BAB V

KESIMPULAN DAN SARAN

5.1 Kesimpulan

HBN dari hasil pengujian tidak sama dengan HBN ASTM E10-8 dan ISO 6506-4 :2005, dikarenakan beberapa faktor, seperti:

- Adanya kesalahan dari mesin, karena mesin belum ada standarisasinya (*machine error*).
- Kualitas dari material yang diuji berbeda-beda.
- Kehalusan atau kekerasan permukaan speeimen mempengaruhi identasi dari bola baja.
- Keakuratan dari alat ukur (jangka sorong) yang digunakan.
- Keakuratan pembacaan alat ukur (*humman error*).

Semakin besar diameter dalam (identasi), maka semakin kecil angka *Hard Brinell Number* nya (HBN).

Demikian sebaliknya jika semakin kecil diameternya maka semakin besar HBN nya dan semakin keras pula *specimen* /material yang diuji.

Dari ke empat Speeimen/material yang diuji material yang paling lunak adalah alumunium dengan HBN 29.77 dan yang paling keras adalah baja karbon rendah dengan HBN 62.24 .

5.2 Saran

Agar tidak merusak alat uji kekerasan brinell padasaat pengujian, di sarankan pengujian menggunakan prosedur seperti yang tertuliskan di teori.

DAFTAR PUSTAKA

1. Askeland R Donald, " The Science and of Materials Engineering ", lst edition, (USA : Chapman & Hall , 1984).

2. B . J. M Beuner, B S Anwir /Matondang, " Pengetahuan Bahan ", 3rd edition, (Jakarta: Bharata Karya Aksara, 1998).

3. George E . Dieter, Sriati Djaprie, " Mechanikal Metallurgy", 3rd edition (Jakarta : Erlangga, 1990).

4. R.S Sutton and R.H. Meyer, " ASTM Standard, ASTM BULL", SAE Handbook, ASM (Metals Handbook, Oktober 1953).

5. West Brook. J. Hand H , " The Sienec of Hardness Testing and lst Research Aplication", Contrad (ed). (Ohio: American society for Metals, Metals park, 1973).

from one scale to another or to approximate tensile strength. These conversion values have been obtained from computer-generated curves and are presented to the nearest 01 point to permit accurate reproduction of those curves. Since all converted hardness values must be considered approximate, however, all converted Rockwell hardness numbers shall be rounded to the nearest whole number.

15.2 *Hardness Testing*:

15.2.1 If the product specification permits alternative hardness testing to determine conformance to a specified hardness requirement, the conversions listed in Table 2, Table 3, Table 4, and Table 5 shall be used.

15.2.2 When recording converted hardness numbers, the measured hardness and test scale shall be indicated in parentheses, for example: 353 HB (38 HRC). This means that a hardness value of 38 was obtained using the Rockwell C scale and converted to a Brinell hardness of 353.

16. Brinell Test

16.1 *Description*:

16.1.1 A specified load is applied to a flat surface of the specimen to be tested, through a hard ball of specified diameter. The average diameter of the indentation is used as a basis for calculation of the Brinell hardness number. The quotient of the applied load divided by the area of the surface of the indentation, which is assumed to be spherical, is termed the Brinell hardness number (HB) in accordance with the following equation:

$$HB = P/[(\pi D/2)(D - \sqrt{D^2 - d^2})] \tag{4}$$

where:

HB = Brinell hardness number,
P = applied load, kgf,
D = diameter of the steel ball, mm, and
d = average diameter of the indentation, mm.

NOTE 10—The Brinell hardness number is more conveniently secured from standard tables such as Table 6 which show numbers corresponding to the various indentation diameters, usually in increments of 0.05 mm.

NOTE 11—In Test Method E 10, the values are stated in SI units whereas in this section, kg/m units are used.

16.1.2 The standard Brinell test using a 10-mm ball employs a 3000-kgf load for hard materials and a 1500 or 500-kgf load for thin sections or soft materials (see Annex on Steel Tubular Products). Other loads and different size indentors may be used when specified. In recording hardness values, the diameter of the ball and the load must be stated except when a 10-mm ball and 3000-kgf load are used.

16.1.3 A range of hardness can properly be specified only for quenched and tempered or normalized and tempered material. For annealed material a maximum figure only should be specified. For normalized material a minimum or a maximum hardness may be specified by agreement. In general, no hardness requirements should be applied to untreated material.

16.1.4 Brinell hardness may be required when tensile properties are not specified.

16.2 *Apparatus*—Equipment shall meet the following requirements:

16.2.1 *Testing Machine*—A Brinell hardness testing machine is acceptable for use over a loading range within which its load measuring device is accurate to ±1 %.

16.2.2 *Measuring Microscope*—The divisions of the micrometer scale of the microscope or other measuring devices used for the measurement of the diameter of the indentations shall be such as to permit the direct measurement of the diameter to 0.1 mm and the estimation of the diameter to 0.05 mm.

NOTE 12—This requirement applies to the construction of the microscope only and is not a requirement for measurement of the indentation, see 16.4.3.

16.2.3 *Standard Ball*—The standard ball for Brinell hardness testing is 10 mm (0.3937 in.) in diameter with a deviation from this value of not more than 0.005 mm (0.0004 in.) in any diameter. A ball suitable for use must not show a permanent change in diameter greater than 0.01 mm (0.0004 in.) when pressed with a force of 3000 kgf against the test specimen.

16.3 *Test Specimen*— Brinell hardness tests are made on prepared areas and sufficient metal must be removed from the surface to eliminate decarburized metal and other surface irregularities. The thickness of the piece tested must be such that no bulge or other marking showing the effect of the load appears on the side of the piece opposite the indentation.

16.4 *Procedure*:

16.4.1 It is essential that the applicable product specifications state clearly the position at which Brinell hardness indentations are to be made and the number of such indentations required. The distance of the center of the indentation from the edge of the specimen or edge of another indentation must be at least two and one-half times the diameter of the indentation.

16.4.2 Apply the load for a minimum of 15 s.

16.4.3 Measure two diameters of the indentation at right angles to the nearest 0.1 mm, estimate to the nearest 0.05 mm, and average to the nearest 0.05 mm. If the two diameters differ by more than 0.1 mm, discard the readings and make a new indentation.

16.4.4 Do not use a steel ball on steels having a hardness over 450 HB nor a carbide ball on steels having a hardness over 650 HB. The Brinell hardness test is not recommended for materials having a hardness over 650 HB.

16.4.4.1 If a ball is used in a test of a specimen which shows a Brinell hardness number greater than the limit for the ball as detailed in 16.4.4, the ball shall be either discarded and replaced with a new ball or remeasured to ensure conformance with the requirements of Test Method E 10.

16.5 *Detailed Procedure*—For detailed requirements of this test, reference shall be made to the latest revision of Test Method E 10.

17. Rockwell Test

17.1 *Description*:

17.1.1 In this test a hardness value is obtained by determining the depth of penetration of a diamond point or a steel ball into the specimen under certain arbitrarily fixed conditions. A minor load of 10 kgf is first applied which causes an initial penetration, sets the penetrator on the material and holds it in position. A major load which depends on the scale being used is applied increasing the depth of indentation. The major load is removed and, with the minor load still acting, the Rockwell number, which is proportional to the difference in penetration between the major and minor loads is determined; this is usually done by the machine and shows on a dial, digital display, printer, or other device. This is an arbitrary number which increases with increasing hardness. The scales most frequently used are as follows:

Scale Symbol	Penetrator	Major Load, kgf	Minor Load, kgf
B	¹⁄₁₆-in. steel ball	100	10
C	Diamond brale	150	10

17.1.2 Rockwell superficial hardness machines are used for the testing of very thin steel or thin surface layers. Loads of 15, 30, or 45 kgf are applied on a hardened steel ball or diamond penetrator, to cover the same range of hardness values as for the heavier loads. The superficial hardness scales are as follows:

Scale Symbol	Penetrator	Major Load, kgf	Minor Load, kgf
15T	¹⁄₁₆-in. steel ball	15	3
30T	¹⁄₁₆-in. steel ball	30	3
45T	¹⁄₁₆-in. steel ball	45	3
15N	Diamond brale	15	3
30N	Diamond brale	30	3
45N	Diamond brale	45	3

17.2 *Reporting Hardness*—In recording hardness values, the hardness number shall always precede the scale symbol, for example: 96 HRB, 40 HRC, 75 HR15N, or 77 HR30T.

17.3 *Test Blocks*— Machines should be checked to make certain they are in good order by means of standardized Rockwell test blocks.

17.4 *Detailed Procedure*—For detailed requirements of this test, reference shall be made to the latest revision of Test Methods E 18.

18. Portable Hardness Test

18.1 Although the use of the standard, stationary Brinell or Rockwell hardness tester is generally preferred, it is not always possible to perform the hardness test using such equipment due to the part size or location. In this event, hardness testing using portable equipment as described in Practice A 833 or Test Method E 110 shall be used.

CHARPY IMPACT TESTING

19. Summary

19.1 A Charpy V-notch impact test is a dynamic test in which a notched specimen is struck and broken by a single blow in a specially designed testing machine. The measured test values may be the energy absorbed, the percentage shear fracture, the lateral expansion opposite the notch, or a combination thereof.

19.2 Testing temperatures other than room (ambient) temperature often are specified in product or general requirement specifications (hereinafter referred to as the specification). Although the testing temperature is sometimes related to the expected service temperature, the two temperatures need not be identical.

20. Significance and Use

20.1 *Ductile vs. Brittle Behavior*—Body-centered-cubic or ferritic alloys exhibit a significant transition in behavior when impact tested over a range of temperatures. At temperatures above transition, impact specimens fracture by a ductile (usually microvoid coalescence) mechanism, absorbing relatively large amounts of energy. At lower temperatures, they fracture in a brittle (usually cleavage) manner absorbing less energy. Within the transition range, the fracture will generally be a mixture of areas of ductile fracture and brittle fracture.

20.2 The temperature range of the transition from one type of behavior to the other varies according to the material being tested. This transition behavior may be defined in various ways for specification purposes.

20.2.1 The specification may require a minimum test result for absorbed energy, fracture appearance, lateral expansion, or