Designation: E103 – 17

Standard Practice for Rapid Indentation Hardness Testing of Metallic Materials[1]

This standard is issued under the fixed designation E103; 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 covers a procedure for rapid indentation hardness testing of metallic materials.

1.2 This practice includes additional requirements in Annex A1 for the direct, indirect, and daily verification of rapid indentation hardness testing machines.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

E10 Test Method for Brinell Hardness of Metallic Materials

E74 Practice of Calibration of Force-Measuring Instruments for Verifying the Force Indication of Testing Machines

2.2 *ISO Standards:*[3]

ISO 17025 General requirements for the competence of testing and calibration laboratories

ISO/IEC 17011 Conformity assessment -- General requirements for accreditation bodies accrediting conformity assessment bodies

3. Terminology

3.1 *Definitions:*

3.1.1 *calibration*—determination of the values of the significant parameters by comparison with values indicated by a reference instrument or by a set of reference standards.

3.1.2 *rapid indentation hardness test*—an indentation hardness test using calibrated machines to force a tungsten carbide ball, under specified conditions, into the surface of the material under test and to measure the depth of the indentation. The depth measured can be from the surface of the test specimen or from a reference position established by the application of a preliminary test force. The depth measurement is usually correlated to another scale or Brinell hardness number.

3.1.3 *verification*—checking or testing to assure conformance with the specification.

4. Significance and Use

4.1 This practice is used when it is desired to make Brinell type hardness tests very rapidly on a high volume of samples, as in the inspection of the output of a heat-treating furnace.

4.2 This practice requires the measurement of indentation depth and eliminates the need to measure the diameter of the indent optically as required in a Brinell hardness test.

4.3 This practice is not a standard Brinell hardness test method and does not meet the requirements of Test Method E10.

4.4 Since the test forces and method of display of the depth measurement differ between manufacturers of rapid indentation hardness testing equipment, the test results from equipment from different manufacturers are not comparable.

5. Apparatus

5.1 *Testing Machine*—Equipment for rapid indentation hardness testing usually consists of a testing machine, which supports the test specimen and applies an indenting force(s) to a ball in contact with the specimen, and a system for measuring and displaying an indication of the depth of the indentation. The test force can be applied either as a single total test force whereby the depth is measured usually from the surface of the test specimen or as a preliminary and total test force whereby the depth is measured as the increase from the preliminary to the total test force.

[1] This test method is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.06 on Indentation Hardness Testing.

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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.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

***A Summary of Changes section appears at the end of this standard**

5.1.1 The testing machine shall meet the requirements of Annex A1.

5.1.2 The testing machine shall ensure that the force to the indenter is applied smoothly and without impact forces that affect the measurement result. Precautions shall be taken to prevent a momentary high test force caused by the inertia of the system, hydraulic system overshoot, etc.

5.1.3 The design and construction of the testing machine shall be such that no rotational or lateral movement of the indenter or test specimen occurs while the test force is being applied or removed.

5.1.4 An anvil, or specimen support, should be used that is suitable for the specimen to be tested. The seating and supporting surfaces of all anvils should be clean and free of foreign material.

5.1.5 The indenters used for rapid indentation testing shall be tungsten carbide balls that meet the requirements defined in Test Method E10, Annex A3.

5.1.6 The mechanism for measuring the depth of the indentation shall conform to the requirements prescribed in A1.3.3. The method for determining the depth of the indentation is determined by the manufacturer of the tester.

5.1.7 A display or output relative to the indentation depth shall be provided. The display may indicate the full or partial depth or the depth may be converted to another relevant scale. In this case, conversion to a related Brinell hardness number is recommended. When used, the method of conversion from depth to another scale or Brinell hardness numbers is determined by the manufacturer of the tester.

5.1.8 Refer to the Equipment Manufacturer's Instruction Manual for a description of the machine's characteristics, limitations, and respective operating procedures.

6. Test Specimens

6.1 Rapid indentation hardness tests can be made on any test specimen that can be tested using the E10 Brinell Test Method.

6.2 *Finish*—When necessary, the surface on which the indentation is to be made shall be filed, ground, machined, or polished with an abrasive material to allow accurate depth measurements and to remove any surface conditions (such as decarburization) that may affect the hardness of the sample. Preparation shall be carried out in such a way that any alteration of the hardness of the test surface (for example, due to overheating or cold-working) is minimized. The surface in contact with the test support anvil, when used, should be clean and free of any conditions which may affect the test results.

6.3 *Thickness*—The thickness of the test specimen shall be at least ten times the depth of the indentation and such that no bulge or other mark showing the effect of the test force appears on the side of the piece opposite the indentation. See Test Method E10, Table 4 for more information about minimum thickness.

7. Procedure

7.1 *Magnitude of Test Force*—The total test force is usually 3000, 1500, or 500 kgf (29.42, 14.71, or 4.903 kN). The preliminary test force, if used, is determined by the manufacturer of the tester. The total test force and ball indenter size used should be the same as the Brinell scale test that is being replaced by the rapid indentation test. When selecting the total test force and ball size to use, refer to Test Method E10, Section 7 for Brinell hardness testing.

7.2 *Spacing of Indentations*—The distance from the center of the indentation to the edge of the specimen, or edge of another indentation, shall be at least two and one-half times the diameter of the indentation.

7.3 *Application of the Test Force(s)*—Bring the indenter into contact with the test surface in a direction perpendicular to the surface without shock, vibration or overshoot. The angle between the indenter force-line and the surface of the specimen should be perpendicular. Apply the test force(s) according to the manufacture's instructions.

7.4 *Depth measurement of the indent*—Measure the depth of the indentation according to the manufacturer's instructions. When this practice is used to monitor the hardness of production parts, it is recommended that the displayed depth indication as defined in 5.1.7 be recorded. All recorded data shall reference this practice.

8. Determination of Hardness Limits

8.1 Rapid indentation hardness tests are normally used to test specimens in limited Brinell hardness ranges. In order to establish the limit(s) of acceptable hardness for a given part or piece, test specimens representing the extreme(s) of acceptability should be tested in the rapid indentation hardness tester that is to be used. The results obtained may be considered the limits of application of the rapid indentation test.

9. Report

9.1 When a report is desired, it is recommended that the following information be reported:

9.1.1 The total test force,

9.1.2 The diameter of the ball indenter,

9.1.3 The displayed value as defined in 5.1.7, and

9.1.4 Reference to this practice.

10. Keywords

10.1 hardness; mechanical test; metals; rapid indentation