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Indian Standard

METHOD OF SAMPLING FERRO ALLOYS FOR SIEVE ANALYSIS AND SIZE DETERMINATION

ICS 77.100
FOREWORD

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

This standard covers the sampling of ferro alloys for sieve analysis and particle size determination. Sampling of ferro alloys for chemical analysis is separately covered in IS 1472 : 1977 ‘Methods for sampling ferro alloys for determination of chemical composition’.

Ferro alloys are generally supplied in containers, drums or bags. Sampling shall be carried out at the time of loading or unloading or during packing/unpacking or from a stockpile. For the purpose of sampling the ferro alloys according to size to be divided in two groups, that is, lump form and crushed form. Devices and tools for sampling and sample preparations are covered in Annex A.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 ‘Rules for rounding off numerical valves (revised)’. 
Indian Standard

METHOD OF SAMPLING FERRO ALLOYS FOR SIEVE ANALYSIS AND SIZE DETERMINATION

1 SCOPE

This standard lays down the procedure to be followed for collection and preparation of samples representing a lot of ferro alloys, namely, ferro manganese, ferro chrome, ferro silicon, silico-manganese, etc, in bulk or in packed form for sieve analysis and size determination.

NOTE — For the purpose of sampling the ferro alloys according to size may be divided into two groups, that is, lump form and crushed form.

2 REFERENCE

The following standard contains provision, which through reference in this text constitutes provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1472 : 1977</td>
<td>Method for sampling ferro alloys for determination of chemical composition</td>
</tr>
</tbody>
</table>

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Consignment — A consignment may consist of one or more lots and sub-lots.

3.2 Crushed Form — Particles below 50 mm.

3.3 Gross Sample — The sample obtained by combining together all the increments from sub-lots. There will be as many gross samples as the number of lots.

3.4 Hand Placing or Manual Single Body Screening — In case of large lump size pieces, each piece is contacted to the aperture of the screen by hand for its possibility of passing through the prescribed square hole aperture screen.

3.5 Increment — The quantity of ferro alloys obtained by sampling device at one time and in one motion from a sub-lot.

3.6 Lot — The quantity of the ferro alloy of one type and grade offered for inspection at one time.

3.7 Lump Form — Particles of size, 50 mm and above.

3.8 Manual Screening — It is a screening operation in which the sieve is shaken manually.

3.9 Mechanical Sieving — An operation in which the sieve is supported and shaken mechanically.

3.10 Nominal Top Size — The upper level of the particle size ranges specified for technical requirements and conditions for delivery of individual types of ferro alloys.

3.11 Screening (Sieving) — It is process of operation where the samples are separated according to the specified particle size by using one or more sieves.

3.12 Size Fraction or Particle Size — During screening operation with one (say 'X') sieve the particles which are passing through that 'X' sieve are designated as '-'X' size particles and which are retained will be designated as '+'X' size. Similarly if two sieves (say 'X' and 'Y') are used, particles retained on sieve are designated as '+'X' and '+'Y' size. Particles passing through and retained on 'Y' sieve are called as '-'X' and '+'Y' size. Particles passed through 'Y' sieve are designated '-'Y' size.

3.13 Size Sample — A sample taken for determination of granulometric composition of a consignment or part of a consignment.

3.14 Sub-lot — The quantity of ferro alloy in one of the various parts into which the lot is divided for the purpose of sampling.

3.15 Top Size — Particles of size expressed by the operative size of a sieve on which not more than one percent of the sample is retained.

4 SAMPLING

4.1 General Rules

4.1.1 General rules of sampling are similar to that as prescribed in IS 1472.

4.1.2 Sampling for determination of ferro alloys for particle size is different from the sampling for chemical analysis.

4.1.3 Sampling shall be carried out at the time of loading or unloading or during packing/unpacking or from a stockpile.

4.1.4 Some of the ferro alloys are friable in nature and
they should be handled properly. Hence, samples for size analysis should be drawn and subjected to sieve test of only such places, which involve minimum further handling.

4.1.5 The ferro alloys are generally delivered duly packed in containers, bags or drums. Similar type of materials packed in similar containers shall be grouped as one lot.

4.1.6 When material in bulk is supplied in trucks or wagons or by any other means the total consignment shall be taken as one lot.

4.1.7 If the mass of consignment/lot is more than 2 000 mt and mass is not homogenous in size, sublots/sub-consignment sampling is advisable for attaining higher precision. Such consignment or lot may be divided arithmetically into sub-consignment/ sub-lot for sampling purpose such that each sub-consignment or sub-lot should not be more than 2 000 mt and sampling plan shall be carried out assuming each sub-consignment or sub-lot as a consignment or a lot. The analysis result of each sub-lot/sub-consignment shall be compiled together for getting the result of a consignment/lot.

5 GROSS SAMPLE QUANTITY

Gross sample quantity is governed by mass of increments and number of increments.

5.1 Mass of Increment

The minimum mass of increment to be taken from lot/sub-lot shall be governed by the nominal top size as specified in Table 1.

5.2 Number of Increments

The number of increments to be taken from a lot/sub-lot shall be governed by the mass of the consignment as specified in Table 2.

5.3 Collection of Increments

5.3.1 Increments from Containers

One in every five containers, bags/drums shall be unloaded on a levelled ground from each lot/sub-lot, spread evenly to the height of the maximum size of particles in the lot being inspected. As it is very difficult to use sampling scoop for lump form owing to its size and heaviness, square frame shall be used in its place. The scoop/square frame used for sampling shall have the dimension as per Annex A.

5.3.1.1 Lump form

The square frame with each side equal to at least 3 times the largest particle or lump size of the material shall be placed at random at one point.

All these pieces which are completely inside the frame and more than 50 percent will be collected as one increment.

5.3.1.2 Crushed form

Increment shall be collected at different spots by a sampling scoop from the spread material. Total material collected in a scoop shall form one increment.

5.3.2 Increments from Wagon/Trucks in Bulk

5.3.2.1 Lump form

Material shall be evenly spread in the wagon/truck. On the top of the levelled material square frame shall be placed at random across the surface and the material shall be collected down to the bottom as described under 5.3.1.1 as one increment.

5.3.2.2 Crushed form

Material shall be evenly spread in the wagon/truck. Increments shall be collected at different spots by a sampling scoop. Total material collected in a scoop shall form one increment.

5.3.3 Increments from Stockpiles

Based on the size of the stack number of spots shall be selected in a definite order on surface to make pits with minimum dia of 0.5 m. On each side of the stack one or two spots shall be selected depending on its length and breadth to make trenches of minimum depth of 0.5 m.

5.3.3.1 Lump form

The entire material from all the pits and trenches is collected, spread evenly on a levelled ground to the height of the maximum size of the particles in the stack and a minimum required sample shall be collected as detailed under 5.3.1.1.

5.3.3.2 Crushed form

The entire material from all the pits and trenches is collected and spread evenly on a levelled ground to the height of the maximum size of the particles in the stack and minimum required sample shall be collected with help of a sample scoop and scrapper. If the square frame is used then place the square frame on the top of the levelled material at random at one point. All these pieces which are completely inside the frame and more than 50 percent inside the frame and down to the bottom shall be collected as once increment.

5.4 From each lot/sub-lot the number of increments shall be collected as per Table 2.

6 PROCEDURE FOR SIEVE ANALYSIS

6.1 Square hole aperture sieves shall be used only unless otherwise specified.
Table 1 Mass of an Increment

\((\text{Clause } 5.1)\)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Nominal Top Size</th>
<th>Mass, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>Group 1</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i) 315</td>
<td>—</td>
<td>337</td>
</tr>
<tr>
<td>ii) 200</td>
<td>—</td>
<td>164</td>
</tr>
<tr>
<td>iii) 150</td>
<td>—</td>
<td>104</td>
</tr>
<tr>
<td>iv) 100</td>
<td>79</td>
<td>55</td>
</tr>
<tr>
<td>v) 75</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>vi) 50</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>vii) 35</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>viii) 25</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>ix) 10</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>x) 6.3</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>xi) 3.15</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>xii) 2</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Group 1 — FeW, FeMo, FeNb
Group 2 — FeCr, FeSiCr, FeMn, FeTi, FeNb, FeSi having a silicon content less than 45 percent, \(\text{Min}\)
Group 3 — FeB, SiCa, FeSiCa, FeSi having a silicon content equal to or greater than 45 percent, \(\text{Min}\)

NOTE — For arriving at mass of increment for other Nominal Top Sizes (NTS) the following formula may be used:

\[
\begin{align*}
\text{a) Group 1 Alloys:} & \quad \text{Mass of increment, kg} = \frac{450}{(300/\text{NTS})^a} \\
\text{b) Group 2 Alloys:} & \quad \text{Mass of increment, kg} = \frac{300}{(300/\text{NTS})^b} \\
\text{c) Group 3 Alloys:} & \quad \text{Mass of increment, kg} = \frac{80}{(300/\text{NTS})^{1.5}}
\end{align*}
\]
6.2 Sieve analysis of ferro alloys susceptible to breakage through handling shall be carried out near the place of sampling.

6.3 A sample for sieve analysis may be divided into fractions of large lump size and the rest by hand separation. During sieve analysis same size lumps shall be separated by hand from the screen.

6.3.1 Large Size Lumps
The large size lumps (see 3.6 and Table 3) may be examined by the method of manual single body screening (see 3.10). The pieces, passed through the sieve in any one direction shall be treated as within the specified size subject to the dimension not exceeding 1.15 times the size range specified in two or three directions. Otherwise that particle will be treated as oversize.

6.3.2 Mechanical sieving (see 3.15 and Table 3) can be carried out for crushed form only and the upper sieve shall be charged such that a layer of thickness should not be more than the aperture of top size of the sieve.

6.3.3 The fraction remaining on each sieve shall be weighed separately. The mass of each fraction shall be calculated as percentage of initial mass of the test sample to determine the size distribution of a consignment as per the equation given below:

\[ I = \frac{m_i \times 100}{m} \]

where

\( I \) = content of a fraction, as percentage by mass;

\( m_i \) = mass, of a fraction in a charge in kg; and

\( m \) = mass of total fraction, in kg.

7 REPEATABILITY
At least two analysis to be carried out. The corresponding fraction \((F)\) should not be more than \('X' \text{ percent}' where \('X' = 0.2 \times F, \text{Min}' with a minimum value of two percent. \('X'\) is the maximum permissible difference between corresponding fraction masses of two analysis of sample of the same material, expressed as percentage. \('F, \text{Min}'\) is the smaller of the two corresponding fractions \('F'\) expressed as a mass percentage.

8 REPRODUCIBILITY
As specified by the interested parties or on mutual agreement between the supplier and the purchaser.

| Table 2 Minimum Number of Increments to be Collected (Clauses 5.2 and 5.4) |
|-----------------------------|---------------------------------|-----------------------------|
| Sl No. | Mass of Consignment \( m \) | Minimum Number of Increments |
| (1) | Over (2) | Up to and Including (3) | (4) |
| i) | 5 000 | 10 000 | 33 |
| ii) | 2 500 | 5 000 | 30 |
| iii) | 1 000 | 2 500 | 28 |
| iv) | 500 | 1 000 | 25 |
| v) | 250 | 500 | 23 |
| vi) | 100 | 250 | 20 |
| vii) | 50 | 100 | 18 |
| viii) | 25 | 50 | 15 |
| ix) | 10 | 25 | 10 |
| x) | 5 | 10 | 8 |
| xi) | – | 5 | 6 |
Table 3 Quantity of Material Taken at One Time in Sieve for Screening

(Clauses 6.3.1 and 6.3.2)

<table>
<thead>
<tr>
<th>No.</th>
<th>Size, mm</th>
<th>Area 2025 cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>50-100</td>
<td>10 kg</td>
</tr>
<tr>
<td>ii)</td>
<td>25-50</td>
<td>5 kg</td>
</tr>
<tr>
<td>iii)</td>
<td>10-25</td>
<td>3 kg</td>
</tr>
<tr>
<td>iv)</td>
<td>Below 10</td>
<td>2 kg</td>
</tr>
</tbody>
</table>

ANNEX A

(Foreword, and Clause 5.3.1)

DEVICES AND TOOLS FOR SAMPLING AND SAMPLE PREPARATION

A-1 For mechanical sampling, only mechanical devices meeting the following requirements shall be used:

a) A sampling device shall cross the entire stream of ferro alloy and take a complete cross-section,
b) The capacity of the sampling device shall be sufficient to take one complete increment at one cut, and
c) The construction of a sampling device shall be convenient for cleaning and checking.

A-2 The following implements shall be used for manual sampling:

a) Scoops,
b) Containers for sampling, and
c) Probes.

A-2.1 A scoop for increment sampling shall be of dimensions corresponding to the increment volumes and shall be sufficiently durable (see Fig. 1 and Table 4). Examples for choosing scoops are given below:

a) Determine experimentally, or based on previous experience or on the data provided, the bulk density, \( \rho \), of a ferro alloy, in kilograms per cubic metre. This will depend on the particle size and ferro alloy grade;
b) Calculate the volume, \( V_i \), of an increment, in cubic metre, using the following equation:

\[
V_i = \frac{m_i}{\rho} - m^3
\]

where

\( m_i \) = mass, of an increment in kg;
\( \rho \) = bulk density of the ferro alloy, in kg/m³; and
c) Using Table 4, select a scoop the volume of which is nearest to the volume obtained according to (b) above.

A-2.2 A container for increment sampling shall be selected on the basis of the volume of a sample (see Fig. 2 and Table 5).

A-2.3 The diameter of the opening of a probe for increment sampling of a consignment of a ferro alloy of less than 10 mm in particle size shall be not less than three times the normal top size. The construction of the probe shall ensure sampling from the whole layer of ferro alloy. Examples of probe constructions are given in Fig. 3.

A-2.4 The devices for crushing of samples shall be selected in accordance with the planned particle size and the hardness of the ferro alloy.

A-2.5 A divider for sample division shall be selected on the basis of the particle size in accordance with Table 6.

A-2.6 Devices and tools used for sampling and sample preparation shall ensure the planned precision at all the stages of the procedure.

A-2.7 All the devices and tools used shall be cleaned, checked and adjusted before sampling.
Table 4 Recommended Dimensions of Scoops for Increment Sampling

*(Clause A-2.1)*

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Number of Scoop</th>
<th>Approximate Volume cm³</th>
<th>Dimensions, mm</th>
<th>Material Thickness mm</th>
<th>a/c</th>
<th>b/c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>15</td>
<td>30</td>
<td>15</td>
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<td>30</td>
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<td>50</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>125</td>
<td>60</td>
<td>35</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>200</td>
<td>70</td>
<td>40</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>300</td>
<td>80</td>
<td>45</td>
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<td>7</td>
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<td>400</td>
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<td>80</td>
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<td>65</td>
<td>110</td>
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<tr>
<td>9</td>
<td>50</td>
<td>1700</td>
<td>150</td>
<td>75</td>
<td>150</td>
<td>130</td>
</tr>
<tr>
<td>10</td>
<td>75</td>
<td>4000</td>
<td>200</td>
<td>100</td>
<td>300</td>
<td>170</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>7000</td>
<td>250</td>
<td>110</td>
<td>250</td>
<td>220</td>
</tr>
</tbody>
</table>

¹ If a scoop is also used for sample division, e = 0, that is, the front of the scoop is cut off.

---

6
Table 5 Recommended Dimensions of Containers for Increment Sampling

(Clause A-2.2)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Approximate Volume, cm$^3$</th>
<th>Dimensions, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>ii)</td>
<td>125</td>
<td>60</td>
</tr>
<tr>
<td>iii)</td>
<td>200</td>
<td>70</td>
</tr>
<tr>
<td>iv)</td>
<td>300</td>
<td>80</td>
</tr>
<tr>
<td>v)</td>
<td>400</td>
<td>90</td>
</tr>
<tr>
<td>vi)</td>
<td>700</td>
<td>110</td>
</tr>
<tr>
<td>vii)</td>
<td>1700</td>
<td>150</td>
</tr>
<tr>
<td>viii)</td>
<td>4000</td>
<td>200</td>
</tr>
<tr>
<td>ix)</td>
<td>7000</td>
<td>250</td>
</tr>
</tbody>
</table>

General Dimensions of Containers:

- **Figure 1**: A Scoop for Increment Sampling
- **Figure 2**: A Container for Increment Sampling
Table 6 Types of Riffle Divider  

(Clause A-2.5)

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Nominal Top Size in Sample, d (mm)</th>
<th>Number of Divider</th>
<th>Width of Riffle (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i)</td>
<td>$5 &lt; d &lt; 10$</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>ii)</td>
<td>$2.4 &lt; d &lt; 5$</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>iii)</td>
<td>$d &lt; 2.4$</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

FIG. 3 EXAMPLES OF PROBES FOR INCREMENT SAMPLING
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Amendments Issued Since Publication

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