SLOVENSKI STANDARD
SIST EN 373:1996

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Varovalna obleka - Ocenitev odpornosti materialov na obrizg staljene kovine

Protective clothing - Assessment of resistance of materials to molten metal splash

Schutzkleidung - Beurteilung des Materialwiderstandes gegen flüssige Metallspritzer

Vetements de protection - Evaluation de la résistance des matériaux a la projection de métal fondu

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English version

Protective clothing - Assessment of resistance of materials to molten metal splash

Vetêments de protection - Evaluation de la résistance des matériaux à la projection de métal fondu

Schutzkleidung - Beurteilung des Materialwiderstandes gegen flüssige Metallspritzer

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Foreword

This European Standard was prepared by CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets" of which the secretariat is held by DIN.

This European Standard has been prepared under a mandate given to CEN by the Commission of the European Communities and the European Free Trade Association, and supports essential requirements of EC Directive(s).

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of an identical text or by endorsement, at the latest by September 1993, and conflicting national standards shall be withdrawn at the latest by September 1993.

In accordance with the CEN/CENELEC Internal Regulations, following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

This European Standard is based on ISO 9185. The annexes A and B are normative.

0 Introduction

There has been an increasing interest over recent years in the flammability performance of textiles. In the metal industries the principal environmental hazards are heat and molten metal splash and this standard is intended to provide a method by which the protective performance of differing materials can be ranked. This standard assesses the performance of materials against large splashes of molten metals in contrast to EN 348 which assesses performance against small droplets.

The test takes into account the heat transfer properties of the material being tested and its dynamic resistance to penetration of the molten metal . The full test procedure is based on stepped increases in mass of metal but it is expected that performance specifications will simply require a specified mass of metal to be poured at which the material should not allow damage to the PVC film.

The principle of the test method is such that any metal can be used but for particular molten metals (e.g. sodium) changes in the materials used for the apparatus will be necessary and additional safety measures needed.

Test conditions for a small range of metals are given in annex A.

1 Scope

This Standard specifies a method for assessing the resistance of materials used in protective clothing to molten metal splash. It is important to note that good resistance of a material to a pure molten metal does not guarantee a good performance against any slag that might be present in a manufacturing process.

2 Definitions

For the purposes of this standard, the following definitions apply.

2.1 Damage to the PVC film

Any smoothing, modification to the embossing or pin-holing of the PVC film extending in total for at least 5 mm across its width. Where the visual change in appearance is in discrete spots, damage occurs when the summation of the widths of each spot exceeds 5 mm across any horizontal section.

2.2 Molten metal splash index

A figure equal to the minimum mass of molten metal poured which just causes damage to the PVC film.

3 Principle

Materials are tested by pouring small quantities of molten metal onto the test specimen supported at an angle to the horizontal on a small pin frame. Damage is assessed by placing a PVC film directly behind the test specimen and noting damage to the film after pouring. Any adherence of the metal to the test specimen surface is also noted. Depending on the result, the test is repeated using a greater or smaller mass of metal, until the minimum quantity to cause damage to the film is observed.

4 Apparatus and materials

4.1 Commercial grade metal, appropriate to the end use.

NOTE: It is recommended that coarse filings or small pieces cut from solid bar or sheet should be used, as fine filings have been found difficult to melt. A range of pouring temperatures used in industry for different metals is given in annex A.

4.2 PVC film [1]), comprising an embossed PVC sheet, of mass per unit area (300 ± 30)g/m² which, when tested as described in annex B shows no smoothing or modification of the embossing of the central area at a block temperature of (166 ± 2)°C but shows smoothing or modification of the central area at a block temperature of (183 ± 2)°C. The PVC film shall be used within one year of receipt.

4.3 Crucible, the approximate external dimensions being a height of 97 mm, a top diameter of 80 mm, a bottom diameter of 56 mm and a capacity (brim full) of 190 ml .

NOTE: For most molten metals, a graphite impregnated material (if an induction furnace is used) or a ceramic material (if a muffle furnace is used) has been found suitable for the crucible.

4.4 Detachable crucible holder, to enable the crucible containing the molten metal to be quickly and safely moved from the furnace to the test apparatus.

4.5 Furnace, capable of operating at a temperature 100°C above the pouring temperature specified in annex A. The furnace type may be either a muffle furnace or an induction type furnace.

NOTE: Muffle furnaces are capable of holding at least four crucibles, i.e. internal furnace size is typically 135 mm x 190 mm x 780 mm, but take several hours to melt metals such as steel, iron and copper. Induction furnaces melt a single crucible of these metals in less than half an hour.

4.6 Temperature probe, either a small thermocouple or an optical non-contact temperature device, capable of measuring molten metal temperatures up to 1650°C to an accuracy of ± 10°C.

4.7 Pouring apparatus, shown in figure 1a, consisting of the pouring device, a means of rotating the pouring device at constant angular velocity, a specimen holder with supporting frame and a sand tray.

The pouring device, consisting of crucible holder and drive shaft, shall be designed and constructed so that the point at which the molten metal pours from the crucible lies on the axis of rotation of the drive shaft. The pouring device shall be manufactured from steel.

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[1]) The PVC film is supplied by the International Wool Secretariat, Valley Drive, Ilkley, West Yorkshire, England. This information is given for the convenience of users of this standard and does not constitute an endorsement by CEN. Equivalent products may be used if they can be shown to lead to the same results (see Annex B).

Figure 1(b) shows an example of a suitable design using a straight drive shaft and a crucible holder into which the crucible fits with its top almost flush to the top surface of the crucible holder. Figure 2 shows an example of equipment that incorporates a cranked drive shaft with a crucible holder into which the crucible fits with its top on the pivot axis. Thus in this equipment the top of the crucible does not fit flush with the top surface of the crucible holder. However, in both these pouring devices, the axis of rotation passes through the pouring edge of the crucible as required.

The specimen holder shall consist of of a rectangular pin frame, (160 ± 2)mm x (248 ± 2)mm external dimension from 8 mm square steel. It shall have four tenter pins, two on the centre line of the top frame and two on the centre line of the bottom frame, spaced (80 ± 2)mm apart and (40 ± 2)mm from the respective corners. The pin frame shall be supported on a suitable frame which enables the angle of the specimen to the horizontal to be varied (see annex A) and the position of the test specimen relative to the pouring device to be adjusted so that the main impact of the molten metal is near the centre of the test specimen.

Examples of suitable pouring apparatus are shown in figure 1(a) and 2, both fitted with electric stepper motors as the means of rotating the pouring device at constant angular velocity. An example of a suitable electric circuit to drive such a device is shown in figure 3.

The pouring device shall be firmly supported by a means that allows adjustment of the pour height, taken at the vertical distance from the drive shaft to the centre of the pin frame, in order that the value specified in annex A can be achieved.

The pouring apparatus should incorporate a means of holding the pouring device stationary in its rest position. In the pouring apparatus shown in figure 1(a) this is achieved by a metal stop.

The sand stray shall have minimum dimensions of approximately 250 mm wide x 350 mm long x 50 mm deep and shall be filled with dry sand to a depth of 30 mm to 40 mm.

4.8 Balance, capable of weighing to an accuracy of 1,0 g.

4.9 Template, in the form of a rigid rectangle (260 ± 2)mm x (100 ± 2)mm with four holes of 5 mm diameter, one in each corner and (10 ± 1)mm from the two adjacent edges, their centres forming the corners of a rectangle (240 ± 2)mm x (80 ± 2)mm.

5 Conditioning

Condition the test specimens for at least 24 hours in an atmosphere having a temperature of (20 ± 2)°C and a relative humidity of (65 ± 2)%.
If testing is not carried out immediately after conditioning, place the conditioned test specimens in a sealed container. Begin testing each specimen within 2 minutes of removing it from either the conditioning atmosphere or the sealed container.
For testing, an atmosphere substantially free from draughts and having a temperature of 10°C to 30°C and 15% to 80% relative humidity shall be used.

6 Preparation of test specimens

Lay out the laboratory sample without tension but free from wrinkles and creases on a flat, smooth surface. Initially, mark and cut seven test specimens using the template with the longer length in the machine direction (except where this does not apply, e.g. leather, when the direction of cutting is unimportant). Using the template, mark the position for the pins (of the pin frame) on the material by spots approximately 2 mm in diameter at the centres of the holes in the template. Cut a similar number of pieces of PVC film and mark the position of the pins in an identical manner.

NOTE: The assessment uses an iterative procedure and therefore the exact number of test specimens needed cannot be stated. Seven test specimens are usually sufficient to give a result. If there is previous experience of the material or if a material is being assessed for compliance with a specification, fewer test specimens will be needed.

7 Operator safety

Protective clothing and equipment meeting the requirements of CEN standards shall be worn by the operator in order to protect against the hazard of accidental splashes from molten metal .

WARNING: In addition to the hazard of molten metal splashes, certain metals (e.g. sodium) ignite spontaneously when heated in air and produce toxic fumes when so heated. Additional safety measures will therefore be necessary when testing the resistance of materials to these metals.

8 Procedure

8.1 Setting up the apparatus

Adjust the position of the pouring device to give the pour height specified in annex A for the molten metal being used. The pour height is the vertical distance from the drive shaft to the centre of the pin frame. Adjust the angle of the pin frame to give the specimen angle to the horizontal specified in annex A.

8.2 Preparation of molten metal

Place approximately 50 g (weighed to the nearest gram) of metal (or multiple of 50 g if it is known that the material under test will withstand a higher amount), either coarse ground or cut from bar or sheet, into the dry crucible and melt it to a temperature slightly above that at which it will remain molten throughout the test (see annex A).

8.3 Attachment of test material to pin frame

Attach a piece of PVC film to the pin frame by pushing the pins through the marked positions with the embossed side uppermost. Position the test specimen over the PVC film and attach it to the pin frame in an identical manner. Ensure that the test specimen is in intimate contact with the PVC film, free from creases and with the face of the material designed to be on the outside of a garment exposed to the molten metal.

8.4 Pouring of molten metal

Carefully transfer the crucible, using the detachable crucible holder, to the pouring ring. Allow the molten metal to cool to the pouring temperature (see annex A) and then operate the pouring device so that the crucible turns through at least 130° from the horizontal at a constant rate of (36 ± 2,5)° per second. This rate is equivalent to a rotation of 90° in (2,5 ± 0,2)s. Pour the metal over the edge of the crucible and not via the pouring lip and ensure that an undamaged edge surface is used.

8.5 Examination

8.5.1 30 s after completion of pouring, remove the test specimen and examine the PVC film for any sign of damage (see 2.1). Note any such damage.

8.5.2 Note and record whether any molten metal has solidified and adhered to the surface of the test specimen.

8.6 Determination of weight of metal poured

Allow any metal remaining in the crucible to solidify sufficiently for it to be scraped out. Weigh this residue to the nearest gram and subtract it from the initial weight of metal melted. Record this as "metal poured" .

9 Iterative Testing

9.1 If there is no damage to the PVC film, repeat the test procedure using new test specimens of material and PVC film and using a quantity of metal in the crucible 50 g more than used in the previous test. If the capacity of the crucible is reached the test is not sufficiently severe to obtain film damage.

If damage is observed proceed to 9.2.

9.2 Repeat the test procedure using a quantity of metal in the crucible 10 g less than used in the previous test. If damage to the PVC film is observed repeat from 9.2. If no damage to the PVC film is observed proceed to 9.3.

9.3 Repeat the test procedure using the same quantity of metal in the crucible used in the previous test. If damage to the PVC film is observed repeat from 9.2. If no damage to the PVC film is observed repeat from 9.3 until four successive tests show no damage to the PVC film.

9.4 Note the highest value of the mass of metal poured (see 8.6) in these four successive tests and the lowest mass of metal poured that caused damage.

9.5 Record the mean of these two values to the nearest gram as the "molten metal splash index."

10 Void tests

Declare any test void and repeat the test using that mass of metal if any of the following occurs:

(a) the impact of the pour wanders horizontally across the test specimen;

(b) the metal runs off the side of the test specimen or strikes within 25 mm of the top edge;