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IS 15865 (2009): Exothermic and Insulating Sleeves for Use in Foundries [MTD 14: Foundry]
Indian Standard
EXOTHERMIC AND INSULATING SLEEVES FOR USE IN FOUNDRIES — SPECIFICATION

ICS 81.080

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

February 2009

Price Group 3
FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Foundry and Steel Castings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Use of preformed exothermic and insulating sleeves is now imperative for foundries to achieve better quality at affordable cost.

This standard aims to achieve better fulfilment of user's expectation by quantification of required performance parameters. It defines the technical requirements of the exothermic/insulating sleeves in terms of quantifiable performance parameters that could also be assessed easily at the users' end.

The manufacturer of the sleeves is required to state the values of vital quality parameters to the user during quotation and supply as per clause 4.7 of this standard.

Annexes A, B, C, D of this standard explain the scientific basis of tests of various parameters of the sleeves as well as the methods of reconfirmations.

Clauses 3.2, 3.4 and 4.3 of the this standard call for agreement between the manufacturer and the purchaser.

Clause 7.3 of this standard indicates forewarning to the user about safety hazards that may arise out of these materials.

For the purpose of deciding whether particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

EXOTHERMニック AND INSULATING SLEEVES FOR USE IN FOUNDRIES — SPECIFICATION

1 SCOPE
This standard covers the requirements for exothermic and/or insulating riser linings called sleeves, in foundries.

2 TYPES OF SLEEVES
a) Exothermic-cum-Insulating Sleeve — The riser linings incorporate exothermic compounds in addition to normal insulating medium.
b) Insulating Sleeve — The riser linings which are made of low density and refractory materials so as to provide insulation to the riser metal in moulds.

3 GENERAL REQUIREMENTS
3.1 For exothermic-cum-insulating sleeves, the composition shall have aluminium in the range of 16 to 20 percent. Both exothermic and/or insulating sleeves shall be classified as Grade A or B or C, depending upon the foundry performance.

The classification Grades A, B and C shall be confirmed subject to Feed Safety Margin (FSM) values obtained in cube and plate testing described in Annexes A and B respectively.

3.2 The shapes and sizes (height and diameter) of sleeves can be decided with the mutual consent of supplier and a foundry

3.3 Sizes and Dimensions
The tolerance on nominal diameter and height shall be as given below. A taper of 1 percent is satisfactory for sleeve heights above 150 mm. The height and tolerance on different dimensions of sleeves are as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Tolerance on Diameter</th>
<th>Tolerance on Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 75 mm, percent</td>
<td>±2 or 5 mm</td>
<td>±1</td>
</tr>
<tr>
<td>More than 75 mm, percent</td>
<td>whichever is less</td>
<td>whichever is ±2</td>
</tr>
</tbody>
</table>

3.4 In order to withstand the rough handling that is exerted on these sleeves during moulding and to maintain desired feeding efficiency, the thickness of the sleeves is open to negotiation between the supplier and foundry. However, as a general guidance, the thickness can be taken as 12 percent of internal diameter of sleeve.

4 PHYSICAL PROPERTIES
4.1 Moisture
Moisture content shall not exceed 3.0 percent in exothermic and/or insulating sleeves.

4.2 Gas Evolution
There shall not be any back pressure of evolved gases in riser metal either during pouring or thereafter. The gas evolution shall be vented through the walls of a sleeve without recourse to the need for any drilling of holes in or around a sleeve. In addition, a sleeve shall be subjected to metal boiling test outlined in Annex C.

4.3 Bulk Density
The sleeve bulk density shall be 0.9 to 1.2. However, other values of bulk density of sleeves can be agreed to between the foundry and the supplier.

4.4 Weight Tolerance
The variation in unit weights of sleeves shall be limited to ±10 percent of nominal weight. The nominal weight can be mutually decided between a supplier and a foundry.

4.5 Compressive Strength
Compressive strength should be 5.0 kg/cm² or higher. The whole sleeve can be tested in compression mode until fracture. Compressive strength is obtained by dividing the highest load by the average cross-sectional area of the sleeve.

4.6 Recommene Modulus Extension Factor (MEF)
Recommended Modulus Extension Factor (MEF) values of sleeves are given below sizewise for exothermic and/or insulating sleeves:

<table>
<thead>
<tr>
<th>Minimum MEF</th>
<th>Exothermic and Insulating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 150 mm diameter</td>
</tr>
<tr>
<td></td>
<td>160 to 225 mm diameter</td>
</tr>
<tr>
<td></td>
<td>250 to 300 mm diameter</td>
</tr>
<tr>
<td></td>
<td>325 to 400 mm diameter</td>
</tr>
<tr>
<td></td>
<td>425 to 500 mm diameter</td>
</tr>
<tr>
<td></td>
<td>525 mm and above</td>
</tr>
</tbody>
</table>
4.7 Plate Test

To ascertain the feeding characteristics of a sleeve, a plate casting shall be designed to evaluate the volumetric feed efficiency defined as volume of metal fed to the casting divided by the casting volume.

The supplier shall specify the Volumetric Feed Efficiency in percent, the test plate dimension and the equivalent sand riser sizes for the sleeves supplied/quoted to enable consuming foundry to undertake assessment of Volumetric Feed Efficiency as described in Annex B.

4.8 Shrinkage Characteristics

No riser pipe/shrinkage extending up to casting shall be allowed. The manufacturer shall specify to the customer the largest size of cube that can be fed fully by the sleeve under conditions as indicated in A-3. Based on the visual examination of sectioned cube and plate castings with risers, sleeve types shall be characterized as Grades A or B or C depending upon the height of sound zone in the riser below the shrinkage capacity. This height of sound zone in a riser between the bottom end of shrinkage cavity and cast surface is termed feed safety margin. In both cube and plate tests, Grades A, B and C sleeve shall yield minimum feed safety margins of 20 percent, 10 percent and 5 percent respectively of sleeve height more than the feed safety margin value given by the sand risers, of same modulus and half its feed efficiency or less, respectively rigged on the same size of cube or plate castings.

4.9 Refractoriness

4.9.1 Sleeves shall withstand molten metal without developing any crack or fusion or significant dilation. Riser surfaces shall show clean strip as knockout. The dilation at the base of riser is only acceptable up to ±2 percent of the diameter for normal heights.

4.9.2 Contamination

Sleeves shall be designed to present neutral medium to riser metal. In any case, the contamination from sleeves to riser metal can be allowed in trace quantities of up to a few pipe levels of the base composition.

4.9.3 Pick-Up of Contaminants

Procedure for determination of pick-up of contaminants shall be as described in Annex D.

5 VISUAL OBSERVATION

5.1 Sleeves shall be homogeneously bonded with smooth and well finished appearance. It shall not contain any cracks, cavities, patches and friable powder. The definitions of edges and corners shall be sufficiently sharp and intact.

5.2 Shape

Sleeves may be designed to have geometric shapes as per the mutual consent. Its shape is expected in close adherence to the dimensions mutually agreed upon and tolerance specified in 3.3. Even so, sleeves shall be free from sagging at either top or bottom end and, in any case, maximum deviation from the geometric shape shall not exceed the percentage tolerance on diameter/height, whichever is applicable.

5.3 Wall Thickness

Normally sleeves are expected to have uniform wall thickness across the diameter though it may vary over the height. The variation in wall thickness shall not exceed the sum total of tolerances on nominal inside and outside sleeve diameters at any given height.

6 PACKING

Sleeves can be packed in any packaging material to minimize the breakage in the transportation and preservation of the physical properties as well as size, shape and appearance during their shelf life.

7 LABELS AND MARKING

7.1 Sleeve type, size and quantity along with manufacturer’s name and trade-mark shall be clearly and legibly displayed on the outside of the package. Batch No./Date of manufacture, shelf life and any warning should be printed as well.

7.2 Sleeves may also indicate manufacturer’s name, logo or trade-mark and the size for easy identification in foundries.

7.3 The label should clearly mention whether sleeves are asbestos free or not. The label should also warn about possible fire hazard and safe storing requirement.

7.4 BIS Certification Marking

The sleeves may also be marked with the Standard Mark.

7.4.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of the conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.
ANNEX A  
(Foreword, and Clause 3.1)  
STANDARD CUBE TESTING FOR EVALUATING FEED SAFETY MARGIN, MODULUS EXTENSION FACTOR AND GRADE OF EXOTHERMIC AND/OR INSULATING SLEEVES

A-1 DEFINITION
Modulus extension factor is defined as the ratio of the effective modulus of an Equivalent Sand Riser and the Geometric Modulus of a sleeve.

A-2 OBJECTIVE
The objective is to quantify the increment in thermal insulating capacity and prolonged solidification time of an exothermic and/or insulating sleeve compared to an equivalent sand riser capable to feed a particular casting to a desired level of solidity.

A-3 PROCEDURE
The effective modulus of a sleeve is best obtained by comparing the performance of an equivalent sand riser on a standard cube casting. The steps are illustrated for the evaluation of a 150 mm diameter and 150 mm high exothermic sleeve.

A-3.1 Calculation for Equivalent Riser and Test Cube Size from Sleeve MEF
Assuming that the Riser-Casting contact area is non-cooling, steps involved are as follows:

a) Sleeve Modulus = \( M_u = \frac{(D \times H)}{(D + 4H)} \)
where
\( D \) = diameter of a sleeve, and
\( H \) = height of a sleeve.

b) Equivalent Sand Riser Modulus = \( M_w = F \times M_u \)
where
\( F \) = MEF of sleeve (given by the supplier).

c) Equivalent Sand Riser Diameter = \( D_w = M_w \times 5 \), if the height of sand riser = \( D_w \)

d) Test Cube Modulus = \( M_t = M_w / 1.2 \)

Therefore, 'a' = Cube Side Length = \( M_t \times 5 \)

Alternatively, 'a' = Test Cube Side = \( (F \times M_u \times 5) / 1.2 \), if Diameter = Height for riser/sleeve.

A-3.2 Following steps are involved in determination of effective modulus of sleeve:

Steps:
1. Choose a standard cube size of 200 mm \( \times \) 200 mm \( \times \) 200 mm.

2. Make the cube casting with 150 mm \( \times \) 150 mm sleeve and 240 mm diameter \( \times \) 240 mm high sand riser keeping the metal and mould conditions constant as given below:

   Metal : 0.25 percent plain carbon steel
   Pouring temperature : 1600°C ± 10°C
   Mould : \( \text{CO}_2 / \text{Sodium silicate} \)
   Running system : Bottom gated 1:2:2
   Riser top cover : 15 mm silica sand/antipiping compounded recommended by the supplier or blind sleeve section riser with cube casting using a power saw and measure feed safety margin as shown in Fig. 1.

A-4 MEF EVALUATION
MEF of a sleeve is obtained by dividing the modulus of equivalent sand riser by the geometric modulus of a sleeve. For example the modulus of 240 mm diameter \( \times \) 240 mm height sand riser is 240\( \times \)5 = 48 mm, assuming riser/casting area is non-cooling. The geometric modulus of 150 mm diameter \( \times \) 150 mm high sleeve is 150/5 = 30 mm, assuming sleeved riser/casting contact area is non-cooling.

Hence, MEF of the sleeve = \( \frac{48 \text{ mm}}{30 \text{ mm}} = 1.6 \)

However, MEF of 1.6 is proved only if the sleeved riser gives FSM at least equal to the FSM value obtained in the sand riser of 240 mm diameter \( \times \) 240 mm high size.

Sleeve Grades
All exothermic and/or insulating sleeves shall be classified as Grades A or B or C if the FSM value is 20 percent or 10 percent or 5 percent of its height more than the FSM value obtained in the equivalent sand riser rigged on identical cube or plate castings.

A-5 RETEST
If any test cube fails to meet the requirements of MEF and Grade Evaluation, an additional Test cube of that size shall be recast if requested by the sleeve manufacturer.
ANNEX B

( Foreword; and Clauses 3.1 and 4.7)

STANDARD PLATE TEST FOR EVALUATING FEED SAFETY MARGIN, VOLUMETRIC FEED EFFICIENCY AND GRADE OF EXOTHERMIC AND/OR INSULATING SLEEVES

B-1 DEFINITION

Volumetric feed efficiency of a sleeve is defined as the percentage of feed metal transferred to the casting during its solidification at the same level of feed safety margin as found in a sand riser of given dimensions mounted on the same casting.

B-2 OBJECTIVE

The objective is to measure volumetric feed efficiency of a sleeve relative to a sand riser of given dimensions.

NOTE — The supplier shall specify test plate size, sand riser dimension, volumetric feed efficiency in percent for the sleeves supplied.

B-3 PROCEDURE

Typically sand risers are expected to give feed efficiency of around 25 percent on plate-like castings. The volumetric feed efficiency of a sleeve is measured on plate-like castings and the steps are given below.

For this example, volumetric shrinkage of 5 percent is assumed for both the castings rigged with sand and sleeved risers:

Steps:

1. Choose a plate casting of 250 mm x 250 mm x 25 mm.
2. Make the casting with 64 mm diameter x 98 mm high sand riser and a sleeve of 156.25 cc internal volume and nearly internal H/D ratio of 1.5, keeping the metal and mould conditions constant as given below:

<table>
<thead>
<tr>
<th>Metal</th>
<th>0.25 ± 0.05 percent plain carbon steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pouring temperature</td>
<td>1 600° ± 10°C</td>
</tr>
<tr>
<td>Mould</td>
<td>CO₂/Sodium silicate</td>
</tr>
<tr>
<td>Running system</td>
<td>Side gated 1:2:2</td>
</tr>
<tr>
<td>Riser top cover</td>
<td>7 mm silica sand cover/anti-piping compound as recommended by</td>
</tr>
</tbody>
</table>
the supplier or blind sleeve

3. Section riser with plate casting using a power saw and measure feed safety margin as shown in Fig. 2.

**B-4 VOLUMETRIC FEED EFFICIENCY**

**B-4.1** The feed efficiency is obtained by calculating percent feed metal supplied to the casting relative to a sand riser. For example, volume of 64 mm dia x 98 mm high sand riser is 309 cc. Assuming 5 percent shrinkage, plate casting of 250 mm x 250 mm x 25 mm needs feed metal of 78 cc. The feed efficiency of the sand riser is 78/309 or 25 percent at some value of feed safety margin.

**B-4.2** If a sleeve of 156.25 cc can feed the plate casting with the same value of FSM as found in the sand riser then its feed efficiency is 78/156.25 cc or 50 percent.

**B-4.3 Sleeve Grade**

An exothermic/insulating sleeve shall be classified as Grades A or B or C if its FSM is 20 percent or 10 percent or 5 percent more than the FSM value of a sand riser having half its efficiency or less, as mentioned in B-4.2. Both the sand and sleeve risers are to be tested on the same size of plate casting as shown in the example given above.

**ANNEX C**

*(Foreword; and Clause 4.2)*

**A TEST FOR CHECKING GAS EVOLUTION OF EXOTHERMIC AND/OR INSULATING SLEEVE AND ENTRAPMENT OF EVOLVED GAS IN THE RISER METAL**

**C-1 OBJECTIVE**

To observe gas evolution of an exothermic and/or insulating sleeve during the exothermic reaction and check for any gas entrapment in riser metal.

**C-2 TEST PROCEDURE**

An open exothermic and/or insulating sleeve can be moulded in green sand or any other medium as shown in Fig. 3. Pour the metal up to one-half of sleeve height and observe for signs of boiling. Cover the metal with recommended anti-piping compound after a few minutes and allow it to solidify. Section the solidified metal with a power saw.

**C-3 OBSERVATION**

a) In case boiling continues for 2 min or longer in the metal poured into a sleeve, then gas evolution can be considered to be excessive.

b) The cut sections of solidified metal along vertical axis visually show a shrinkage pipe in its centre and some dispersed porosity around it. Any gas porosity around the surface and/or all over the cut section indicates gas entrapment.
C-4 CONCLUSION

Any sleeve, exothermic or insulating, will be considered unfit for use in a foundry if it gives persistent boiling in riser metal for 2 min or longer and the cut section of solidified riser metal clearly shows entrapped gas near the surface and/or its over.

![Fig. 3 Test Mould for Checking Gas Evolution and Gas Entrapment Riser Metal](image)

ANNEX D

(Foreword; and Clause 4.9.3)

PROCEDURE FOR DETERMINATION OF PICK-UP OF CONTAMINATING ELEMENTS IN STEEL CASTINGS

D-1 OBJECTIVE

The objective is to monitor amount of pick-up of various contaminants detrimental to steel from sleeves used.

D-2 TEST PROCEDURE

Analytical procedure shall be limited to spectrographic methods. Spectrographic test shall be conducted at 0.7 mm or more below the casting-sleeve interface. Preparation of casting surface for spectrographic analysis shall be done by matching.

D-3 LOCATION

Specimens 1, 2 and 4 (see Fig. 4) shall be taken no closer than riser casting or sleeve-casting interface.

![Fig. 4 Location of Specimen for Determination of Pick-Up of Contaminating Elements in Steel Castings](image)

Specimen 4 shall be taken directly below the vertical centrel ine of the riser at the interface to ascertain effect due to segregation. Specimen 3 may be taken from any location at least 25 mm away from mould-metal interface. The analysis at any location shall be average of 3 sparks.

D-4 ACCEPTANCE CRITERIA

Values for the maximum permissible pick-up in test cubes should be as under:

<table>
<thead>
<tr>
<th>Element</th>
<th>Maximum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>0.05 percent</td>
</tr>
<tr>
<td>Boron</td>
<td>0.001 percent</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.30 percent</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.003 percent</td>
</tr>
<tr>
<td>Lead</td>
<td>0.003 percent</td>
</tr>
<tr>
<td>Tin</td>
<td>0.003 percent</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.01 percent</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.01 percent</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.01 percent</td>
</tr>
</tbody>
</table>

D-5 EXCEPTION

Whenever buffer cores or metals pads more than 15 mm are used to separate sleeves from casting, it is not necessary to determine pick-up of contamination.
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This Indian Standard has been developed from Doc: No. MTD 14 (4603).

Amendments Issued Since Publication

<table>
<thead>
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<th>Amend No.</th>
<th>Date of Issue</th>
<th>Text Affected</th>
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Printed by the Manager, Govt. of India Press, Faridabad