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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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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 183, *Copper, lead, zinc and nickel ores and concentrates*.

This third edition cancels and replaces the second edition (ISO 12742:2007), which has been technically revised. The main changes to the previous edition are as follows:

— Clause 3, 'Terms and definitions', added.

— 6.2: reference to 7.4.4 for partial drying in event that sample received above transportable moisture limit (TML) added.

— Clause 6: reference to ISO 12743 sampling procedures added.

— 7.3: description of the flow state changed for clarity.

— 7.4.2: permission to deviate from the sample mass requirements of ISO 10251 for moisture determination added.

— 7.4.4: procedure for partial drying of sample received above TML added.

— 7.6.1: inclusion of data points with greater than 12 mm displacements in the graphical method provided that the points fall on the linear portion of the graph.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The first edition of this document was published in 2000 as a guidance document because there had been insufficient test programme participants to allow precision data to be derived.

The second edition included the addition of the graphical method for determination of the flow point as a means of validating the bracket method. This version has been revised to make it easier to understand and follow.

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

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

1 Scope

This document specifies a flow-table method for the determination of the transportable moisture limit (TML) of copper, lead and zinc sulfide concentrates, which can liquefy during transport.

It is applicable to the determination of the TML of concentrates containing 10 % to 80 % (mass fraction) of lead, 10 % to 65 % (mass fraction) of zinc or 10 % to 55 % (mass fraction) of copper and is applicable to TML values in the range 3 % to 28 % (mass fraction).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10251, *Copper, lead, zinc and nickel concentrates — Determination of mass loss of bulk material on drying*

ISO 12743, *Copper, lead, zinc and nickel concentrates — Sampling procedures for determination of metal and moisture content*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
flow moisture point
percentage of moisture at which a flow state is reached

3.2
transportable moisture limit
maximum percentage of moisture that a cargo can contain during transport without the risk of liquefaction

4 Principle

The moisture content of the sample is adjusted by mixing with water. The mixture is converted to a conical shape using a mould and tamper. The sample is placed on the flow table and the mould is removed. The flow characteristics are determined 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.

The TML is calculated as 90 % of the flow moisture point.

5 Apparatus

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

5.1 Flow table and frame[1)], as specified in Annex A.

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

5.2 Mould[1)], as specified in Figure A.1.

5.3 Tamper[1)].

The required tamping pressure can 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.

5.4 Calliper ruler.

5.5 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

5.6 Measuring cylinder, of capacity 50 ml to 200 ml.

5.7 Burette, of capacity 10 ml.

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5.8 Mixing bowl[2], hemispherical, of diameter approximately 30 cm.

It is recommended that an automatic mechanical mixer having a mixing bowl as described is used, as this leads to improved precision.

5.9 Rubber gloves.

5.10 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.

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

5.12 Airtight containers.

6 Sampling and sample preparation

6.1 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 in accordance with ISO 12743, 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.

The sample used to determine TML should not be used to determine moisture content.

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.

6.2 Laboratory sample

Samples for the determination of TML shall be taken in accordance with ISO 12743. The laboratory sample shall not weigh less than 12 kg. To minimize changes to the flow characteristics of the sample, it shall not be oven-dried or ground during its preparation, although partial drying as described in 7.4.4 is allowed.

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6.3 Sample preparation

Homogenize the laboratory sample as quickly as possible to prevent moisture losses. Take nine test samples as follows:

a) Sample 1

Take not less than 2 kg from the laboratory sample. This sample is to be used for determining the moisture content of the sample as received. Place this sample on a drying tray or pan.

b) Sample 2

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

c) Samples 3 to 6

Take four samples of approximately 1,2 kg from the laboratory sample. These samples are to be used for the main TML test. Store these samples in appropriately labelled airtight containers.

d) Samples 7 to 9

Take three samples of approximately 1,2 kg from the laboratory sample. These samples are to be used for confirmation of TML by the graphical method. Store these samples in appropriately labelled airtight containers.

7 Procedure

7.1 General

Copper, lead and zinc concentrates can 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 be completed within the day of commencement. Where possible, sample containers should be covered with plastic film or any other suitable airtight cover.

The moisture result from sample 1 provides information about how far the material under test is from the flow moisture point.

As more accurate results are obtained when the moisture of the test portion is close to the flow moisture point, a preliminary test is carried out (sample 2). The result of this test is used to adjust the moisture of the final test portion to 1 % to 2 % relative below (samples 3 and 4) and above (samples 5 and 6) the flow moisture point.

To check the main flow moisture point graphically, three more samples (samples 7 to 9), having moisture values higher than the flow moisture point, are tested. The flow moisture point is the extrapolation to zero of the least squares linear regression of the test portions showing a measurable displacement. The value obtained this way will be used to validate the main flow moisture point.

7.2 Preparation of test portions[3)]

7.2.1 General

Sample 1 shall be prepared in accordance with ISO 10251. Proceed to 7.7.

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Samples 2 to 9 shall be prepared in accordance with 7.2.2 to 7.2.6.

7.2.2 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.

7.2.3 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 using Formula (1).

$$p_T = \rho_D \times d_{max} \times g \quad (1)$$

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 (= 9,81 m/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 can be estimated from Table 2.

Table 2 — Tamping pressures for selected concentrates[a]

Typical concentrate type	Bulk density kg/m^3	Tamping pressure at maximum cargo depth kPa			
		2 m	5 m	10 m	20 m
Copper	2 000	39 [2,8]	98 [6,9]	196 [13,9]	392 [27,7]
Lead	2 100	41 [2,9]	103 [7,3]	206 [14,6]	412 [29,1]
Zinc	1 950	38 [2,7]	96 [6,8]	192 [13,5]	384 [27,1]

[a] Values in square brackets are the equivalent kilogram-force (kgf) when applied via a 30 mm-diameter tamper head.

Appendix 2 in the ISMBC code[1] nominates suitable methods that can be used to determine a value for bulk density for use in the calculation of tamping pressure using Formula (1).

7.2.4 Tamping procedure

The number of tamping actions (applying the correct, steady pressure each time) should be 35 for the bottom layer, 25 for the middle layer and 20 for the top layer. Tamping shall be performed successively