Designation: E255 – 23

Standard Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition[1]

This standard is issued under the fixed designation E255; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes the sampling of copper (except electrolytic cathode) and copper alloys in either cast or wrought form for the determination of composition.

1.2 Cast products may be in the form of cake, billet, wire bar, ingot, ingot bar, or casting.

1.3 Wrought products may be in the form of flat, pipe, tube, rod, bar, shape, or forging.

1.4 This practice is not intended to supersede or replace existing specification requirements for the sampling of a particular material.

1.5 The values stated in SI units are to be regarded as standard. The values in parentheses are given for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* A specific precautionary statement appears in Appendix X4.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials

3. Terminology

3.1 For definitions of terms used in this practice, refer to Terminology E135.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lot, n—as used in this practice*, the unit to be sampled, in pounds or pieces.

3.2.2 *test sample, n—as used in this practice*, a composite of material taken by approximate proportional weight from each of the test pieces and from which the test portion shall be taken.

NOTE 1—Appendix X1 describes the refinery shapes. Appendix X2 describes the fabricators' forms.

4. Significance and Use

4.1 This practice is intended primarily for the sampling of copper and copper alloys for compliance with compositional specification requirements.

4.2 The selection of correct test pieces and the preparation of a representative sample from such test pieces are necessary prerequisites to every analysis. The analytical results will be of little value unless the sample represents the average composition of the material from which it was prepared.

5. Selection of Test Pieces

5.1 *Casting:*

5.1.1 *Finished Product or Shipment Sample:*

5.1.1.1 A shipping lot shall consist of all castings of the same configuration and size necessary to comply with the requirements of a single purchase order.

5.1.1.2 Castings are frequently produced in advance of orders and manufacturer's or foundry lots may intermingle in stock.

5.1.1.3 Since the size and configuration of castings vary, the number of test pieces to be selected shall be subject to agreement between the manufacturer or supplier and the purchaser.

5.1.2 *Manufacturer's or Foundry Sample:*

5.1.2.1 For routine sampling and at the option of the manufacturer, a lot shall consist of the following:

[1] This practice is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.05 on Cu, Pb, Zn, Cd, Sn, Be, Precious Metals, their Alloys, and Related Metals.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

(a) All of the metal poured from a single furnace or crucible melt, or

(b) All of the metal poured from two or more furnaces into a single ladle, or

(c) All of the metal poured from a continuous melting furnace between charges, or

(d) All of the metal poured from an individual melting furnace, or group of melting furnaces, having a uniform melting stock, operating during the course of one-half shift, not to exceed 5 h.

5.1.2.2 The sample taken for lot analysis shall be obtained during the pouring of the liquid metal into the mold, or molds, in such a manner as to be representative of the lot and able to be drilled or used in solid form.

5.1.2.3 Plant sampling practices should be developed and implemented which will give homogeneous samples representative of the cast or heat, and free of porosity. Analytical results are frequently obtained by an atomic emission technique and, depending upon the metallurgical history of the sample, results may vary. Therefore, it is advisable to cool or quench the sample in a reproducible manner.

5.1.2.4 When foundry lot traceability is specified in the purchase order, additional samples shall be taken, identified, and set aside when so requested by the purchaser.

5.2 *Cast Product:*

5.2.1 For routine sampling and at the option of the manufacturer, a lot shall consist of all of the metal poured from a single furnace melt or all of the metal poured from a continuous melting furnace during a single casting cycle.

5.2.2 Unless otherwise agreed between the manufacturer and the purchaser, sampling of a single lot shall be as follows:

5.2.2.1 *Single Furnace Charge*—The number of samples required depends on the size of the melting furnace and homogeneity of the melt. A small well-stirred, alloying furnace such as one inductively heated and of less than 22 680 kg (50 000 lb) shall require but one sample taken midway in the pour. A large mechanically stirred furnace shall require a minimum of three samples taken, one each at the beginning, middle, and end of the casting period.

5.2.2.2 *Continuous Melting Furnace*—A minimum of one sample shall be taken for each 3 h of the casting cycle.

5.3 *Wrought Products:*

5.3.1 *Finished Product or Shipment Sample:*

5.3.1.1 The lot size, gross sample size, and selection of test pieces shall be as follows:

(a) Lot Size—An inspection lot shall be 4535.9 kg (10 000 lb) or less of the same mill form, alloy, temper, and nominal dimensions, subject to inspection at one time; or it shall be the product of one cast bar from a single melt charge, whose weight shall not exceed 9071.9 kg (20 000 lb), which was continuously processed and subject to inspection at one time.

(b) Gross Sample—The gross sample shall be four or more pieces selected to be representative of the lot. Should the lot consist of four pieces or less, the entire lot shall constitute the gross sample.

(c) Test Piece—Each test piece shall be selected to be representative of the lot.

5.3.1.2 When possible, test pieces shall be selected in a manner that will represent correctly the material furnished but also avoid needless destruction of finished product (such as when samples representative of the material are available from other sources).

5.3.2 *Manufacturer's or Foundry Sample:*

5.3.2.1 For routine sampling, the manufacturer shall have the option of taking samples during the course of manufacture. Samples may be taken at the time castings are poured or from the semifinished product.

5.3.2.2 When samples are taken at the time castings are poured, at least one sample shall be taken for each group of castings poured from the source of molten metal.

5.3.2.3 When samples are taken from the semifinished product, a sample shall be taken to represent each 4535.9 kg (10 000 lb), or fraction thereof, except that not more than one sample shall be required per piece. Only one sample need be taken from the semifinished product of one cast bar from a single melt charge continuously processed.

6. Sampling

6.1 *General Considerations:*

6.1.1 The saw, drill bit, cutter, or other tool used shall be thoroughly cleaned prior to use. The speed of sampling shall be so regulated that excessive heating and consequent oxidation is avoided. Carbide-tipped tools are recommended. Steel tools, when used, shall be magnetizable to assist in the removal of extraneous iron. Only carbide-tipped or other wear-resistant tools shall be used to sample metal which contains a magnetic phase.

6.1.1.1 In the rare instance where tool lubricant is necessary to obtain a satisfactory sample, the lubricant shall be one that will not react with the metal. The lubricant shall be completely removed immediately after the sampling operation by washing with a solvent which also does not react with the metal.

6.1.2 The test pieces shall be clean and free from scale, dirt, oil, grease, and other extraneous contaminants before sampling.

6.1.3 Test pieces taken from product not subject to significant segregation shall be sampled by drilling, milling, or sawing each test piece. Sampling may also be performed by clipping if pieces are thin or small.

6.1.4 Test pieces taken from product subject to significant segregation shall be sampled by drilling or sawing completely through each test piece, or by milling the entire cross section of each test piece.

6.2 *Finished Product or Shipment Sampling:*

6.2.1 *Castings:*

6.2.1.1 Different parts of a casting may vary in composition. Therefore, a sample from a single casting shall be taken with care to be representative of that casting. To obtain a sample representative of the finished product lot, a number of test pieces should be sampled individually. Regardless, the sample should be taken that will be representative and large enough to suffice for all of the required determinations.

6.2.1.2 Where possible, depending on size and configuration, the casting shall be sampled by drilling five holes equally spaced around or along the casting. The drilling

shall be done dry and the drill size shall be the largest practical, but not less than 6.4 mm (¼ in.). Care shall be exercised that no dirt, scale, or other foreign material is included with the drillings.

6.2.1.3 When limited by size or configuration, or both, the castings shall be sampled by milling the entire cross-section, by sawing through the cross section at several points, or by drilling entirely through the casting at several points.

6.2.2 *Cast Products*—Horizontally or vertically cast products shall be sampled by drilling a minimum of five holes at points equally spaced between the test piece ends. For billet, wire bar, and ingot these holes shall be along the middle line and for cake on a diagonal line between opposite corners. Alternatively, the cross section of the product may be milled at similar points. Sampling test pieces of mass greater than 454 kg (1000 lb) shall be subject to agreement between the manufacturer and the purchaser.

6.2.3 *Wrought Products*—Flat product, rod, bar, shape, tube, or forging shall be sampled by drilling, milling, or sawing the entire cross section at a minimum of three points along the length of the test piece. Thin material may be folded or stacked for sampling or, alternatively, it may be clipped.

6.3 *Manufacturer's or Foundry Lot:*

6.3.1 The sampling procedure used is dependent on the nature of the particular operation and, therefore, shall be at the discretion of the particular operation.

6.3.2 When a complete cross section is required for spectrochemical analysis, it shall be properly identified prior to using the remainder of the test piece for other test sampling.

NOTE 2—Appendix X3 addresses principles of sampling theory. Appendix X4 addresses application of sampling theory.

7. Sampling Preparation

7.1 *Finished Product or Shipment Lot:*

7.1.1 For metal that does not contain a magnetic phase, drillings, millings, sawings or clippings shall be carefully subjected to a strong magnet to remove any iron particles introduced during sampling.

7.1.2 For metal that contains a magnetic phase, a wear-resistant tool, such as carbide tipped, shall be used and magnetic cleaning shall not be applied.

7.1.3 The test sample shall be prepared by thoroughly mixing equal masses of drillings, millings, sawings or clippings that are of uniform size.

7.1.4 The test sample shall weigh at least four times that required for the total analysis, and shall be divided into four equal portions. Each portion shall be placed in an identified container and sealed; one portion each shall be reserved for the manufacturer and the purchaser; one portion shall constitute the reserve; and, when necessary, one portion shall be used for any umpire testing.

7.1.4.1 Material to be stored over a long period, which oxidizes readily, or which alters in composition under varying atmospheric conditions should be kept under a protective gas, such as nitrogen, in an airtight container of suitable size and composition. This same storage method should be used when contamination by paper or cardboard fibers is a concern.

7.2 *Manufacturer's or Foundry Sample*—The preparation of the manufacturer's or foundry sample shall be at the discretion of the reporting laboratory.

8. Preparation of Test Portion

8.1 Preparation of the test portion for analysis varies with the particular method used and shall be the responsibility of the reporting laboratory.

9. Resampling

9.1 In case of dissatisfaction with the sample prepared from the finished product, either party may require the material to be resampled.

10. Keywords

10.1 copper; copper alloys; sampling

APPENDIXES

(Nonmandatory Information)

X1. DEFINITIONS OF REFINERY SHAPES

X1.1 *billet*—cast shape used for piercing and extrusion into tubular products or for extrusion into rods, bars, and shapes; circular in cross section, usually 76 mm to 406 mm (3 in. to 16 in.) in diameter, normally ranging in weight from 45 kg to 1905 kg (100 lb to 4200 lb).

X1.2 *cake*—cast shape used for rolling into plate, sheet, strip, or shape; rectangular in cross section and of various sizes, normally ranging in weight from 63 kg to 28 200 kg (140 lb to 62 000 lb).

X1.3 *cathode*—unmelted, electrodeposited, and somewhat flat plate normally used for melting. The customary size is about 0.914 m (3 ft) square, about 12.7 mm to 25.4 mm (½ in. to 1 in.) thick, weighing up to about 163 kg (360 lb), and may have hanging loops attached. Cathodes may also be cut to smaller dimensions.

X1.4 *ingot and ingot bar*—cast shape used for remelting (not fabrication). Ingots normally range in weight from 9 kg to 16 kg (20 lb to 35 lb) and ingot bars from 23 kg to 323 kg (50 lb to 70 lb). Both are usually notched to facilitate breaking into smaller pieces.

X1.5 *wire bar*—a refinery shape used for rolling into rod or flat product for subsequent processing into wire, strip, or shape. Approximately 89 mm to 127 mm (3.5 in. to 5 in.) square in cross section, usually 1.56 m (54 in.) in length and ranging in

weight from 91 kg to 191 kg (200 lb to 420 lb). Usually tapered at both ends.

X2. DEFINITIONS OF FABRICATORS' PRODUCTS

X2.1 *flat product*—a rectangular or square solid section of relatively great length in proportion to thickness. Included in the designation "flat product," depending on the width and thickness, are plate, sheet, strip, and bar. Also included is the product known as "flat wire."

X2.2 *pipe*—a tube conforming to the dimensions commercially known as "standard pipe sizes."

X2.3 *rod*—a solid section, round, hexagonal, or octagonal in straight lengths. Round rod for further processing into wire (known as "hot-rolled rod," "wire-rod," "redraw wire," or "drawing stock") is furnished coiled.

X2.4 *shape*—a solid section, other than flat product, rod, or wire furnished in straight lengths; shapes are usually made by extrusion but may also be fabricated by drawing.

X2.5 *tube*—an unidirectionally elongated hollow product of uniform round or other cross section having a continuous periphery.

X2.6 *wire*—a solid section, including rectangular flat wire but excluding other flat products, furnished in coils or on spools, reels, or bucks.

X3. PRINCIPLES OF SAMPLING THEORY

X3.1 Some theoretical aspects of sampling cast metal shapes and other metallurgical materials for chemical analysis are described in this Annex. While recognized that cost, time, and other practical considerations may necessitate substantial deviations, it was deemed necessary to outline the theories and foundations of correct metallurgical sampling.

X3.1.1 Molten alloys will be homogeneous only when all components are completely dissolved and perfectly distributed by mixing, and when the temperature throughout the molten mass is above that of the liquidus.

X3.1.2 Casting, however, solidified even from such a homogeneous melt, will in most cases be heterogeneous. The degree of heterogeneity of the solid phase will depend on the composition and rate of cooling of the melt. For example, a cylindrical casting of high-lead alloy may contain almost pure lead in its central core which solidified last. Conversely, the cooled surface areas of copper-tin alloy castings often contain tin concentrations far above the average for the whole casting. Due to the almost ever-present problem of segregation, sampling of cast metal shapes shall be adapted to the particular conditions of each separate case.

X3.1.3 Continuously cast shapes may be sampled by removing material of uniform thickness from a complete cross section. Such samples can be obtained by sawing, turning, or milling. Although such samples provide correct representation of the cast at the time of sampling, they would, of course, not be valid if the composition of the melt changed during the casting operation.

X3.1.4 A hypothetically correct but prohibitively expensive method of sampling horizontally and vertically cast metal shapes would be to cut complete segments from the top to the bottom of the casting. The minimum sample volume required for geometrically correct representation of all diffusion layers would be as follows:

X3.1.4.1 Twenty-five percent of the volume for shapes of rectangular top view;

X3.1.4.2 Twelve-and-one-half percent of the volume for shapes of square top view;

X3.1.4.3 A segment of any width for shapes of circular top view.