Designation: B 724 – 00

Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Newage, Portable, Non-Caliper-Type Instrument[1]

This standard is issued under the fixed designation B 724; 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 test method covers indentation hardness testing of aluminum alloys using a Newage, portable, non-caliper-type, hardness instrument which provides readout values numerically equivalent to Rockwell B-scale as determined by Test Methods E 18.

NOTE 1—This is a comparative Rockwell B test and does not provide an actual Rockwell B test value. HRBN, the values obtained from the Newage instrument, are numerically equivalent to Rockwell B values, but do not represent an actual Rockwell B test in accordance with Test Methods E 18.

1.2 This test method measures indentation hardness of heat-treatable aluminum alloys having a hardness from 30 to 100 HRBN, a thickness greater than 1.50 mm (0.060 in.), and pieces too large to be tested by a caliper type instrument.

NOTE 2—This test method covers two instruments (one analog and one digital) which operate differently. Refer to the manufacturer's instruction for proper operation.

1.3 The flat surface size of the area being tested must be compatible with the instrument support area and the material must not deflect during the test.

1.4 The values stated in SI units are the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

B 648 Test Method for Indentation Hardness of Aluminum Alloys by Means of Barcol Impressor[2]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[3]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Standards[4]

E 691 Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods[4]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms relating to hardness testing appearing in Test Methods E 18 shall apply to terms used in this test method.

3.1.2 *HRBN*—The suffix "N," added to the HRB scale designation, indicates hardness numbers derived using this test method which can be related to, but are not necessarily identical to, Rockwell-B (HRB) values obtained in accordance with Test Methods E 18. When reporting results derived using this test method, this designation should follow the numeric value.

4. Summary of Test Method

4.1 A portable hand-held and hand-operated instrument rests firmly upon an aluminum alloy surface. The manual downward movement of the tester in a steady, even and synchronous manner toward the surface moves a penetrator into the surface. Depth of penetration between preload and full load as reflected on the display of the unit, (dial or digital) is an indication of the hardness value.

4.1.1 The indicator of dial read-out units is read while the tester is in the fully depressed position, while the digital display of digital read-out units is read when the tester is in the fully released position, since the reading is automatically locked in at the preload position as the unit is being released.

NOTE 3—Another portable non-caliper-type instrument is employed in Test Method B 648. One hand is used to operate the instrument. Hardness numbers are given as Barcol Impressor readings.

5. Significance and Use

5.1 The instrument may be used on a variety of geometries of aluminum alloy test pieces, providing the surface being tested has proper support for the instrument.

5.2 This test method is intended for quality assurance and production control purposes. This test method is not intended to be an independent material-acceptance test.

5.3 The thickness of the test piece shall be such that a mark or bulge is not produced on the reverse side of the test piece and the test piece does not deflect during the test.

5.4 Calibration of the instrument through the use of reference blocks is required for true comparative hardness values.

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[2] *Annual Book of ASTM Standards,* Vol 02.02.

[3] *Annual Book of ASTM Standards,* Vol 03.01.

[4] *Annual Book of ASTM Standards,* Vol 14.02.

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6. Apparatus

6.1 *Newage, Portable, Non–Caliper–Type Instrument*, containing means of applying the desired loads, an indenter and an indicating device. This instrument interacts through hand power and spring load to indent.

6.1.1 The indenter of dial read-out units shall consist of a carbide tip bonded to a threaded shaft. The tip is conical, and it shall have an included angle of 110.0 ± 1.0°. The top of the cone shall possess a flat surface of 160.0 ± 10.0 µm in diameter. The indenter of digital read-out units shall consist of a diamond bonded to a threaded shaft. The tip is conical, and shall have an included angle of 100° ± 1° and a flat area of 62 ± 2 µm in diameter.

NOTE 4—A single indenter and load combination are used in each instrument. The combination of load and indenter produces a result numerically equivalent to Rockwell B.

6.1.2 *A dial scale* having graduations of at least every two hardness points, HRBN shall indicate hardness on dial read-out units. *Digital read-out* units shall have a digital display resolution of 0.1 hardness points HRBN. The range of either unit shall encompass at least from 30 to 100 HRBN.

6.1.3 For each hardness point, HRBN, the penetration of the indenter of a dial read-out or digital read-out unit can be estimated from Fig. 1. This relationship may vary with the alloy and temper being used.

6.1.4 The dial read-out test instrument shall apply a preload of 4 N and a full load of 49 N, while the digital unit shall apply a preload of 12 N and a full load of 49 N. The hardness number is the distance traveled by the penetrator between the pre-load and full load, as indicated on the dial of the instrument.

7. Hazards

7.1 This instrument is delicate. Extended use in a substantially dusty or corrosive environment may lead to erroneous results.

7.2 During operation, the indenter is impressed slowly and smoothly into the surface of the material being tested. Lateral movement or rocking may damage the indenter.

7.3 When temperature of test piece exceeds 23°C (73°F), lower hardness values may result.

8. Test Piece

8.1 The test piece shall be a portion of the material whose area is suitable for testing (see 8.2 and 8.3).

8.2 The surface area of the material in contact with the base area of the testing device must be free of debris and extreme irregularity.

8.3 The contact area of the indenter shall be smooth, clean, and free of mechanical damage. The surface may be lightly polished to eliminate die lines, scratches, laps, seams and surface cracks prior to hardness testing, provided the surface hardness is not affected. A surface finish of 3.2 µm or finer is recommended.

9. Calibration

9.1 *Calibration of Aluminum-Alloy Reference Hardness Blocks*—Using a Rockwell bench-type machine, calibrated in accordance with Test Methods E 18, an aluminum-alloy reference block should be tested and calibrated in accordance with that method. Using the "B" scale, uniformly distribute five impressions within a 50 mm by 50 mm (2 by 2 in.) area of the reference block. Read the dial of the Rockwell-type bench machine to the nearest 0.1 HRB value. The difference between the largest and smallest of the five readings (repeatability) shall not exceed 1.5 HRB units.

NOTE 5—The Rockwell bench-type machine should also be calibrated using NIST traceable Rockwell B test blocks, when these become available.

9.1.1 The 50 mm by 50 mm area of the reference block which contains the five calibration hardness impressions shall be suitably delineated at its boundaries and designated as the Newage, portable instrument, calibration area. Mark the reference blocks with the average of the five hardness readings made in accordance with 9.1.

NOTE 6—Reference Hardness Blocks used to calibrate the Newage instrument must have a hardness value within ± 10 Rockwell B points of the actual material to be tested.

9.2 *Calibration of the Newage, Portable Hardness Instrument*—Whenever possible, calibrate the portable hardness instrument using its bench-type adapter. Use of the

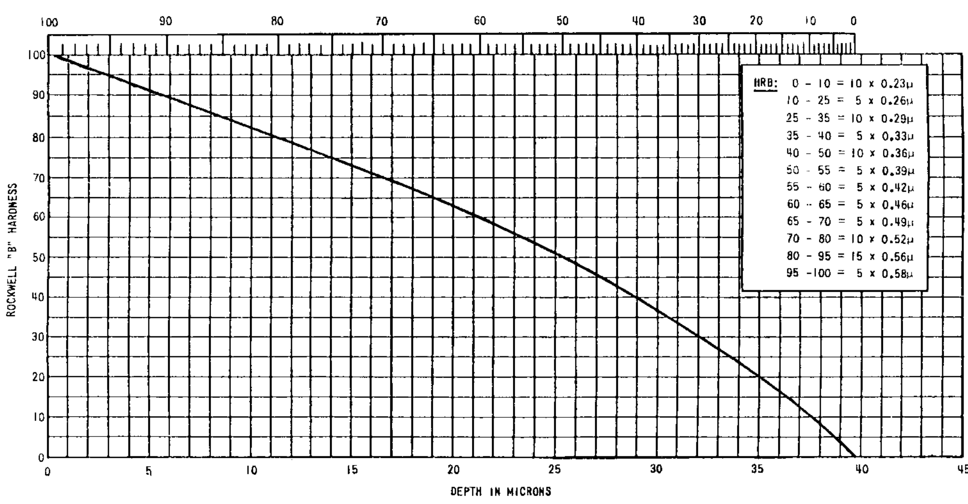

FIG. 1 Depth of Penetration in Rockwell B Tests of Some Brass

instrument in this mode should minimize a possible effect of the surface irregularities produced by the calibration hardness indentations described in 9.1, and should provide suitable support for both the instrument and the test block. If a bench-type adapter is not available, the calibrated reference block should be large enough to support its tester on the full base cross section.

9.2.1 Make at least five hardness impressions on the reference block, separated from each other and from the impression made by the Rockwell bench-type machine by at least 3 mm. When making these impressions using either the dial read-out or digital unit, press the tester against the surface of the metal to be tested using a continuous, slow, smooth motion. Refer to the operating manual of your unit for specific operating instructions.

The instrument may be used in any position: horizontal, slanted, vertical, or inverted. However, when applying the load on a dial read-out unit, the pressure axis indicator (red dot) on top of the instrument must remain within its concentric circle. This tells the operator that the load is being correctly applied.

9.2.2 The average of the hardness impression shall not differ from the calibrated hardness of the reference block by more than ± 1.5 HRBN points nor shall the difference between the lowest and highest hardness readings be more than two HRBN points.

9.2.3 If the portable instrument fails calibration, adjust the display, either dial read-out or digital in accordance with the instructions provided by the manufacturer. Adjust the amount necessary to bring the instrument into calibration and repeat the calibration procedure described in 9.2.1 and 9.2.2.

9.2.4 If the results of the calibration continue to show the accuracy of the instrument is unsatisfactory, the instrument shall not be used to make measurements in accordance with this test method.

9.3 *Calibration Prior to Testing*—An instrument in calibration for one particular aluminum alloy and temper may not be in calibration for another alloy and temper. Therefore, it is necessary to calibrate the instrument prior to testing, using a hardness reference block as close as possible to the estimated hardness of the test piece.

10. Test Procedure

10.1 Prepare the test surface in accordance with Section 8 and support the test piece so that there will be no deflection in the test piece during the test. Uniformly support the base of the instrument over its entire area so that sliding or rocking will not occur during the hardness impression. Care shall be taken to ensure that the indenter is perpendicular to the test area and that the instrument is operated in accordance with the procedures given in 9.2.1.

10.2 Make five hardness impressions in the test area and report the average of these as the hardness. A distance of at least 3.0 mm (0.120 in.) shall separate hardness impressions.

10.3 For curved surfaces, use an accessory base which provides a V-shaped anvil support.

10.4 For recessed areas use an accessory prolongater which extends the penetrator by a suitable amount, usually 50 mm (2 in.).

10.5 When possible use a bench adapter.

11. Interpretation and Recording of Results

11.1 Hardness readings shall be discarded only when a calibration change is discovered after the readings have been made or when improper operator techniques can be cited.

11.2 Single readings of hardness shall have a value not less than one half the least scale graduation.

11.3 Recording of results shall include the following:

11.3.1 Identification of material,

11.3.2 Identification of test piece and location of impressions,

11.3.3 Instrument model and manufacturer,

11.3.4 Accessories used to adapt the instrument to test piece geometry,

11.3.5 Number of impressions,

11.3.6 HRB hardness of reference block,

11.3.7 Average of HRBN values, and

11.3.8 Date of test.

12. Precision and Bias

12.1 The within-laboratory, single-operator, single-instrument, same-day relative precision of this method in the determination of hardness (HRBN) of aluminum alloys having a HRB of 55 (averaged over six participating laboratories) was ± 1.4; on material with HRB of 75 it was ± 1.1; on material with HRB of 84 it was ± 0.8. In all of the foregoing, the range corresponds to two standard deviations as defined in Practice E 177.

NOTE 7—This section is based on results from the dial read-out instrument and while the results from the digital readout instrument are expected to be comparable, there is no data to support this assumption.

12.2 *Repeatability Interval*:

12.2.1 On the basis of test error alone, the difference, in absolute value, of two test results obtained in the same laboratory on the same material with HRB of about 55 will be expected to exceed ± 1.9 HRBN only about 5 % of the time. On material with HRB of about 75 the repeatability interval will be expected to exceed ± 1.6 HRBN only about 5 % of the time; on material with HRB of about 84 the repeatability interval will be expected to exceed ± 1.1 HRBN only about 5 % of the time. Thus, if such a difference is found to be larger than the repeatability interval, there is reason to question one or both of the test results.

NOTE 8—For the preceding, see 16.8.3.1 of Practice E 691.

12.3 *Reproducibility Interval*:

12.3.1 On the basis of test error alone (including both the within- and between-laboratory components), the difference, in absolute value, between two test results obtained in different laboratories on the same material with HRB of about 55 will be expected to exceed ± 3.9 HRBN only about 5 % of the time; on material with HRB of about 75 the reproducibility interval will be expected to exceed ± 2.3 HRBN only about 5 % of the time; on material with HRB of about 84 the reproducibility interval will be expected to exceed ± 1.6 HRBN only about 5 % of the time. Thus, if such a difference is found to be larger than the reproducibility interval, there is reason to question one or both of the test results.

NOTE 9—For the preceding, see 16.8.4.3 of Practice E 691.

12.4 *Accuracy*:

12.4.1 The accuracy of the hardness tester must be determined with reference to a standardized and calibrated bench-type hardness tester.

12.4.1.1 Linear statistical correlation in the range from 33–90 HRB and contrasting between a bench type and portable instrument can give product moment correlation coefficient of 0.99 + based upon six observations at nine levels.

12.4.1.2 Any future average of six tests at the same level with 95 % confidence is expected to be ± 1.2 HRB. At the same confidence level the future average of many observations will be expected as ± 0.4 HRB at or near the hardness level of 70 HRB. At 40 and 100 HRB, data from a corresponding test is expected to show the accuracy limit decreases to ± 0.7 HRB for the future average of many observations.

NOTE 10—See "Engineering Statistics" Bowker and Lieberman Prentice-Hall. Also, NBS Handbook 91, "Experimental Statistics," Natrella or other standard test for fitting straight lines.

NOTE 11—These components of variability have been estimated from interlaboratory test results, a copy of which is on file at ASTM Headquarters.[5]

13. Keywords

13.1 newage portable instrument

[5] Supporting data have been filed at ASTM Headquarters and may be obtained by requesting Research Report RRB07–1000.

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