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Copper, lead and zinc sulfide concentrates — Determination of transportable moisture limits — Flow table method

Concentrés sulfurés de cuivre, de plomb et de zinc — Détermination des limites d'humidité transportable — Méthode de la table d'écoulement

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Foreword

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

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12742 was prepared by Technical Committee ISO/TC 183, *Copper, lead and zinc ores and concentrates*.

Annex A forms a normative part of this International Standard.

Copper, lead and zinc sulfide concentrates — Determination of transportable moisture limits — Flow table method

WARNING — This International Standard may involve hazardous materials, operations and equipment. It is the responsibility of the user of this International Standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies a flow table method for the determination of the transportable moisture limit (TML) of copper, lead and zinc concentrates which may liquefy during transport.

This International Standard is applicable to the determination of the TML of concentrates containing 10 % (*m/m*) to 80 % (*m/m*) of lead, or 10 % (*m/m*) to 65 % (*m/m*) of zinc, or 10 % (*m/m*) to 55 % (*m/m*) of copper. It is applicable to TMLs in the range 3 % (*m/m*) to 28 % (*m/m*).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 10251:1997, *Copper, lead and zinc sulfide concentrates — Determination of mass loss in bulk material on drying.*

ISO 12743:1998, *Copper, lead and zinc sulfide concentrates — Sampling procedures for determination of metal and moisture content.*

3 Principle

Adjustment of the moisture content of the sample by mixing with water. Conversion of the mixture to a conical shape using a mould and tamper. Placement of the sample on the flow table and removal of the mould. Determination of the flow characteristic by repeated dropping of the flow table while observing the behaviour of the sample. When sufficient water has been added to the sample so that plastic deformation occurs during the dropping of the flow table, the sample is considered to be at its flow moisture point.

Calculation of the TML as 90 % of the flow moisture point.

4 Apparatus

NOTE Copper, lead and zinc concentrates may gain or lose moisture rapidly when exposed to air. The laboratory should be designed so that excessive temperatures, air currents and humidity variations are avoided.

4.1 Flow table and frame, as specified in annex A.

The flow table mounting shall be as specified in Figure A.1.

4.2 Mould, as specified in Figure A.1.

4.3 Tamper.

The required tamping pressure may be achieved by using calibrated, spring-loaded tampers or some other suitable design of tamper that allows a controlled pressure to be applied via a 30 mm diameter tamper head as specified in Figure A.2.

4.4 Balance, top loading, having the sensitivity specified in Table 1.

Table 1 — Sensitivity of balance and precision of weighing

Mass of sample plus tray g	Precision of balance and weighing g
100	0,01
200	0,02
300	0,03
400	0,04
500	0,05

4.5 Measuring cylinder, 100 ml to 200 ml capacity.

4.6 Burette, 10 ml capacity.

4.7 Water applicator, for adding a fine spray of water to the sample, having a capacity greater than 200 ml and 5 ml calibration divisions.

4.8 Mixing bowl, hemispherical of 30 cm diameter.

4.9 Rubber gloves.

4.10 Drying trays or pans, having dimensions that permit the sample to be spread to a thickness of less than 30 mm.

The trays shall be made of corrosion-resistant and heat-resistant material such as stainless steel, glass or enamel plate.

4.11 Drying oven, ventilated, with forced circulation of air or inert gas, regulated at a temperature of 105 °C ± 5 °C.

5 Sampling

5.1 General

TML figures are required to be updated on a periodic basis, usually six monthly or when there is a known change to the process used to produce the material. The reported figure should be the mean of samples taken during the period.

To ensure that the TML result is representative, increments of the material shall be taken either

a) while a stockpile is being built up or broken down or

b) while loading or discharging a vessel.

These increments are combined to form the sample used to determine TML.

NOTE 1 The sample used to determine TML should not be used to determine moisture.

NOTE 2 Stationary sampling of stockpiles should never be used for the determination of TML. This method of sampling can only be used to provide an indicative moisture value for use during the planning of shipping schedules.

5.2 Laboratory sample

Samples for the determination of TML shall be taken in accordance with ISO 12743. The laboratory sample shall not weigh less than 5 kg. To minimize changes to the flow characteristics of the sample it shall not be oven dried or ground during its preparation.

5.3 Separation of test sample into test portions

Place the laboratory sample in the mixing bowl (4.8) and gently mix it thoroughly. Remove four test portions (A, B, C and D) from the mixing bowl as follows:

a) Test portion A

Take approximately 1,2 kg of sample which is to be used for determining the moisture content of the sample "as received". This test is performed in accordance with ISO 10251. With routine samples, the result of this test provides the operator with a guide as to how much water to add to the samples, thereby speeding up the TML test.

b) Test portion B

Take approximately 1,2 kg of sample. This sample is to be used for the preliminary TML test. Store this sample in an appropriately labelled airtight container.

c) Test portion C

Take approximately 1,2 kg of sample. This sample is to be used for the first duplicate of the final TML test. Store this sample in an appropriately labelled airtight container.

d) Test portion D

Take approximately 1,2 kg of sample. This sample is to be used for the second duplicate of the final TML test. Store this sample in an appropriately labelled airtight container.

6 Procedure

6.1 General

Copper, lead and zinc concentrates may undergo rapid changes in moisture when exposed to air, so all stages of the test should be accomplished in the shortest time period and shall definitely be completed within the day of commencement. Where possible, sample containers should be covered with plastic film or any other suitable airtight cover.

As more accurate results are obtained when the moisture of the test portion is close to the flow moisture point, a preliminary test shall be carried out. The result of this test is used to adjust the moisture of the final test portion to 1 % to 2 % below the flow moisture point.

6.2 Preparation of test portions

6.2.1 General

Test portions B, C and D are prepared, with test portion B prepared first to determine the preliminary flow moisture point in accordance with 6.2.2 to 6.3.5.

Once the preliminary flow moisture point has been determined, test portions C and D are then prepared and the main flow moisture point determined in accordance with 6.4.2 to 6.4.6.

6.2.2 Filling the mould

Place the mould on the centre of the flow table and fill it in three stages with the test portion as follows:

a) the first charge, after tamping, shall aim to fill the mould to approximately one third of its depth;

b) the second charge, after tamping, shall fill the mould to about two thirds of its depth;

c) the third and final charge, after tamping, shall reach to just below the top of the mould (see Figure 1).

The quantity of test portion required to achieve each of these stages will vary from one material to another, but is readily established after experience has been gained on the packing characteristics of the material being tested.

6.2.3 Tamping pressure

The aim of tamping is to simulate the amount of compaction prevailing at the bottom of a shipboard cargo for the material being tested. The correct pressure to be applied via the tamper is calculated as follows:

$$p_\mathrm{T} = \rho_\mathrm{D} \times d_\mathrm{max} \times \mathrm{g} \qquad (1)$$

where

p_T is the tamping pressure, in pascals;

ρ_D is the bulk density, in kilograms per cubic metre;

d_max is the maximum depth of the cargo, in metres;

g is the acceleration due to gravity (= 981 cm/s^2).

If, when calculating the tamping pressure, there is no information available concerning the cargo depth use the maximum likely depth.

Alternatively, the pressure may be estimated from Table 2.

Table 2 — Tamping pressures for selected concentrates [a]

Typical concentrate type	Bulk density kg/m^3	Maximum cargo depth			
		2 m	5 m	10 m	20 m
Copper	2000	39 [2,8]	98 [6,9]	196 [13,9]	392 [27,7]
Lead	2100	41 [2,9]	103 [7,3]	206 [14,6]	412 [29,1]
Zinc	1950	38 [2,7]	96 [6,8]	192 [13,5]	384 [27,1]

[a] Values in brackets are equivalent kgf when applied via a 30 mm diameter tamper head.

6.2.4 Tamping procedure

The number of tamping actions (applying the correct, steady pressure each time) should be about 35 for the bottom layer, 25 for the middle layer and 20 for the top layer. Tamping shall be performed successively over the complete area including the edges of the sample, to form a uniform surface for each layer (see Figure 1).

6.2.5 Removal of the mould

Tap the mould on its side until it becomes loose, leaving the material in the shape of a truncated cone on the flow table.

6.3 Determination of flow moisture point

6.3.1 General

The determination of the flow moisture point is carried out by controlled dropping of the flow table and observation of the sample, followed by addition of water if necessary as outlined in the following steps.

6.3.2 Dropping the flow table

Immediately after removing the mould, raise and drop the flow table up to 50 times through a height of 12,5 mm at a rate of 25 times/min. Whilst the flow table is going through these cycles, observe the behaviour of the material using the information provided in 6.3.3 as a guide for determining the flow state.

6.3.3 Identification of the flow state

The impacting action of the flow table causes the grains of the material to re-arrange themselves to produce compaction of the mass. As a result, the fixed volume of moisture contained in the material at any given level increases as a percentage of the total volume. A flow state is considered to have been reached when the moisture content and compaction of the material produce such a level of saturation that plastic deformation occurs. At this stage, the moulded sides of the cone may deform, giving a convex or concave profile (see Figure 2). With repeated action of the flow table, the cone continues to slump and to flow outwards. In certain materials, cracks may also develop on the top surface.

Further criteria to use when determining if the flow state has been reached are as follows:

a) Cracking with the appearance of free moisture is not an indication of development of a flow state. In most cases, measurement of the deformation is helpful in deciding whether or not plastic flow has occurred. A template which, for example, will indicate an increase in diameter of up to 3 mm in any part of the cone, is a useful guide for this purpose.

b) Measuring the diameter of the cone, at the base or at half height, will always be useful. By addition of water in increments of 0,3 % to 0,5 % by mass and applying 25 drops of the flow table, the first diameter increase will generally be between 1 mm and 5 mm and after a further increment in water content the base diameter would have expanded to between 5 mm to 10 mm.

c) When the moisture content is approaching the flow moisture point, the cone begins to show a tendency to stick to the mould.

d) When the cone is pushed off the table, it may leave tracks (stripes) of moisture on the table. If such stripes are seen, the moisture content may be above the flow moisture point. Slight deformation of the cone may appear at moisture contents lower the flow moisture point, but in that case the test portion will leave no moisture tracks when removed.

6.3.4 Determination of preliminary flow moisture point

If the material exhibits any of the properties described in 6.3.3, then the flow moisture point has been reached. Stop the flow table and immediately take a 200 g ± 20 g portion of the material on the flow table and place in a pre-weighed drying tray or pan (4.10). Immediately weigh the sample and tray and determine the moisture as described in 6.5. When the moisture has been determined proceed with the main flow moisture point determination as described in 6.4.

If the material does not exhibit any of the properties described in 6.3.3 or simply crumbles and bumps off in fragments with successive drops of the table (see Figure 3), the flow moisture point has not been reached and more water needs to be added to the sample as described in step 6.3.5.

6.3.5 Addition of water for preliminary flow moisture point test

Once it has been ascertained that the material is not at the flow moisture point, stop the flow table and return the material to the mixing bowl. Using the water applicator (4.7) add between 5 ml and 10 ml of water; if necessary more water may be added. Thoroughly mix this added water into the material, either with rubber gloved fingers or an automatic mixer. Fill the mould again and repeat steps 6.2.2 to 6.3.4 until a flow state is reached.

NOTE The addition of water can also be achieved by measuring the mass of water added rather than the volume of water.

6.4 Procedure for the main flow moisture point determination

6.4.1 General

Once the preliminary flow moisture point has been determined on test portion B, the moisture content of test portions C and D are adjusted to approximately the last value that did not cause the flow state in the preliminary test.

6.4.2 Preparation of test portions for main flow moisture point determination

Prepare test portion C for the main flow moisture point test according to steps 6.2.2 to 6.2.5.

Figure 1 — Example of third stage of filling the mould

Figure 2 — Example of the material at the flow point

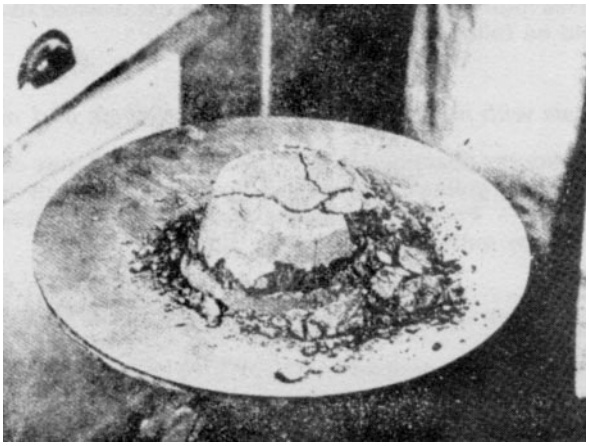

Figure 3 — Example of material crumbling but not at the flow point