Available online at http://www.ijirr.com

International Journal of Information Research and Review
Vol. 2, Issue, 09, pp.1155-1157, September, 2015

IRR INTERNATIONAL JOURNAL

OPEN ACCESS JOURNAL

ISSN: 2349-9141

Full Length Research Paper

EFFECT OF SHORTENED HEAT TREATMENT ON THE HARDNESS AND MICROSTRUCTURE OF 320.0 ALUMINIUM ALLOY

[1]Mr. Pankaj Shende, [2]Nagesh, A. and [3]Vandana Somkumar

[1]Department of Engineering, EIT, MAI-Nefhi, Asmara, Eritrea
[2]Department of Physics, EIT, MAI-Nefhi, Asmara, Eritrea
[3]Department of Mechanical, NITTTR, Bhopal, MP, India

***Corresponding Author**

Received 27th August 2015; Published 30th September 2015

Abstract

Improvement of Al-Si alloys properties in scope of classic method is connected with change of Si precipitations morphology through: using modification of the alloy, maintaining suitable temperature of overheating and pouring process, as well as perfection of heat treatment methods. Growing requirements of the market make it necessary to search after such procedures, which would quickly deliver positive results with simultaneous consideration of economic aspects. Presented in the paper shortened heat treatment with soaking of the alloy at temperature near temperature of solidus could be assumed as the method in the above mentioned understanding of the problem. Such treatment consists in soaking of the alloy to temperature of solution zing, keeping in such temperature, and next, quick quenching in water (20^0C) followed by artificial ageing. Temperature ranges of solution zing and ageing treatments implemented in the adopted testing plane were based on analysis of recorded curves from the ATD method. Obtained results relate to dependencies and spatial diagrams describing effect of parameters of the solution zing and ageing treatments on HB hardness of the investigated alloy and change of its microstructure. Performed shortened heat treatment results in precipitation hardening of the investigated 320.0 alloy, what according to expectations produces increased hardness of the material. The micro structural and mechanical characterization of heat treatable 6xxx (Al-Mg-Si-Cu based) wrought aluminum alloys was studied. The aim of this work was to produce a fine grained, high strength 6xxx series aluminum alloy by adjusting the processing conditions, namely deformation, solution zing and aging.

Keywords: Aluminum Alloys, ATD, Heat Treatment, HB Hardness, Microstructural Characterization Heat Treatment, Strength, Ductility.

Copyright *© Mr. Pankaj Shende et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.*

To cite this paper*:* Mr. Pankaj Shende, Nagesh, A. and Syed Tanyeer, 2015. Effect of shortened heat treatment on the hardness and microstructure of 320.0 aluminium alloy*, International Journal of Information Research and Review.* Vol. 2, Issue, 09, pp.1155-1157, September, 2015.

INTRODUCTION

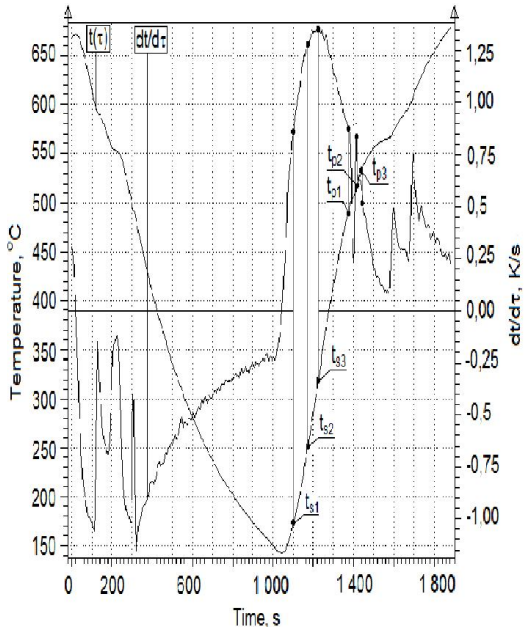
Well known advantages of aluminum alloys, like low mass, good mechanical properties, corrosion resistance, mach inability, high percentage of recycling, and low costs, are the driving force for their development, i.e. usage in new applications as early as in stage of development of a structures, as well during development of new technological solutions. Mechanical and technological properties of castings from 3xx.x group depend mostly on properly performed process of melting and pouring, design of a casting and mould, and possible heat treatment. Using knowledge on crystallization course in manufacturing processes of pouring in order to improve their structure, and launching a modern methods of the heat treatment (Czekaj, 2005; Stankowiak and Bydałek, 2007; Sokolowski, 2001) belong to important factors havineffect on better quality of the castings, and thereby causing that the alloys from 3xx.x group are so attractive in many applications, inclusive of e.g. cylinder heads of combustion engines.

Still growing demands in terms of mechanical properties of material for castings, resulting from e.g. downsizing of engines and strong competition on automotive market force the search for optimal solutions assuring proper mechanical and technological properties without increased manufacturing costs of a given component.

Numerous studies on heat treatment parameters were already performed for the Al-Si-Cu alloys, both with and without addition of Mg (Colley *et al.,*., 2011; Han *et al.,*., 2008; Sjölander and Seifeddine, 2010; Pezda, 2010; Pezda, 2010). Han in the study (Han *et al.,*., 2008) reports that in case of the 319 alloy the solutioning temperature is included within range of 490 Aluminum alloys have been the material of choice for aircraft construction since the 1930s. The aerospace industry relies heavily on 2xxx and 7xxx alloys, while6xxx aluminum alloys are of particular interest nowadays.

MATERIALS AND METHODS

The 320.0 (AlSi7Cu3Mg) alloy, belonging to group of Al-Si-Cu-Mg alloys, is used to production of, inter alia, castings of cylinder heads and cylinder blocks (Dobrzański *et al.,*., 2006; Carrera *et al.,*., 2007; Krupiński *et al.,*., 2008) and in other applications of automotive industry, mainly in casting process ins and moulds (engine crankcases, engine oil pans) and in metal mould Analysis of chemical composition was performed with use of optical emission spectrometry method with inductively coupled plasma on PerkinElmer, model Optima 4300 Dv, optical emission spectrometer in Bosmal R&D Institute in Bielsko-Biala. Investigated alloy was melted in electric resistance furnace and was subjected to treatment of refining (Rafal 1-0,4%). In the next stage the investigated alloy was poured into metallic mould used to production of standardized strength test pieces according to PN-88/H-88002 standard. Measurement of Brinnell hardness was performed in compliance with PN-EN ISO 6506-1:2008 standard with use of Brinnell hardness tester of PRL 82 type, with steel ball having diameter of 10mm under load of 9800 N maintained for 30 seconds. As a measurement surfaces were used milled heads of the strength test pieces. Process of solidification and melting of the alloy was recorded with use of automatic Crystal dim at analyzer. In the Fig. 1 are depicted crystallization curves of the investigated alloy, recorded with use of the ATD method, with marked characteristic points. Fig. 1. Curves of the ATD method for the 320.0 alloy Temperatures of solutioning and ageing treatments were selected on the base of values of points on melting curves from the ATD method



RESULTS AND DISCUSSION

Hardness of not heat treated HB10/1000/30 alloy was included within limits of 80-84. After performed heat treatment of the alloy, obtained hardness HB10/1000/30 amounted from 52 to 138. Making comparison of obtained values from the test of the alloy without and with the heat treatment. It has been confirmed the highest increase of the HB hardness for the systems marked as No. 4 (tp - 485 ^{o}C; tp - 1,5 hour; ts - 175 ^{o}C; ts - 8hours), No. 7 (tp - 485 ^{o}C; tp - 3 hours; ts - 175 ^{o}C; ts - 5 hours)and No. 13 (tp - 510 ^{0}C; tp - 1,5 hour; ts - 175 ^{o}C; ts - 5 hours). With a slightly lower hardness, amounted to 110-121HB10/1000/30, were characterized test pieces from the systems No. 1, 16, 8, 10, 19 and 25, for which ageing temperature amounted to 175 oC.2 types of particles in the α-Al matrix: large black particles and tiny (5-10 μm) gray script-like features. With the assistance of EDS analysis, the features were possibly identified as Mg2Siand (Fe, Mn, Cu) 3SiAl12. Highly alloyed 6xxx had complex intermetallics originating from cast ingots. Since iron was the omnipresenm purity element and had a very low solubility in aluminum, iron-rich phases could be seen in all aluminum alloys.

Conclusions

Performed shortened heat treatment of the 320.0 alloy has resulted in explicit improvement of the HB hardness, which maximal values in light of performed investigations can be obtained after solution zing of the alloy at temperature 485-500o C during 1 to 3 hours and ageing at temperature **175^{o} C** during 2 to 6hours. In this study, the effect of deformation on mechanical properties of a 6xxx series aluminum alloy was investigated. Following the determination of the ideal conditions for solution zing and ageing processes, specimens were mechanically deformed by swaging at 4 different deformations and then heat treated.

REFERENCES

Alkahtani, S. 2011. Mechanical performance of heat treated319 alloys as a function of alloying and aging parameters. Materials =& Design. 41, 358-369. DOI:10.1016/j.matdes.2012.04.034.

ASM Specialty Handbook, "Aluminum and AluminumAlloys", Materials Information Society, 1996.

ASTM Standard, "B557M Tension TestingWroughtand Cast Aluminum and Magnesium-Alloy Products", 2002.

Cai, M., Field D.P. and Lorimer G.W. 2004 ."AS ystematic Comparison of Static and Dynamic Ageing ofTwo Al–Mg–Si Alloys", Materials Science and Engineering,A373, 65-71.

Carrera, E. *et al.* 2007. Measurement of residual stresses incast aluminium engine blocks. *Journal of Materials Processing Technology,* 189, 206-210.

Chakrabarti, D.J. and Laughlin, D.E., 2004. "Phase Relationsand Precipitation in Al–Mg–Si Alloys withCu Additions", Progress in Materials Science, 49,389-410.

Colley, L. J., Wells, M. A., MacKay, R. and Kasprzak, W. 2011. Dissolution of Second Phase Particles in 319-typeAluminium Alloy. Heat Treating 2011: Proceedings of the 26th Conference, (pp. 189-198). ASM International,Materials Park, OH.

Czekaj, E. 2005. Short-lived ultra high temperature siliconspheroidization treatment. Archives of Foundry. 5(17), 51-68.

Dahle, A. K., *et al*. 2005. Eutectic modification andmicrostructure development in Al-Si Alloys. *Materials Science and Engineering,* A. 413-414, 243-248. DOI:10.1016/j.msea.2005.09.055.

defects in castings from Al-Si-Cu alloys. *Archives of Foundry,* 6(22), 598-605.

Dobrzański, L. A., Krupiński, M. and Sokolowski, J. H. 2006 Use of artificial intelligence methods to classification of

Dorward, R.C. and Bouvier, C. 1998. "ARat ionalizationof Factors Affecting Strength, Ductility and Toughnessof AA6061-Type Al–Mg–Si–(Cu) Alloys", Materials Science and Engineering, A254, 33-44. Hirth, S.M., Marshall, G.J., Court, S.A. and

Górny, Z. 1992. Casting alloys of non-ferrous metals.Warszawa: WNT.

Han, Y. *et al.* 2014. Optimizing the tensile properties of Al-Si-Cu-Mg 319-type alloys: Role of solution heat treatment. Materials Design. In Press. DOI:10.1016/j.matdes.2014.01.060.

Han, Y. M., Samuel, A. M., Samuel, F. H. and Doty H.W. 2008. Dissolution of Al2Cu phase in non-modified and Srmodified 319 type alloys. International Journal Cast Metals Research. 21(5), 387-393. DOI:10.1179/136404608X347662

Ibrahim, M. F. 2011. Metallurgical parameters controllingthe microstructure and hardness of Al–Si–Cu–Mg base alloys. Materials and Design. 32(4), 2130-2142. DOI:10.1016/j.matdes.2010.11.040.

Krupiński, M., Dobrzański, L. A. and Sokolowski, J. H. 2008. Microstructure analysis of the automotive Al-Si-Cu castings. *Archives of Foundry Engineering*. 8(1), 71-74.

Lloyd, D.J. 2001. "Effects of Si on the Aging Behaviourand Formability of Aluminium Alloys Based onAA6016", Materials Science and Engineering, A319-321, 452-456.

Matsuda, K., Teguri, D., Uetani, Y., Sato, T. and Ikeno, S. 2002. "Cu-Segregation at the Q_/α-Al Interfacein Al–Mg–Si–Cu Alloy", Scripta Materialia, 47, 833-837.

Pezda, J. 2010. Effect of heat treatment operations on theRm tensile strength of silumins. *Archives of Foundry Engineering,* 10(4), 61-64.

Pezda, J. 2010. Heat treatment of the EN AC-AlSi9Cu3(Fe) alloy. *Archives of Foundry Engineering*. 12(2), 99-102.

Pietrowski, S. 2001. Silumins. Łódź: Technical UniversityEditorial.

Poniewierski, Z. 1989. Crystallization, structure andproperties of silumins. Warszawa: WNT.

Ravi, C. and Wolverton, C. 2004. "First-Principles Studyof Crystal Structure and Stability of Al–Mg–Si–(Cu) Precipitates", Acta Materialia, 52, 4213-4227.

Singh, R.K., Singh, A.K. and Prasad, N.E. 2000. "Textureand Mechanical Property Anisotropy in an Al–Mg–Si–Cu Alloy", Materials Science and Engineering,A277, 114-122.

Sjölander, E. and Seifeddine, S. 2010. Optimisation ofsolution treatment of cast Al–Si–Cu alloys. Materials andDesign. 31, 44-49. DOI:10.1016/j.matdes.2009.10.035.

Sokolowski, J. H., *et al.* 2001. Improvement of 319Aluminum Alloy Casting Durability by High Temperature Solution Treatment. *Journal of Advanced Materials Processing Technology,* 109, 174-180.

Stankowiak, A. and Bydałek, A. W. 2007. The influence othe cryogenic processing after saturating on proprietyAlCu4, 7 cast alloy. *Archives of Foundry Engineering,* 7(2),147-152.

Sun, Y., Baydo˘gan, M. and C, imeno˘glu, H. 1999. "TheEffect of Deformation Before Ageing on the WearResistance of an Aluminium Alloy", Materials Letters, 38, 221-226.

Troeger, L.P. and Starke, E.A. 2000. "Microstructuraland Mechanical Characterization of a Superplastic 6xxx Aluminum Alloy", Materials Science and Engineering,A277, 102-113.

Wang, P.S., Lee, S.L. and Lin, J.C. 2000. Effects of solutiontemperature on mechanical properties of 319.0 aluminumcasting alloys containing trace beryllium. *Journal of Materials Research,* 15(9), 2027-2035. DOI:10.1557/JMR.2000.0291.

Wasilewski, P. 1993. Silumins - Modification and itsimpact on structure and properties. Katowice: PANSolidification of metals and alloys. 21, *Monography*.

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

****