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**Zinc sulfide concentrates —  
Determination of silver content —  
Acid dissolution and flame atomic  
absorption spectrometric method**

*Concentrés sulfurés de zinc — Dosage de l'argent — Méthode par  
dissolution acide et spectrométrie d'absorption atomique dans la  
flamme*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 183, *Copper, lead, zinc and nickel ores and concentrates*.

This second edition cancels and replaces the first edition (ISO 15247:1999), of which the warning in A.3.1 in [Annex A](#) has been revised.

This corrected version of ISO 15247:2015 incorporates the following corrections:

- in [4.4](#), “hydrofluoric acid” has been changed to “hydrochloric acid”;
- in [9.1](#), in the definition of variables used in Formula (3), “ $s_R$ ” has been changed to “ $s_L$ ”.

# Zinc sulfide concentrates — Determination of silver content — Acid dissolution and flame atomic absorption spectrometric method

## 1 Scope

This International Standard specifies an acid dissolution and flame atomic absorption spectrometric method for the determination of silver content of zinc sulfide concentrates.

The method is applicable to the determination of silver in zinc sulfide concentrates containing up to 60 % (m/m) zinc in the form of zinc blende and related materials.

The method is applicable to silver contents from 10 g/t to 500 g/t.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 385, *Laboratory glassware — Burettes*

ISO 648, *Laboratory glassware — Single-volume pipettes*

ISO 1042, *Laboratory glassware — One-mark volumetric flasks*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*.

ISO 4787, *Laboratory glassware — Volumetric instruments — Methods for testing of capacity and for use*

ISO 9599, *Copper, lead, zinc and nickel sulfide concentrates — Determination of hygroscopic moisture content of the analysis sample — Gravimetric method*

## 3 Principle

Decomposition of the concentrate in hydrochloric and nitric acids. Dissolution of the digestion residue in hydrochloric acid and measurement by flame atomic absorption at 328,1 nm.

## 4 Reagents

During the analysis, use only reagents of recognized analytical grade and water that complies with grade 2 of ISO 3696.

**4.1 Silver metal**, minimum 99,99 % purity.

**4.2 Nitric acid**, ( $\rho_{20}$  1,42 g/ml), chloride content < 0,5 mg/ml.

**4.3 Nitric acid**, (500 ml/l).

To 250 ml of water carefully add, with stirring, 250 ml of nitric acid (4.2).

**4.4 Hydrochloric acid**, ( $\rho_{20}$  1,16 g/ml to 1,19 g/ml).

**4.5 Hydrochloric acid**, (200 ml/l).

To 800 ml of water carefully add, with stirring, 200 ml of hydrochloric acid (4.4).

**4.6 Ammonia solution**, ( $\rho_{20}$  0,89 g/ml).

**4.7 Ammonia solution**, (250 ml/l).

To 750 ml of water add, with stirring, 250 ml of ammonia solution (4.6).

**4.8 Silver standard solutions**

**4.8.1 Silver standard solution**, (1 000  $\mu\text{g/ml}$ ).

Weigh 0,500 0 g of silver metal (4.1) into a 250 ml conical beaker, add 50 ml of nitric acid (4.3), cover, and heat gently until the metal dissolves. Remove the cover and evaporate gently to near dryness. Add 250 ml of hydrochloric acid (4.4) and warm until the solution clears. Cool, and transfer to a 500 ml volumetric flask. Dilute to volume with water and mix thoroughly.

This solution should be freshly prepared, unless it is being used on a regular basis.

**4.8.2 Silver standard solution**, (100  $\mu\text{g/ml}$ ).

Pipette 10 ml of silver standard solution (4.8.1) into a 100 ml volumetric flask containing 45 ml of hydrochloric acid (4.4). Dilute to volume with water and mix thoroughly.

Standard solutions should be prepared at the same ambient temperature as that at which the determinations will be conducted.

Silver standard solutions should be stored in brown glass bottles.

**4.9 Calibration solutions**

To six 100 ml volumetric flasks, each containing 20 ml of hydrochloric acid (4.4), add from a burette (5.2) 0 ml, 1 ml, 2 ml, 3 ml, 4 ml, and 5 ml of silver standard solution (4.8.2). Dilute to volume with water and mix thoroughly.

These standards contain 0  $\mu\text{g}$ , 1  $\mu\text{g}$ , 2  $\mu\text{g}$ , 3  $\mu\text{g}$ , 4  $\mu\text{g}$ , and 5  $\mu\text{g}$  of silver per ml and shall be freshly prepared.

Calibration solutions should be prepared at the same ambient temperature as that at which the determinations will be conducted.

## **5 Apparatus**

Ordinary laboratory apparatus and the following.

**5.1 Volumetric glassware**, of class A complying with ISO 385, ISO 648, and ISO 1042 and used in accordance with ISO 4787.

**5.2 Burette**, grade A 10 ml capacity, capable of being read to 0,02 ml.

**5.3 Atomic absorption spectrometer (AAS)**, equipped with a glass bead in the spray chamber rather than a flow spoiler.

**5.4 Balance**, precision analytical, capable of being read to 0,1 mg.

## 6 Samples

### 6.1 Test sample

Prepare an air-equilibrated test sample in accordance with ISO 9599.

NOTE A test sample is not required if predried test portions are to be used (see [Annex A](#)).

### 6.2 Test portion

Taking multiple increments, extract a test portion from the test sample in such a manner that it is representative of the whole contents of the dish or tray. Weigh to the nearest 0,1 mg approximately 1 g of test sample. At the same time as the test portion is weighed, weigh test portions for the determination of hygroscopic moisture in accordance with ISO 9599.

Alternatively, the method specified in [Annex A](#) can be used to prepare predried test portions directly from the laboratory sample.

## 7 Procedure

### 7.1 Number of determinations

Carry out the determinations at least in duplicate and as far as possible under repeatability conditions on each test sample.

NOTE Repeatability conditions exist where mutually independent test results are obtained with the same method on identical test material in the same laboratory by the same operator using the same equipment within short intervals of time.

### 7.2 Blank test

Carry out a blank test in parallel with the analysis using all reagents specified in the determination but omitting the test portion. The purpose of the blank test in this method is to check the quality of the reagents. If a significant blank value is obtained as a result of the blank test, check all reagents and rectify the problem.

### 7.3 Decomposition of test portion

Transfer the test portion to a 250 ml conical beaker and moisten with 1 ml of water.

All glassware should be washed in ammonia ([4.7](#)) and rinsed with water prior to use to remove any silver adhering to the glass surface.

Add 35 ml of nitric acid ([4.3](#)), cover with a watch glass, and heat at a low temperature until the reaction ceases.

Add 10 ml of hydrochloric acid ([4.4](#)), raise the cover slightly, and evaporate to dryness. Remove from the hotplate and cool.

Add a further 10 ml of hydrochloric acid ([4.4](#)) and again evaporate to dryness.

Rapid heating can cause samples to splatter or spit. Care should be taken to ensure that this does not occur.

Re-dissolve in 25 ml of hydrochloric acid ([4.5](#)). Heat to boiling, remove from the hotplate and cool.

Transfer the solution to the volumetric flask indicated in [Table 1](#) by washing and diluting to volume with hydrochloric acid ([4.5](#)).