Influence on Mechanical Properties by Age Hardening of B-16 Material

DENIS PINTO[1], ABHISHEK K[2], RAKSHITH H S [3], S M SUNDAR [4], YATHISH K K[5]
[1,2,3,5] *Assistant Professor, Department of Mechanical Engineering, Sahyadri College of Engineering & Management (VTU), Karnataka, India*
[4] *CEO, Caliper engineering and lab Pvt Ltd. Sahyadri, Mangalore Karnataka, India*

Abstract- ***Many Chromium based alloys are strengthened by using heat treatment process known as age hardening. The intention of this process is to perform many uses such as to enhance the mechanical properties. By adjusting the processing conditions such as time, temperature and atmosphere. It consists of heating the metal where the constituents will form an homogeneous mass. The process will be holding at that temperature until diffusion occurs after that the quenching is done to gain the proper structure. Heat treated metals are comparatively soft and workable and unstable. After solution treatment and quenching the hardness is achieved either at room temperature or at any suitable temperature. Age hardening is one of the heat treatment process where generally low temperature and long-term process. Temperature range is from 150C-250C, time varies from 10 to 50 hrs. The time and temperature is considered carefully. This is done in order to select the cycle which produces optimal distribution pattern. The mechanical behavior of B-16 material is studied by age hardening in this study. The mechanical properties are monitored by using the rock well hardness test and tensile tests. The greater the hardness of the material greater the strength of the material to withstand the plastic deformation. The value of Rockwell hardness of the stud is 258HBN and that of nut is 215 HBN. The hardness is compared with the reference value.***

Indexed Terms: quenching, B-16, Chromium, BHN, age hardening.

I. INTRODUCTION

Precipitation hardening, also Known as age hardening or particle hardening, is a heat treatment process used to increase the yield strength of malleable materials, including most structural alloys of aluminum, magnesium, nickel, titanium, and some steels and stainless steels. In super alloys, it is known to cause yield strength anomaly providing excellent high-temperature strength.

Precipitation hardening relies on changes in solid solubility with temperature to produce fine particles of an impurity phase, which impede the movement of dislocations, or defects in a crystal's lattice. Since dislocations are often the dominant carriers of plasticity, this serves to harden the material. The impurities play the same role as the particle substances in particle-reinforced composite materials. Just as the formation of ice in air can produce clouds, snow, or hail, depending upon the thermal history of a given portion of the atmosphere, precipitation in solids can produce many different sizes of particles, which have radically different properties. Unlike ordinary tempering, alloys must be kept at elevated temperature for hours to allow precipitation to take place.

This time delay is called "aging". Solution treatment and aging is sometimes abbreviated "STA" in specifications and certificates for metals. Many Chromium based alloys are strengthened by a heat treatment process known as Age hardening. The first step is the solution treatment for certain temperature until α phase exists, and then holding the sample for that temperature until all the secondary phase dissolves primary phase. The sample is then rapidly cooled for low temperature. The aging process thus applied at room temperature which is still at to phase region. The precipitated clusters thus formed ill strengthen the material.

II. EXPERIMENTAL DETAILS

2.1 Materials:

To accumulate the study primarily the B-16 material is selected which is cut from the raw material. The material is chosen superior mechanical properties as well as it contributes better to the heat treatment property. Which helps in manual fabrication of the stud and nut. In conditions of aging this metal has superior machining property.

2.2 Sample Preparation:

The material was selected to prepare the specimen as per ASTM, as this material possesses the machining property towards threading. The samples as per ASTM for various tests were made using the various machining operations. CNC machining was employed to prepare the specimens. The specimens were planned to prepare for different cutting parameters. Prepared Specimen is then age hardened and tested by using the Brinnell hardness and tensile test.

To investigate the Hardness and tensile property of B-16 specimens are Machined and tested according to ISO/IEC Directives part 3. International standard ISO1148 as prepared by technical committee ISO/TC 107, metallic and other organic coatings. The material is chosen from ASTM standard A193 from B-16 bar stock. The hardness test is done as per ASTM E-10-2017 standard and the tensile test is done as per ASTM A370 standard.

2.3 Chemical composition of stainless-Steel ASTM A193 Grade B-16 material:

Constituents	Standard (%)	Obtained (%)
C	0.36-0.47	0.39
Mn	0.45-0.7	0.5
Si	0.15-0.35	0.3
P	0.035	0.024
S	0.04	0.01
Cr	0.8-1.15	1.15
V	0.25-0.35	0.25
Mo	0.50-0.65	0.5
Al	0.015	0.01

III. RESULT AND DISCUSSION

Determination of Hardness and Tensile Strength:

3.1.1 Hardness Test:

Type of Equipment: HPO 250
Type of Indenter: Tungsten Carbide Ball
Diameter of Ball: 2.5mm
Test Force: 187.5kgf

Brinell Hardness Values:

Sl No	BHN(STUD)	BHN (NUT)
1	260	210
2	255	211
3	255	211
4	256	210
5	255	212
6	255	215

3.1.2 Tensile Test:
Gauge Diameter = 12.41 mm
Cross Section area = 120 mm^2
Original Gauge Length = 50 mm
Yield Load = 59147.80 N
Yield Strength = 735.18 N/mm^2
Ultimate Tensile Load = 88373.15 N
Ultimate Tensile Strength = 850.52 N/mm^2
Final gauge Length 76.88 mm
Elongation = 29.56 %
Final Diameter 8.07 mm
Reduction of Area 57.82 %

IV. CONCLUSION

Peak age hardening temperature was found to be 750℃ for all both bolt and nut studied in this research: B-16 chromium-based alloy material with 0.8 to 1.15 Chromium can be age hardened to have two different hardness.

Hardness of the material can be increased by changing the relevant temperature and time, by performing quench-controlled age hardening treatment, the obtained hardness was 30% higher than that achieved with conventional heat treatment.

Investigating age hardening of the alloys containing Chromium one may observed bimodality on their hardness-time curve. - Tensile strength and elongation of the samples were found to increase from 500 MPa with conventional heat treatment to 850MPa.

ACKNOWLEDGEMENT:

Present work was carried out by the author during his work at Sahyadri college of Engineering & Management, Mangalore, Karnataka. Author is highly thankful to his supervisors caliper Engineering and Lab Pvt. Ltd. for their valuable support and guidance to this work. Author is highly thankful to caliper Engineering and Lab Pvt. Ltd for providing opportunity to work in their labs.

REFERENCES

[1] Y. Liu, D. Jiang, B. Li, T. Ying, and J. Hu, "Heating aging behavior of Al–8.35Zn–2.5Mg–2.25Cu alloy," Mater. Des., vol. 60, pp. 116–124, 2014.

[2] H. Yu et al., "High strength and large ductility in spray-deposited Al–Zn–Mg–Cu alloys," J. Alloys Compd., vol. 601, pp. 120–125, 2014.

[3] Guinier–Prestonzones(dark particles) in Al–4%Cu alloy.(from G. Zlateva and Z. Martinova, Microstructure of metals and alloys, CRC Press, Boca Raton, 2008

[4] Hirth, S.M., Marshall, G.J., Court, S.A. and Lloyd, D.J., "Effects of Si on the Aging Behaviour and Formability of Aluminum Alloys Based on AA6016", Materials Science and Engineering, A319- 321, 452-456, 2001

[5] Zehn, L., Kang, S.B. and Kim, H.W., "Effect of Natural Aging and Preaging on Subsequent Precipitation Process of an Al-Mg-Si Alloy with High Excess Silicon", Materials Science and Technology, 13, 905, 1997

[6] Evren TAN and Bilgehan ¨OGEL. Influence of Heat Treatment on the Mechanical Properties of AA6066 Alloy. Turkish J. Eng. Env. Sci. 31 (2007), 53 – 60. c_ T¨UB˙ITAK.