method)*

1.2.2.2 Other dimensions

Other dimensions such as length and width shall be tested on at least 5 samples selected at random. Equipment and tolerances shall conform to an appropriate standard if possible, e.g. EN 12085, EN 822 or EN 1848 (for sheets and foils). *(select the appropriate method)*

For more complex shapes individual measurement methods on critical dimensions are necessary. A description of the complex shape should be given in writing or by a drawing. The recorded accuracy should be the same as for the thickness.

1.2.3 Viscosity

The test should be carried out in accordance with EN ISO 3219 or EN 12092. *(select the appropriate method)*

1.2.4 Density

The preferred unit of density is kg/m³.

The test shall be carried out at standard laboratory conditions (shall be conditioned at (23 ± 2)°C and at (50 ± 5)% rh). The volume of regular shaped samples shall be determined by calculations derived from the dimensions. The volume of irregular shaped samples shall be determined by the displacement of a suitable liquid.

The following standards are suitable[7] *(select the appropriate method)*:

- for solids EN 1015-10, EN 1602, EN 323 or ISO 9427,
- for liquids and pastes ISO 2811-1, -2, -3
- for prefabricated shapes EN 13470
- for powders and granules EN 543

1.2.5 Weight per unit area/length

The unit of the weight per unit area shall be kg/m² and for the weight per unit length kg/m. The weight per unit area of sheets shall be determined by weighing at least 3 samples and measuring the linear dimensions to an accuracy of ± 1% in accordance with EN 1849-2. For small samples EN 12127 could be used. The weight per unit length shall be measured by weight of at least 3 samples and measuring the length to an accuracy of ±1%.

1.2.6 Particle size distribution

The form of the particles shall be described in appropriate terms (e.g. for non-regular shaped particles such as chopped fibres, flakes etc.).

The test (sieve analysis) shall be carried out in accordance with EN 1015-1. This method is suitable for regular shaped granules.

Other possible test methods are described in: EN 933-1 (fine and medium sized particles); EN 12192; EN 13279-2 (fine and very fine grains) and EN 1235. *(select the appropriate method)*

1.2.7 Content of non-volatile components

The test shall be carried out in accordance with EN ISO 3251, if necessary EN 13820. *(select the appropriate method)*

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[7] Some materials compact under their own weight and therefore shall be measured in accordance with an appropriate method.

1.2.8 Ash content/loss of mass at a certain temperature

The test shall be carried out in accordance with EN ISO 3451-1.
Protective foils or coatings shall be removed before testing, if possible.

Deviating from EN ISO 3451-1 the reactive material/product shall be heated only once.

The appropriate temperature and duration[8] of temperature impact for testing reactive products shall be defined before e.g. by the applicant or in pre-tests

In order to find out the appropriate test temperature for the specific intumescent material, the temperature in the oven shall be increased in steps of 50 K (300°C, 350°C, 400°C, 450°C etc). Leave the specimens in the oven until the material has completely reacted.

For ablative products the test temperature shall be 600 °C.

The duration of the test depends on the intumescent capacity of the material and can differ at different temperatures. Normally 30 minutes are considered as suitable.

1.2.9 "Fingerprint"

Several methods are available to determine the inherent properties of specific reactive materials using commercially available analytical equipment.

These include Infra-Red Analysis (IR) and Thermo-Gravimetric Analysis (TGA) or Differential Thermal Analysis (DTA). Some materials will give clear and reproducible results with one of these methods others may require a combination of these methods. In general the combination of IR and TGA or DTA delivers suitable results for clear evaluation. The tests shall be carried out on at least 2 specimens.

NOTE 3
Since TGA and DTA samples are generally very small, it shall be the responsibility of the test laboratory to ensure that the samples are homogeneous and representative.

Test procedure for the "Fingerprint"

General
The "Fingerprint" is a method using a combination of infrared spectrum with thermal analysis of the reactive material.

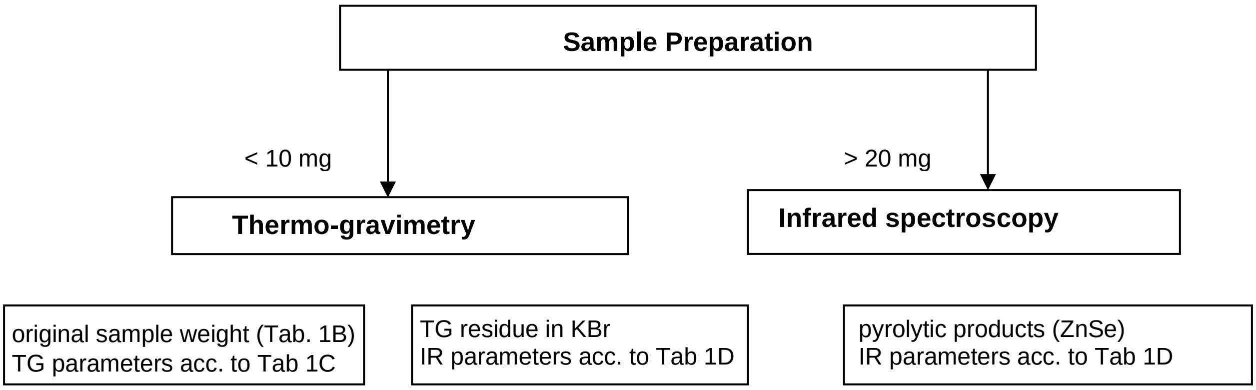

Figure 1a: Scheme of analysis

Part 1: Thermo-analytical methods (general principles see ISO 11358)

<u>Preparation of the specimens</u>
An identical preparation of the samples shall be provided for the thermo-analytical and infrared-spectroscopy analyses:

- Separation of a representative part quantity (ideally approx. 1g, at least approx. 30 mg) e.g. by means of a scalpel from the fire protective mass
- In the case of a highly heterogeneous sample composition: homogenizing by grinding up in a pot mill (ball mill) or in a mortar – in the case of reaction resin-bounded materials, if necessary, by using liquid nitrogen. The required quantity of original sample weights is then taken from the homogenized mass.
- Original sample weight without further treatment directly into the sample crucible according to

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[8] The duration of heating depends on the ability of the intumescent material/product to foam and differs for the products. Normally a heating for 30 minutes could be taken for sufficient, but be careful with materials/products with phase-out foaming.

Table 1B analysis parameter Table 1C.

The quantity of the original weighted sample used for the TG should be chosen such that an increase in volume occurring with some materials during the process of analysis does not lead under no circumstances to an escape of components or parts of the sample from the test receptacle.

Table 1B: Recommended maximum quantity for usual sizes of test receptacle

size of receptacle / µl	40	70	300	900
max. quantity / mg	3	4	10	30

Table 1C: TG/TGA parameters for the analysis of fire protective materials

Crucible	standard Alox crucible with perforated lid
Original sample weight	see Table 1B
Cleansing gas / Flow	nitrogen / 50 ml/min
Range of temperature	50 – 800 °C
Rate of heating	10 K/min
Graphical representation	both TG and DTG curve

Part 2: Infrared Spectroscopy (general principles of EN 1767**)**

Preparation of Specimen

An identical preparation of the samples shall be provided for the thermo-analytical and infrared-spectroscopy analyses:

- Separation of a representative part quantity (ideally approx. 1g, at least approx. 30 mg) e.g. by means of a scalpel from the fire protective mass
- In the case of a highly heterogeneous sample composition: homogenizing by grinding up in a pot mill or in a mortar – in the case of reaction resin-bounded materials, if necessary, by using liquid nitrogen. The required quantity of original sample weights is then taken from the homogenized mass.
- Pyrolysis or KBr method according to instructions, analysis parameters Table 1D.

Pyrolysis

1. A typical piece of the sample material (approx. 20 – 50 mg) is placed in the lower part of a dry mini-format test tube (8 x 70 mm)
2. The tube is covered at its outer upper end with a 1 cm wide filter paper collar wetted with cold water, which is fixed by means of a test tube clamp.
3. The test tube is held with its bottom into a Bunsen-flame, which is preferably carried out underneath the exhaust. The test tube remains in the flame (if necessary, turn in and out) until pyrolysis of the sample. The developing steams and vapours condense at the inner side of the test tube edge in the area of paper collar.
4. The condensate is taken with a clean glass rod and uniformly applied directly on a ZnSe crystal. The spectrum is recorded with the parameters according to Table 1D as reference against an empty crystal.

KBr method

1. 300 mg KBr powder (“spectroscopy grade”) are homogenized with the residue from the TG analysis (maximum 1 mg) e.g. in an agate mortar.
2. The powder shall be processed by pressing a KBr pellet together with the residues. The inner space of the press tool shall be evacuated for 1 or 2 minutes before pressing, in order to eliminate air and water vapour (humidity).
3. This KBr pellet will be directly compared with a plain KBr pellet in the reference sample position.

Table 1D: IR parameters for the analysis of fire protective materials

Range of wave number	4000 – 600 cm^{-1}
Dispersion	>4 cm^{-1}

1.2.10 Cone-Calorimetry

The test shall be carried out in accordance with ISO 5660-1.
The result is the typical time- temperature/heat release curve.

1.2.11 Expansion ratio

The expansion ratio shall be determined on at least 6 specimens to assess the ability of the material to create a foam/char in the event of fire. The mean value and the standard deviation shall be recorded in the test report.

The original thickness of the dried specimen shall be measured according to 1.2.2.1.

The thickness shall be determined after expansion again. If the expansion of the material is not uniform, the thickness after expansion shall be determined from the average value of the maximum and minimum thickness.

An example of suitable equipment and apparatus for determining the expansion ratio is shown hereafter. Other equipment or test methods are acceptable provided the results are reproducible and the test method is recorded.[9]

Example for a suitable test device and test procedures for determining the expansion ratio

General

The principle of testing the expansion ratio is to expose an intumescent material to a certain temperature for a particular duration, to restrict the expansion to one direction, to measure the changed thickness after expansion (foam height) and to express this in relation to the original thickness (before heat exposure).

Examples of suitable apparatus and equipment to determine the foam height are shown in figure 1b

If the specific intumescent material is manufactured of more than one nominal thickness or more than one nominal density, the maximum thickness/density and the minimum thickness/density should be tested.

Pastes, mortars, stoppers and putties shall be tested preferably with a maximum thickness of approximately 5 mm and coating materials with a thickness of approximately 2 mm.

Determination of the suitable test temperature

The test temperature required for the determination of the foam height of a specific intumescent material shall be determined in pre-tests.

In order to find out the appropriate test temperature for the specific intumescent material, the temperature in the oven shall be increased in steps of 50K (300°C, 350°C, 400°C, 450°C etc). Leave the specimens in the oven until the material has completely reacted.

The duration of the test depends on the intumescent capacity of the material and can differ at different temperatures. Normally 30 minutes are considered as suitable.

It will be helpful to create an expansion-time-temperature curve. If a maximum occurs in this curve the optimal test duration should be defined depending on the temperature to minimise scatter of results.

The determined test temperature and the relating time of exposure to heat shall be recorded and shall be used for all further tests for determining the foam height of this specific material.

Test method

Preparation of the specimens

At least six circular specimens of a diameter corresponding to the inner diameter of the specimen holder with a tolerance of ± 0,5 mm shall be cut out of the intumescent material. The thickness of the sample shall be measured with an accuracy of 0,1 mm at the centre of the disc and at four symmetrically placed positions ca. 10 mm from the edge of the specimen. The mean value should be recorded together with the standard deviation.

For intumescent materials in the form of powder or granules the weight of the specimens and the filling height shall be determined.

If necessary, the thickness of the specimens may be reduced such that the foam height does not exceed the height of the specimen holder. Such handling shall be recorded.

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[9] To achieve a reproducible result, the test parameters, e.g. temperature, duration, mass of the weight on top of the specimen etc. shall be selected appropriately and shall be recorded precisely.

Test device

Key

Pipes: according to EN 10216-5, wall thickness 2 mm

C	specimen holder
D	upper frame
E	lower frame
F	spacer bar

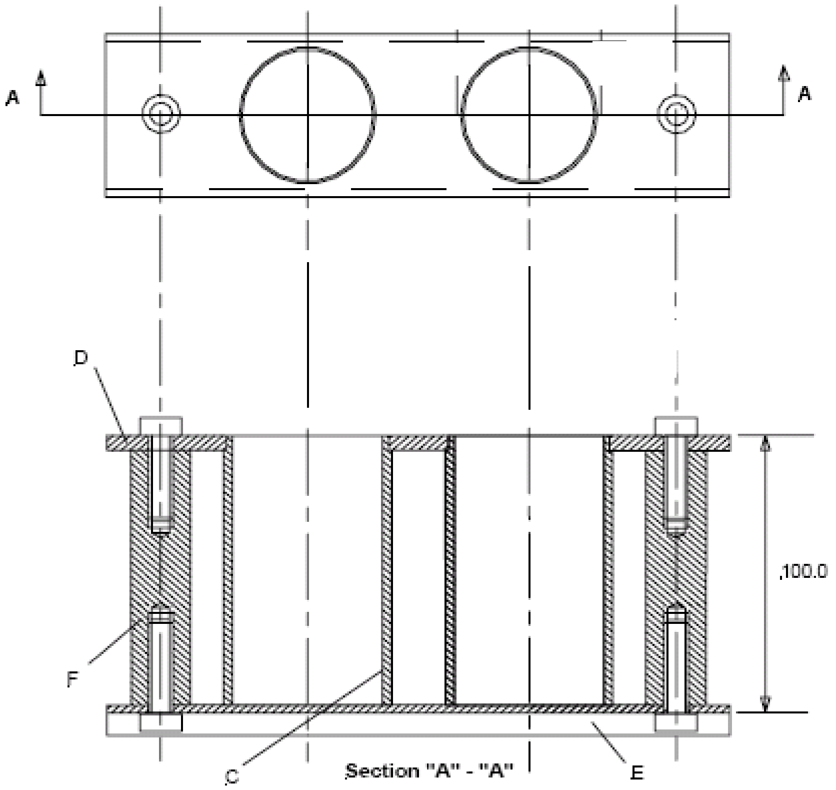

Figure 1b – Test device

Test procedure

A temperature controlled muffle oven being able to reach a stable temperature of at least 600°C is needed. The oven shall be pre-heated to the stable temperature as required for the test and as determined during the pre-test.

The specimen will be placed into the specimen holder of the test device (figure 1b).

The test device shall be placed quickly (to minimise heat loss) into the centre of the muffle oven at the particular temperature for the pre-defined duration. The test temperature should be re-established within 5 minutes in the oven.

Wearing protective clothing and gloves the test device shall be removed from the oven as soon as reasonably practicable after the test. The foam height will be determined within 5 minutes after the specimens have been removed from the oven.

***Test method modification 1*:**

For this method circular weights (5g; 10g, 20g, 50g, 100g etc.) of a diameter corresponding to the specimen holder are put on top of the specimen before testing. After exposure to heat the height of the lower surface of the lifted weight shall be equated with the foam height.

***Test method modification 2*:**

For this modification no weights are used and the foam will expand freely in one direction in the specimen holder. After the heat exposure the measurements shall be carried out at five points symmetrically arranged with one central as done before testing (see "Preparation of the specimens").

For both methods the mean value of the measurement represents the "maximum foam height" at a certain temperature after a certain time of heat exposure. Minor voids or cavities within the structure of the foamed specimens do not have to be taken into consideration.

The expansion ratio is the quotient of the mean value of thickness of an expanded specimen of the intumescent specimen divided by the mean value of the original thickness of the same specimen before expansion.

1.2.12 Expansion pressure

The expansion pressure shall be determined on at least 6 specimens to assess the ability of the material to develop pressure during foaming. The mean value and the standard deviation shall be recorded in the test report.

Examples of suitable equipment and apparatus for determining the expansion pressure are shown hereafter.
Other equipment or test methods are acceptable provided the results are reproducible and the test method is recorded.

Examples of suitable test devices and test procedures for determining the expansion pressure

General

Examples of suitable apparatus and equipment to determine the expansion pressure of an intumescent material are shown in figure 1c and 1d.
If the specific intumescent material is manufactured of more than one thickness or more than one density, the maximum thickness/density and the minimum thickness/density should be tested.

Pastes, mortars, stoppers and putties shall be tested with a maximum thickness of 5 mm, coating materials preferably of a thickness of approximately 2 mm.

Test method I

Preparation of the specimens

At least 6 circular specimens of a diameter of at least 50 mm (corresponding to diameter of the used steel ring) with a tolerance of ± 0,5 mm[10] , shall be cut out the intumescent material. The thickness of the specimen shall be measured with an accuracy of ± 0,1 mm at the centre of the disc and at four symmetrically placed points approximately 10 mm from the edge of the specimen. The mean value shall be recorded with the standard deviation.
For intumescent materials being tested in the ring necessarily (e.g. pastes, powder, granules) the weight of the specimens shall be determined.

Test device I (see figure 1c)

Test procedure

The measuring device for determining the expansion pressure, acting at given temperatures by an intumescent material, is built into a frame consisting of a base plate (1), two pillars (2) and a pressure plate (3).
The heated upper pressure receptor (13) is rigid during the test but can be swung out for cleaning purposes, is connected with the frame through a guide system (5, 6, 7). In order to enable the specimens to be quickly inserted, the top plate can be adjusted in height by 15 mm by means of the lever (8, 9).
The heated lower pressure receptor (14) transmits the force occurring during the test via a transmission device to the force transducer (10) mounted on the base plate.
The transmission device has a hand wheel adjustment that allows specimen thickness of up to 32 mm.
The spindle (11) serves as a locking device for the mechanism.

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[10] The specimen should be as large as possible to reduce the edge influences, but the actual size will depend on the apparatus (e.g. ring size).

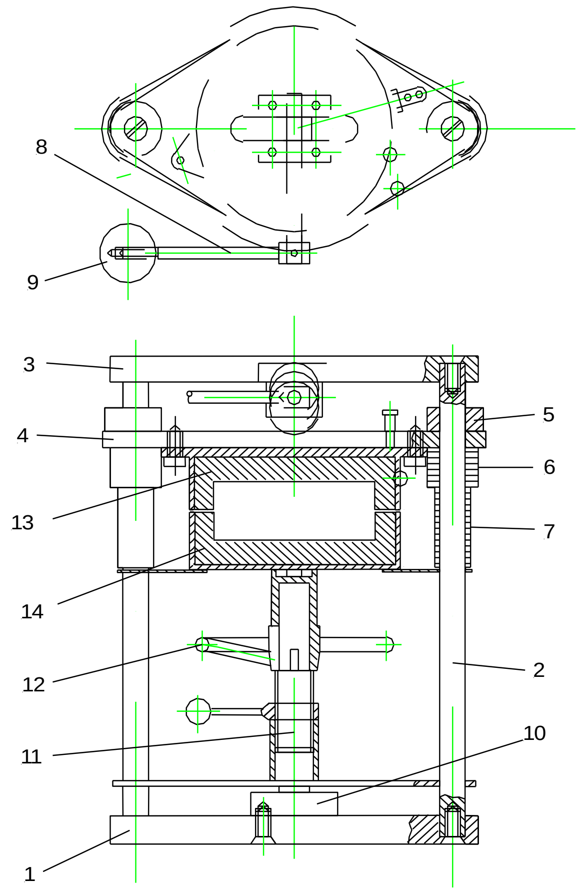

Figure 1c - Test device I

Key

1	base plate	6	guide system	11	spindle
2	pillars	7	guide system	12	hand wheel
3	pressure plate	8	lever	13	heated upper pressure receptor
4	top plate	9	lever	14	heated lower pressure receptor
5	guide system	10	force transducer		

Preparation of the test device

In the neutral/zero position of the heating plates a pre-pressure of approximately 60 N shall exist. The starting positions for the heating plates required for the test and the appropriate spacing between them shall be established by measurement. The setting will take into account the thickness of the specimen.

The heating plates shall be spaced 1 mm greater than the height of the steel ring in use to avoid pre-pressuring the specimen and to compensate for uneven foaming at the beginning of the test.

Test method I, modification 1: Testing without lateral restriction

The specimens shall be placed centrally between the two aluminium foils into the apparatus according to figure 1c.

NOTE 4:

This method is not applicable for powders and granules.

Test method I, modification 2: Testing with lateral restriction

The specimens shall be placed into two steel rings, which are adjusted to the size of the specimen to be tested according to item. The internal diameter of steel rings made of stainless steel should have a tolerance of + 0,2/ - 0 mm.

If possible the steel rings shall have a web height of 4 mm or 9 mm (tolerance + 0,1 mm). The specimens will then have a maximum height of 5 mm or 10 mm respectively.

The specimen shall be placed in the steel ring centrally between two aluminium foils (50µm thick) into the apparatus according to figure 1c.

NOTE 5:
For testing specimens placed in a steel restraining ring, the heating receptors shall be spaced at a distance exceeding 1 mm from the web height of the ring.

Measurement of the expansion pressure and evaluation of the results

The expansion pressure [N/mm^2], temperature and time elapsed shall be continuously recorded. The test is performed until the maximum pressure is clearly exceeded, but not longer than 10 min.
The test report shall qualify the maximum expansion pressure for each specimen thickness.
The test report shall record clearly whether the modification with lateral restriction or without lateral restriction was used to obtain the recorded results.

Test method II using the device in figure 1d

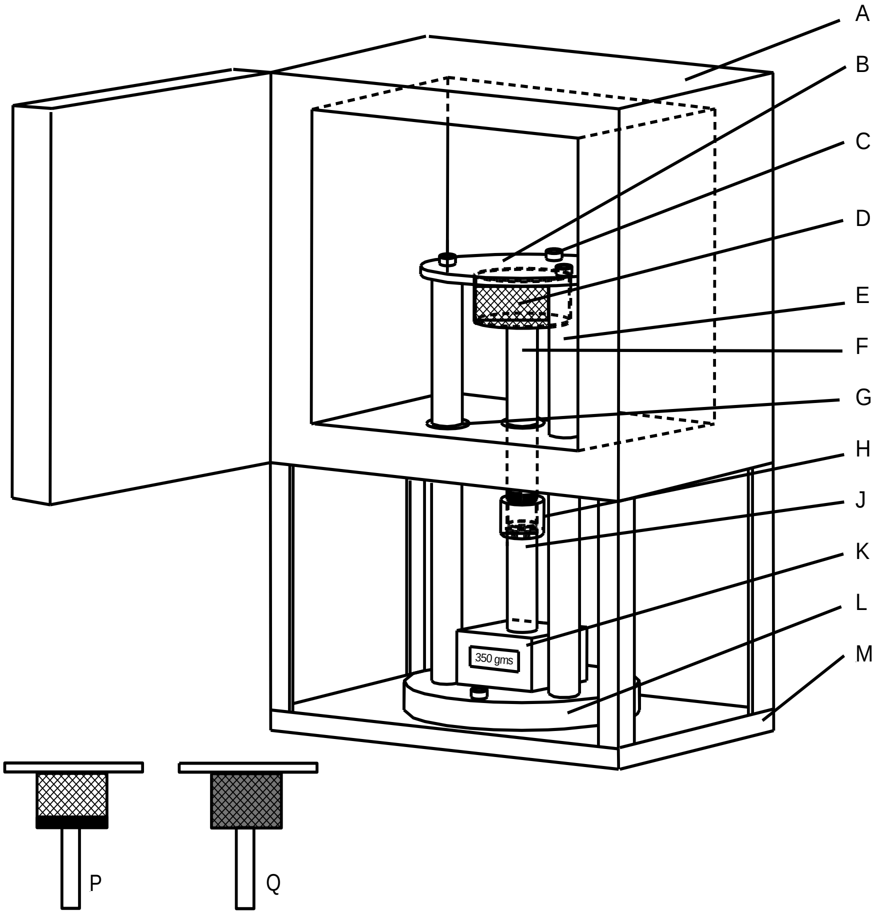

Figure 1d - Test device II

Test procedure

The test procedure is based on the principle of measurement of the range of expansion pressures at a fixed volume of expansion.

The test is conducted under normal laboratory conditions.

A specimen of chosen thickness is cut to a size corresponding to the internal dimensions of the specimen containing die (D) +0,0/ – 0,5 mm.

A specimen containing die is selected that has an internal height that will allow the required ratio of expansion of the specimen e.g. specimen thickness 4,0 mm in a containing die of internal height of 20,0 mm will limit the expansion ratio to 5:1

The specimen is placed into the specimen containing die as shown in (P) and the reaction plate (B) is secured above the specimen containing die using set screws (C) but preloading the Piezo-resistive force sensor (K) is avoided by winding the threaded adjustment collar (H) to give a slight clearance between the reaction plate and the specimen containing die.

The Piezo-resistive force sensor is set to zero by initially finely adjusting the collar to give a small reading on the sensor and then winding back until the sensor just registers zero.
The muffle furnace door is closed and the furnace (A) is heated at a fixed rate
The time when heating commences is recorded.
The time and temperature that the specimen activates is recorded.
The time and temperature at which a positive force is registered by the sensor is recorded.
Subsequently pressures and temperatures are recorded at intervals of 2 minutes.

Test results

From the recordings a chart can be produced indicating pressure and temperature on the ‘Y’ axis versus time elapsed on the ‘X’ axis.

Comparing charts of identical specimen tests will provide evidence of the furnace heating curve consistency and where the heating regime is consistent the charts will show the range of pressure characteristics of a given material at a predetermined expansion ratio.

The expansion ratio may be varied by using specimen containing dies of different heights

1.2.13 Flexibility

The flexibility of reactive products shall be tested in accordance with EN ISO 1519.

1.2.14 Limiting Oxygen Index (LOI)

The LOI shall be determined in accordance with ISO 4589-2.

1.2.15 Insulating efficiency

The insulating efficiency shows the delay in heat transmission caused by the ablative material. The test shall be carried out according to the following proposal

General, specimen and preparation

This small scale furnace fire test shall be carried out at a constant temperature of 500°C ± 20 °C.

The specimens shall consist of steel panels of a nominal thickness of 5 mm and a minimum of size 300 mm x 200 mm. A minimum number of two panels coated by the reactive (ablative) material shall be tested in comparison to a similar unprotected one.

The specimens shall be stored for drying in standard atmosphere (23°±2°C and 50% ± 5% relative humidity) for a period of time as specified by the manufacturer.

Before exposing to heat the specimens shall be weighed. The weight shall be recorded.

Test Procedure

A temperature controlled muffle oven being able to reach a stable temperature of at least 500°C is needed.

The specimen may be tested individually or together with other in one test depending on the size of the oven. The specimen shall be placed in the opening of the oven properly sealed in a vertical position such that only the ablative layer is exposed to the heat. The panel shall be mounted in a frame which forms part of one side (wall) of the furnace. The protected surface (covered with the reactive material) shall be faced to the heat.

The non-fire side shall be covered using vermiculite or calcium silicate board with a minimum of 50 mm thickness with a density of 475 ± 25 kg/m^3.

Two thermocouples shall be attached to the non-fire side of the steel panels. These thermocouples shall be located close to the centre in a distance of 2 cm. The thermocouples shall be of the K type according to EN 1363-1 but without a copper disc and without an insulation pad. The thermocouples shall be fixed to the back of the steel panels by welding following the ENV 13381-4: 2002.

Result

The test is finished when the temperature of the two thermocouples reaches 280 ºC.

The time for reaching this temperature has to be recorded for the protected and the unprotected panel separately. The difference of this time is a criterion for heat transmission delay caused by the reactive material and shall be recorded.

2 Aspects of durability and capability of the product regarding the declared performance under final use conditions *(added completely as annex to the resp. EAD or relevant clauses to be implemented in clauses 2.2.x of the resp. EAD)*

2.1 General Stipulations

The durability of reactive products may change significantly when exposed to specific use conditions. This change may result in a product not achieving the expected performance. This indicates that the product probably does not meet the required resistance to the intended application conditions.

Where a product is not subject to further processing (e.g. external protection or encapsulation) to achieve its final form, it shall be tested for durability in accordance with the guidance in this document.

When a product is subject to further processing e.g. encapsulation in waterproof casings, the durability tests should be conducted in accordance with the product specification.[11]

The following types of final intended use conditions[12] are considered to be relevant for reactive products, components and products and should be tested correspondingly:

Type X: product intended for use at conditions exposed to free weathering

Type Y_1: product intended for use at temperatures below 0°C with exposure to UV (occasionally) but no exposure to rain

Type Y_2: product intended for use at temperatures below 0°C (occasionally), but with no exposure to wetness, rain or UV (exception: re-drying short-term condensation)

Type Z_1: product intended for use at internal conditions with high humidity (permanent, changing or temporary condensation), excluding temperatures below 0°C

Type Z_2: product intended for use at internal conditions with relative humidity lower than 85 % rh (relative humidity) excluding temperatures below 0°C (frost-free and dry).

NOTE 6

Assumption: *Generally materials that meet requirements for type X, meet the requirements for all other types. Materials that meet requirements for type* Y_1 *also meet the requirements for type* Y_2, Z_1 *and* Z_2. *Materials that meet the requirements for type* Y_2 *also meet the requirements for type* Z_1 *and* Z_2. *Materials that meet the requirements for type* Z_1, *also meet the requirements for type* Z_2.

2.2 Testing and Assessing of durability

2.2.1 General

The principle of the durability tests is to select essential physical and/or chemical properties of the product and to check whether these properties will change during the exposure to defined exposure conditions.

For the assessment, the applicant and the responsible technical assessment body (RTAB) should agree the appropriate selection of the relevant properties (relevant for the product's performance) from Table A to describe the durability.

If this Technical Report is used for preparing harmonised product standards, the specification writer should define which properties shall be considered being essential for the final use.

The test results for the unexposed and for the exposed specimens shall be compared. This stipulates that the samples for the exposure tests shall be of the same quality as those for the tests of unexposed specimens. So it would be an advantage, if all specimens are taken from the same sample but also the results from product testing for unexposed specimens may be used for this comparative purpose.

The evaluation "no essential change in performance" shall be given if the mean value of the tested property of the exposed specimen does not deviate more than ± 15 % of the mean value of the initial test (unexposed specimens). No single result of exposed specimens shall be less than 80% of the mean value of the initial test.

If the result falls outside these criteria, additional 4 specimens of the same sample should be exposed, tested and assessed. All four additional specimens shall fulfil the pass criteria.

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[11] This means that the product should be tested in its final form or alternatively the performance of the protective layer, foil, encapsulation etc. should be separately assessed in an appropriate test.

[12] The designation of the use conditions may change by specification writers according to their needs.(see EAD N° 350402-00-1106 or EAD N°350141-00-1106)

2.2.2 Preparation and conditioning of specimens

All samples shall be prepared as the manufacturer recommended and as intended in practice (curing and curing period, exposure with protection as intended etc.). It is in the responsibility of the applicant and the RTAB to agree the best method for testing complex shaped materials or products. The type of protection, if any, shall be recorded in the test report.

The samples shall be supported on racks or special devices (made of an inert material) to put them into the test chamber preferably in a vertical position, 20 mm separated from each other. The size of the sample shall be sufficient for at least 3 specimens for every reaction test and every option model (e.g. thinnest/thickest variation of thickness) and product variation.

Before and after environmental exposure the samples and specimens shall be conditioned at a temperature of (23 ± 3) °C and a relative humidity of (50 ± 5) %.

Before and after exposure the specimen shall be weighed. The change of weight, if any, shall be recorded.

After exposure and before the post environmental testing the specimens shall be maintained in conditions of a temperature of (23 ± 3) °C and a relative humidity of (50 ± 5) %. Visual changes in colour, texture etc. should be recorded.

2.2.3 Testing reactive products intended for type X applications

Reactive materials, components and products intended for outdoor use are usually exposed to free weathering – rain, UV, high temperatures in summer, frost and frost-thaw in winter. To be able to assess the fitness of the reactive material for outdoor use the following exposure-tests shall be carried out:

Step 1: UV Chamber
The sample shall be weighted and then exposed in a UV chamber to the conditions according to EN ISO 4892-3:2006, with a Type A lamp combination A.2 (table 1) according to cycle N°3 (table 4).

Air, humidified and temperature-controlled, shall be blown into the test bench. The specimens shall be sprayed with distilled or demineralised water.

A sample for at least 3 specimens as required for the reaction tests[13] shall be stored preferably in a vertical position for 28 days in the UV chamber conducting the following procedure:

Continuous UV-irradiation for 28 days,

1 cycle takes 6 h divided as follows:

- 5 h dry phase at (50 ± 3)°C and at relative humidity below 15 % and
- 1 h exposed to water spray[14], at (25 ± 3)°C without controlled humidity

This cycle shall be repeated 112 times without interruption. After testing the specimens shall be visually assessed, weighted and the observations shall be recorded.

Step 2: Environmental Chamber
After the UV chamber test the same sample shall be exposed for further two weeks to the procedure according to table 2A in a controlled environmental chamber without interruption[15]:

After the exposure the specimens shall be cut from the sample and shall be tested according to the reaction test[16] e.g. for expansion ratio or/and expansion pressure or thermal efficiency.

Table 2A Exposure condition cycle for reactive products without temperature restriction

period/	6 hour phase			
day	1st (6 hours)	2nd (6 hours)	3rd (6 hours)	4th (6 hours)
1. + 2.	(20 ± 3)°C, saturated rh	(70 ± 3)°C, (20 ± 5)% rh	(20 ± 3)°C, saturated rh	(70 ± 3)°C, (20 ± 5)% rh

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[13] At least 3 specimens are required for each reaction test. If more than one test is intended (e.g. expansion ratio and expansion pressure) the number of specimens will grow. So the exposed sample/s should be of sufficient size.

[14] Advice: Use water of approximately (20 ± 5) °C.

[15] The cycle of exposure according to table 2A or 2B shall be repeated twice

[16] Specific deviations and modifications concerning the conditioning, the shape and size of the specimen, the exposure conditions and the reaction test/s shall be recorded.

3. + 4.	(20 ± 3)°C, saturated rh	(30 ± 3)°C, (40 ± 5)% rh	(40 ± 3)°C, saturated rh	(30 ± 3)°C, (40 ± 5)% rh
5. + 6 + 7	(- 20 ± 3)°C	(40 ± 3)°C, saturated rh	(- 20 ± 3)°C	(40 ± 3)°C, saturated rh

NOTE 7

The chamber temperature change shall be at a rate of (1,5 ± 0,5) K/min. During the period of temperature change the change of humidity is not controlled, but condensation should be avoided. The duration of temperature change is included in the duration of an exposure phase.

2.2.4 Testing reactive products intended for type Y_1 applications

To be able to assess the fitness of the reactive products intended to be used under unheated internal or sheltered external conditions (no rain) the following tests shall be carried out:

Step 1: UV Chamber

A sample for at least 3 specimens as required for the reaction tests[13] shall be stored preferably in a vertical position for 28 days in the UV chamber and exposed to a continuous UV-irradiation according to EN ISO 4892-3:2006, with a Type A lamp combination A.2 (table 1) at a temperature of (50 ± 3) °C and at a humidity below 15 % (dry conditions) without interruption.

After testing the sample shall be visually assessed and the observations shall be recorded.

Step 2: Environmental Chamber

After the UV chamber test the same sample shall be exposed for two weeks to a procedure according to table 2A or to table 2B (no frost) in a controlled environmental chamber without interruption.

Table 2B Exposure condition cycle for reactive products not for application at low temperature[17]

period/	6 hour phase			
day	1st (6 hours)	2nd (6 hours)	3rd (6 hours)	4th (6 hours)
1. + 2.	(20 ± 3)°C, saturated rh	(70 ± 3)°C, (20 ± 5)% rh	(20 ± 3)°C, saturated rh	(70 ± 3)°C, (20 ± 5)% rh
3. + 4.	(20± 3)°C, saturated rh	(30 ± 3)°C, (40 ± 5)% rh	(40 ± 3)°C, saturated rh	(30 ± 3)°C, (40 ± 5)% rh
5. + 6 + 7	(- 5 ± 3)°C	(40 °± 3)°C, saturated rh	(- 5 ± 3)°C	(40 ± 3)°C, saturated rh

NOTE 8

The chamber temperature change shall be at a rate of (1,5 ± 0,5) K/min. During the period of temperature change the change of humidity is not controlled, but condensation should be avoided. The duration of temperature change is included in the duration of an exposure phase.

NOTE 9

If a product cannot withstand the temperature of 70°C this may be reduced to 60°C but for the 10 ºC reduction the exposure duration of this temperature phase of the cycle shall be increased by a factor of two. This reduction is not applicable for type X.

NOTE 10

The declaration of the use categories type Y_1 and Y_2 shall include limits of temperatures, e.g. type $Y_{1,\ (0/+60)\ ^\circ C}$.

After the exposure the specimens shall be cut from the exposed sample and shall be tested according to the reaction test e.g. for expansion ratio or/and expansion pressure or thermal efficiency.

2.2.5 Testing reactive products intended for type Y_2 applications

To be able to assess the fitness of the reactive material/product intended to be used for internal and sheltered external conditions (no UV, no rain) the following tests shall be carried out:

A sample for at least 3 specimens as required for the reaction tests[13] shall be stored preferably in a vertical position in a controlled environmental chamber and shall be exposed to the conditions according to table 2A or to table 2B for 21 days without interruption.

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[17] There are reactive products which are sensitive to heavy frost but are suitable for semi-exposed applications in a moderate climate, so these products may be tested for type Y_1 at the alternative temperature acc. to table 2B.

After the exposure the specimens shall be cut from the sample and shall be tested according to the reaction test e.g. for expansion ratio or/and expansion pressure or thermal efficiency.

2.2.6 Testing reactive products intended for type Z_1 applications

For this test an airtight cabinet or chamber as described in EN ISO 11503 should be used.

A sample for at least 3 specimens as required for the reaction tests[13] shall be stored preferably in a vertical position in an environmental chamber for 21 days and exposed to the following procedure without interruption:

- 8 hours at (40 ± 3)°C and 98 % to100 % rh followed by
- 16 hours at (23 ± 3)°C and (50 ± 5)% rh[18]

After the exposure the specimens shall be cut from the sample and shall be tested according to the reaction test e.g. for expansion ratio or/and expansion pressure or thermal efficiency[16].

2.2.7 Type Z_2 - testing reactive products intended for internal application under normally dry conditions without frost

For this test the specimens shall be cut out from a sample before exposure. The specimens shall be of the same dimensions and size as required for the reaction tests.

At least 3 specimens as required for the reaction tests[13] shall be stored preferably in a vertical position in an environmental chamber for 21 days and exposed to the following cycle:

- 4 h at (5 ± 3)°C and (50 ± 5)% rh
- 4 h at (23 ± 3)°C and (80 ± 5)% rh
- 16 h at (40 ± 3)°C and (50 ± 5)% rh

This test shall be repeated for 21 cycles without interruption.

After the exposure the specimens shall be cut from the sample and shall be tested according to the reaction test e.g. for expansion ratio or/and expansion pressure or thermal efficiency.

2.3 Appropriate durability tests relating to specific application conditions

The idea of these additional tests is to assess the suitability of the reactive products for specific application fields not covered by the use conditions of type X, type Y_1 and Y_2 and type Z_1 and Z_2 in a uniform way.

The following tests will give an approach to test and evaluate uniformly the resistance of a reactive material/product to specific influences e.g. the exposure to chemicals or permanent wetness, interaction with neighbouring materials, if expected or desired.

The following tests procedures provide evidence for the performance of the reactive material/product when exposed to specific conditions of application.

2.3.1 Preparation, conditioning of specimen and evaluation of the results

The preparation of samples shall be carried out according to 2.2.2. The evaluation of the results shall follow the principles of 2.2.1. Remarkable features or deviations should be recorded.

2.3.2 Effects of temperature

2.3.2.1 Effects of higher temperatures - effects of drying

If a reactive material/product in use is intended to be exposed to higher temperatures permanently (e.g. 60 °C, 80 °C, 100 °C), the following test could give an approach for assessment.

A temperature-controlled device is needed to set a constant test temperature.

The sample (size sufficient for at least 3 specimens for each intended reaction test)[13] shall be stored in a vertical position into the pre-heated device at a constant temperature as selected. The test sample shall be exposed to the expected temperature e.g. 80°C at a relative humidity of 50 % ± 5 % for a period of 40 days.

The test temperature, the humidity and all observations (e.g. change in colour, in texture etc.) shall be recorded in the test report.

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[18] In practise it is common to open the chamber door if the ambient conditions approximately meet the temperature of (23 ± 3) °C.

After the exposure the reaction tests e.g. for expansion ratio or/and expansion pressure or thermal efficiency shall be carried out to show whether a change in performance happened caused by high temperature and drying.

2.3.2.2 Effects of constant low temperatures - effects of permanent frost

If a reactive material/product in use is intended to be exposed to permanent frost (e.g. chill rooms, refrigeration rooms), the following test could give an approach for assessment.

A temperature-controlled chilling device is needed to set a constant temperature at (-20 ± 2) °C at a dry atmosphere (relative humidity of ≤ 20 %).

The sample (size sufficient for at least 3 specimen for each intended reaction test)[13] shall be stored in a vertical position into the pre-cooled device. The test sample shall be exposed to a constant temperature of -20 °C ± 2 K and at a relative humidity of ≤ 50 % ± 5 % for a period of 40 days.

The temperature, the relative humidity and all observations shall be recorded in the test report.

After the exposure test the reaction tests for expansion ratio or/and expansion pressure or thermal efficiency shall be carried out to show whether a change in performance happened caused by freezing.

2.3.2.3 Effects of frost-thaw-changes

Normally (exception: products on the basis of sodium/potassium silicate) intumescent and ablative materials tolerate frost-thaw-changes at temperatures between -5 °C and +5 °C because the nature of their binders.

If a specific assessment is needed, the test should use the test procedure and the equipment of EN 494:2015-12.

Testing the resistance of reactive products to frost-thaw exposure

The basis of this test is EN 494, cl. 7.4.1.

Preparation of specimen

The test specimen should be cut from the sample before exposed to frost-thaw.

A sufficient number[13] of specimen should be available for testing the expansion ratio, the expansion pressure or the thermal insulation efficiency after the exposure.

Test devices

1. **Freezer** with recirculating air/forced air circulation, which could reach a temperature of **-**10 C ± 2 K within 1 hour fully loaded.
2. **Water basin**, temperature controlled at a temperature of 20°C ± 4 K

Test procedure

The specimen should be stored at ambient temperature (> 5°C) for 48 h.
Before starting the exposure every specimen should be weighted.
Afterwards the specimen shall pass 100 frost-thaw-cycles as follows:
Step 1: the specimen will be subjected freezing in the freezer,

- cooling down to a temperature of **-**10 C ± 4 K within 1h to 2h depending on the thickness of the specimen. The specimen shall be kept at **-**10 C ± 4 K for at least 1 h.

Step 2: the specimen will be set from the freezer into the water basin

- thaw in warm water at a constant temperature of 20°C ± 4 K within 1h to 2 h depending on the thickness of the specimen. The specimen shall be kept at 20 C ± 4 K for at least 1 h.

During the steps of the cycle (freezing and thawing) the specimen shall be stored this way, that the cold air or the warm water enclose them fully and can circulate freely.

Every frost-thaw-cycle should take ca. 6h.

If manual handling is done, it should be allowed to have a break once of max. 72 h. During this break the specimen shall be stored under water at 20°C ± 4 K. If every step is controlled manually and if a break is done, it shall be recorded.

When finishing the exposure, the specimen shall be weighted again. All observations and changes shall be recorded.

2.3.3 Resistance to over-painting

It is not possible to devise a single test for all imaginable paints. Sometimes it could be sufficient to test a representative of a family of paints e.g. on the basis of epoxy resin or alkyd resin, latex or other emulsion paints etc.

Resistance to specific paints may be demonstrated using the intended paint in the following test:

For this test the specimens shall be cut out from an over-painted sample before exposure. The over-painting should be carried out according to the manufacturer's recommendation (time for drying, number of layers etc.) and as intended in practice. The specimens shall be of the same dimensions and size as required for the reaction tests.

At least 3 pre-conditioned specimens (for each intended reaction test) over-painted with the specified paint and allowed to dry to constant weight at a temperature of (23°± 3)°C and a relative humidity of (50 ± 5)% will be tested in the reaction test without removing the paint to show whether there is a change in performance happened caused by over-painting. [19]

2.3.4 Resistance to permanent wetness

The following short-term test is suitable to test reactive products applied in areas where a state of permanent wetness could occur (e.g. penetration seals for liquid-lines in case of pipe rupture).

A pre-conditioned sample for at least 3 specimens (for each intended reaction test)[13] of approximately 50 mm x 50 mm, at least 20 cm^2, shall be stored in desalinated water at a temperature of (23°± 2) °C for 4 weeks in a vertical position. After the exposure the specimens shall be stored in standard atmosphere of a temperature of (23°± 3) °C and a relative humidity of (50 ± 5) % until a constant weight.

The weight of the specimens shall be recorded before and after exposure. Furthermore the test report shall record the time to come again to a constant weight and all observations if any.

After the exposure the specimens shall be cut out for the reaction tests and shall be tested to show whether there is a change in performance happened caused by the water treatment.

2.3.5 Resistance to chemicals

If relevant, tests shall be carried out concerning reaction to fire of the reactive product after exposure.

2.3.5.1 Liquid chemicals

It is not possible to devise a single test for all imaginable liquid chemical, solvents and liquid cleaning agents.

If specific exposure in practice is expected, the expected liquid should be used for the exposure test. Such liquids could be: dilutions of organic or inorganic acids e.g. HCl, H_2SO_3, NaOH etc., of halogen-salts or alkali substances, disinfectants, liquid oxidants, degreasing agents, solvents, heating oil.

The following short-term test is suitable to test reactive products applied in areas where an exposure to or a splashing with liquid chemicals, solvents and cleaning agents could occur (e.g. at the lower edge of fire-doors, penetrations or air transfer grilles in bathrooms, joint seals for rooms for disinfection in hospitals, penetrations for heating oil transporting pipes or for lines for refrigerants).

A pre-conditioned sample for at least 3 specimens (for each intended reaction test) of at least 20 cm^2 shall be dipped completely into the specific test liquid every day for 10 seconds for a period of 3 weeks. After the third week the sample shall be stored at standard atmosphere (23°± 3) °C and (50 ± 5) % rh for equilibrium but at least for one week.

The weight of the specimens shall be recorded before and after exposure and before testing and all observations if any.

After the exposure test the specimens shall be cut out for the reaction tests and shall be tested to show whether there is a change in performance happened caused by splashing.

2.3.5.2 Chemical Vapours

It is not possible to devise a single test for all imaginable chemical vapours, sprays or aerosols.

If specific exposure in practice is expected, the expected substance should be used for the exposure test. Such vapours could be: disinfectants, air freshener, solvents or gases for cleaning treatment

The following short-term test is suitable to test reactive products applied in areas where chemical vapours or aerosols could occur (e.g. conservatories, dry laundries, disinfection rooms, storage rooms).

A pre-conditioned sample for at least 3 specimens (for each intended reaction test) of at least 20 cm^2 shall be stored in an airtight chamber at a temperature of (30°± 3) °C for 4 weeks. All 12 hours the aerosol shall be blown into the test chamber. After the exposure the specimens shall be stored in standard atmosphere of (23°± 3) °C and (50 ± 5) % until a constant weight.

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[19] For intumescent materials especially the qualification of the expansion ratio is of interest to avoid an obstruction of foaming caused by over-painting.

The weight of the specimens shall be recorded before and after exposure. Furthermore the test report shall contain the time to come again to a constant weight and all observations if any.

After conditioning the reaction tests shall be carried out to show whether there is a change in performance happened caused by the exposure.

2.3.6 Effects in contact with metal or plastics

The basis of the following tests is a visual comparison done between exposed and unexposed specimens, in order to show the influence of the interactive effects by the change of appearance and to warn the observer that adverse effects could influence the function of the construction products (e.g. blistering, sweating, decomposition, change of shape and colour).

2.3.6.1 Reactive products in permanent contact with metal

The test shall be carried out to discern an interactive effect of reactive products in contact with metal e.g. normal steel, aluminium, copper, alloys.

At least 3 unprotected metal specimens of the intended thickness and a size of approximately 20 mm x 100 mm shall be pressed directly into deep contact with a sheet of the intended reactive material of the same size. The both sheets shall be fixed on each other by small clips made of an inert material. Liquids shall be brushed or sprayed as a layer. The prepared specimens shall be stored in a horizontal position – reactive under the metal sheet - for a contact period of 40 days in the standard atmosphere of (30°± 3)°C and (80± 5)% relative humidity. If other conditions are intended in practice, the intended conditions should be used.

After the test the reactive material shall be removed. The appearance of all metal specimens shall be examined for evidence of corrosion. The results shall be recorded in appropriate terms in the test report. If necessary other tests of the metal could follow (e.g. microscopy)

2.3.6.2 Reactive products in permanent contact with plastics

The test shall be carried out to discern an interactive effect of reactive products in contact with plastics e.g. PVC, PE, PP etc.

The specimens of a size of approximately 150 mm x 40 mm made of the kind of plastics intended for the permanent contact (e.g. PVC, PE, PP etc.) shall be pressed directly into deep contact with a sheet of the intended reactive material of the same size. The both sheets shall be fixed on each other by small clips made of an inert material. Liquids shall be brushed or sprayed as a layer. The prepared specimens shall be stored in a horizontal position – reactive under the metal sheet - for a contact period of 40 days in the standard atmosphere of (30°± 3)°C and (80± 5)% relative humidity. If other conditions are intended in practice, the intended conditions should be used.

After the test the reactive material shall be removed. The appearance of the plastic specimens shall be examined for changes. In addition a comparative test of tensile strength according to EN ISO 527 (exposed to contact/not exposed to contact) could be carried out to decide whether there has been a deleterious effect or not.

3 List of references *(former ANNEX D, inserted as additional list to clause 4 of every resp. EAD)*

EN 323:1993-08	Wood-based panels – Determination of density
EN 494:2015-12	Fibre-cement profiled sheets and fittings – product specification and test methods, cl. 7.4.1 Frost-thaw test
EN 543:2003-08	Adhesives- Determination of apparent density of powder and granule adhesive
EN 822:2013-05	Thermal insulating products for building applications - Determination of length and width
EN 823:2013-05	Thermal insulating products for building applications - Determination of thickness
EN 933-1:2012-03	Test for geometrical properties of aggregates – part 1 Determination of particle size distribution – Granulometric analysis
EN 1015-1:2006-12	Methods of test for mortar and masonry – Determination of particle size distribution (sieve analysis)
EN 1015-10:2006-12	Methods of test for mortar and masonry – Determination of dry bulk density of hardened mortar
EN 1235:2003-08	Solid fertilizer – test sieving (ISO 8397 modified)
EN 1363-1:2012-10	Fire Resistance – General Requirements
EN 1602:2013-03	Thermal insulating products for building applications - Determination of the apparent density
EN 1603:2006-09	Thermal insulating products for building applications - Determination of dimensional stability under constant normal laboratory conditions (23°± 3 C /50 ±5 % relative humidity)
EN 1604:2013-03	Thermal insulating products for building applications - Determination of dimensional stability under specified temperature and humidity conditions
EN 1767:1999-06	Products and systems for the protection and repair of concrete structures; Test methods; Infrared analysis
EN 1848-1:1999-02	Flexible sheets for waterproofing – Determination of length, width and straightness
EN 1849-1,-2:2010-04	Flexible sheets for waterproofing – Determination of thickness and mass per unit area
EN 10216-5:2013-12	Seamless steel tubes for pressure purposes – technical delivery conditions – part 5: Stainless steel tubes
EN 12085:2013-03	Thermal insulating products for building applications - Determination of linear dimensions
EN 12092:2001-10	Adhesives - Determination of viscosity
EN 12127:1997-10	Textiles – Determination of mass per unit area using small samples
EN 12192	Products and systems for the protection and repair of concrete structures Granulometric analysis;
	Part 1:2002-05 Test method for dry components of premixed mortar
	Part 2:1999-05: Test methods for fillers for polymer bonding agents
EN 13279-2:2014-03	Gypsum binders and gypsum plasters Part 2 Test methods
EN 13470:2001-12	Thermal insulating products for building equipment and industrial installation - Determination of the apparent density of preformed pipe insulation
ENV 13381-4:2002	Contribution to Fire Resistance of structural members – Part 4: Steel elements
EN 13820:2003-12	Thermal insulating materials for building applications - Determination of organic content

EN ISO 1519:2011-04	Paints and varnishes – Bend test – Cylindrical mandrel
EN ISO 2808:2007-05	Paints and varnishes – Determination of film thickness
EN ISO 3219:1994-10	Plastics – Polymers/resins in the liquid state or as emulsion or dispersion – Determination of viscosity using a rotational viscosimeter with defined shear rate
EN ISO 3251:2008-06	Paint and varnishes – Determination of non-volatile matter content
EN ISO 3451-1:2018-04	Plastics – Determination of ash; method A
EN ISO 4589-2:2017-08	Plastics – Determination of burning behaviour by oxygen index - Part 2 Ambient temperature test
EN ISO 4892-1:2016-10	Plastics – Method of exposure to laboratory light sources – General
EN ISO 4892-3:2006	Plastics – Method of exposure to laboratory light sources – Fluorecent UV lamps
EN ISO 11358-1:2014-10	Plastics – Thermogravimetry (TG) of polymers – Part 1 General principles
EN ISO 13788:2013-04	Hygrothermal performance of building components and building elements – Internal surface temperature to avoid critical humidity and interstitial condensation – calculation methods
ISO 554:1976	Standard atmospheres for conditioning and/or testing - Specifications
ISO 2811	Paints and varnishes – Determination of density
	Part 1:2016-08 Pyknometer method
	Part 2:2011-06 Immersed body method
	Part 3:2011-06 Oscillation method
ISO 5660-1:2015-03	Reaction to fire test - Heat release, smoke production and mass lost rate (Cone calorimeter method and smoke production rate)
ISO 9427:2003	Wood-based panels – Determination of density
ISO 11503:1995-07	Paints and varnishes – Determination of resistance to humidity (intermittent condensation)