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Effects of Process Parameters and Mechanical Properties of Stir Cast Aluminium 6063 Alloy: A Review

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***Abstract*: Aluminium is widely used in industries due to their light weight and good machinability. Defects caused during casting is higher in aluminum hence optimization of process parameters is required for good casting quality of Aluminium alloy. Even though there are advanced casting methods available the defects during casting process is not reduced hence optimization of process parameters is required during the casting process. The microstructure refining is done by either controlling the process parameters or addition of grain refiners. In this research the microstructure is refined by both the foresaid methods to obtain better mechanical properties at optimum combination of stir casting process parameters and amount of Ti.**

***Keywords*: Aluminium Alloys, microstructure, process parameters, grain refiners.**

1. Introduction

Aluminium is light in weight and has high strength which is important in automotive and aerospace industries. Pure aluminium does not fit the requirements of the most of the industries therefore they are alloyed with some other metals like silicon, copper, magnesium etc., to increase their mechanical properties. The aluminium 6063 alloy is one of the grades of aluminium with silicon and magnesium as their major alloying metals. Aluminium 6063 has excellent mechanical properties and good weldability. Due to its good mechanical properties, it is widely used in producing safety parts and suspension components and wheels in automotive industry. Chemical compositions together with process parameters are responsible for microstructure which controls the mechanical properties. In this research specimens are made with different process parameters and different composition of titanium and compared with the properties of aluminium 6063 alloy. There are different casting methods available for casting aluminium but the defects occurring during the casting process cannot be eliminated completely. The quality of casting is affected by process parameters without the control of the casting parameters it leads to defects like surface defects, cracks and poor mechanical properties

Important stir casting parameters

- Molten metal temperature
- Stirring speed
- Stirring time

1) Effect of molten metal temperature on aluminium

Observations indicated that the lower pouring temperature which is nearer to the molten temperature produced good casting quality. The change of viscosity is significant with increase in temperature while comparing Al alloy composites. But, both viscosity is increased when processing temperature is increased. The changes of viscosity influence the particle distribution in the Al matrix.

2) Effect of stirring time on aluminium

Effect of stirring time helps in the composites mainly two ways: to distribute the particles in the liquid, and to create perfect interface bond between reinforcement and matrix. The holding time between matrix and reinforcement is considered as important factor in the processing of composites.

3) Effect of stirring speed on aluminium

When speed increases tensile strength also increased because the mixing of reinforcement material will be good due to high speed. The tensile strength is high because of good mixing of both materials. So always a high speed is desirable for better results.

2. Experimental procedure

A. Stir casting process

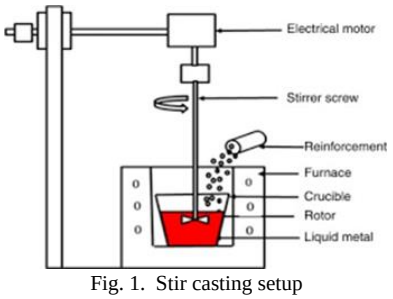

Fig. 1. Stir casting setup

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. Stir Casting is the simplest and the most

cost effective method of liquid state fabrication

B. *Specimen preparation*

Aluminium 6063 is melted in the furnace to its molten state to about the temperature of about 600 C. The aluminium is kept in molten state and the titanium powder is added to molten metal. The mixture is mixed with the help of a stirrer. This process is carried to produce samples of different parameters like stirring speed(200 rpm,220rpm,240 rpm),stirring time(1,2,3)minutes, molten metal temperature(600,620,640) Celsius and titanium (1 wt%,1.25wt%,1.5 wt %).

Table 1
Compositional details of specimen made

Specimen	Molten metal temperature	Stirring speed	Stirring time	Titanium composition
S1	600	200	1	1wt%
S2	620	220	2	1.25wt%
S3	640	240	3	1.3wt%
S4	Unalloyed Aluminium 6063 Alloy			

C. *Tensile test*

Tensile strength measures the force required to pull something such as rope, wire, to the point where it breaks. The tensile strength of a material is the maximum amount of tensile stress it can take before failure. The tensile test was carried on universal testing machine according to ASTM E8 standard and the results were noted.

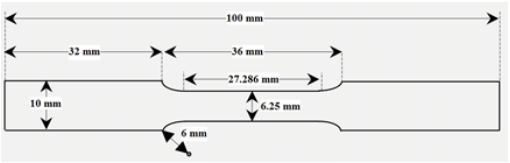

Fig. 2. Tensile test specimen

D. *Impact test*

The impact test was carried on charpy impact equipment with the following specimen dimensions.

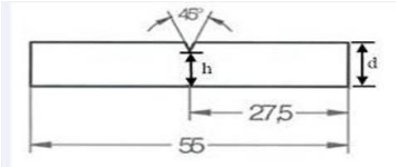

Fig. 3. Charpy impact test specimen

E. *Micro structural observation*

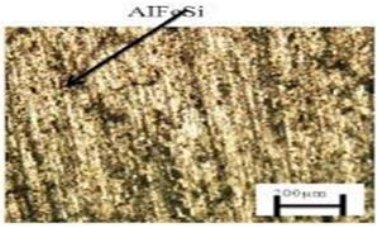

Fig. 4. Micro structural Image

Microstructure observation is done by polishing the surface of the specimen. The polishing is done by using silicon carbide papers of different grades. After polishing the specimens are smoothened with the help of fabric to obtain smooth surface with no scratch. Then the specimen is observed by scanning electron microscope to observe the micro structure.

3. Results and discussions

A. *Effect of stirring temperature*

It is observed that by increasing the temperature, tensile strength decreases because when stirring is done at higher temperature it takes much time to get solidified, due to which all the particles go down to bottom of crucible. And when materials getting solidified the particles is not distributed so well.

B. *Effect of stirring speed on tensile strength*

When speed increases tensile strength also increased because the mixing of material was good due to high speed. The tensile strength is high because of good mixing of both materials.

C. *Effect of stirring time on tensile strength*

Increasing the stirring time increases tensile strength because the mixing of material was good due to more time of mixing.

4. Conclusion

From the literatures that we have reviewed, the following points are noteworthy.

1. It is observed that the hardness value for the produced sample increases to the variation of stirring speed.
2. Hardness value of the Stirring time initially increases and then slightly decreases
3. Hardness value decreases with increase in melting temperature
4. Tensile strength of Aluminium alloys decreases, while increasing the molten metal temperature.
5. By increasing the stirring time, the tensile strength increases.
6. Tensile strength increases on increasing stirring speed
7. The addition of Mn causes the reduction of the number of β-Al5FeSi phases, Therefore, the tensile properties seem to be more dependent on the dimensions of the inter metallics
8. The reduction of the Mg content leads to an increase in elongation but also reduce the tensile strength, yield strength and hardness values.

References

[1] Annalisa Fortini, Mattia Merlin, Elettra Fabbri, Stefano Pirletti,Gian Luca Garagnani,"On the influence of Mn and Mg additions on tensile properties, microstructure and quality index of the A356 aluminum foundry alloy" ECF21, 20-24 June 2016.

[2] Bharath V, Madev Nagaral, V Auradi and S. A. Kori. (2014). “Preparation of 6061Al- Al2O3 MMC’s by Stir Casting and Evaluation of Mechanical and Wear Properties”. Procedia Materials Science 6, 1658–1667.

[3] Abedi K., Emamy M., 2010. The effect of Fe, Mn and Sr on the microstructure and tensile properties of A356-10% SiC composite

Materials Science & Engineering A 527, 3733–3740. Bäckerud S.L., Chai G., Tamminen J., 1990.
[4] Q Hu, H Zhao, F Li, Microstructures and properties of SiC particles reinforced aluminum-matrix composites fabricated by vacuum-assisted high pressure die casting, Materials Science & Engineering A, 2016
[5] Shriyash S. Shinde, S. G. Kulkarni and S. S. Kulkarni (May 2015). "Manufacturing of Aluninium Matrix Composite by using Stir Casting Method". International Journal of Innovations in Engineering Research and Technology [IJIERT], Volume 2, Issue 5.
[6] Shubham Mathur, Alok Barnawal. (December 2013). "Effect of Process Parameter of Stir Casting on Metal Matrix Composites". International Journal of Science and Research, Volume 2, Issue 12.
[7] S. Mathur and A. Barnawal, "Effect of Process Parameter of Stir Casting on Metal Matrix Composites", International Journal of Science and Research (IJSR), vol. 2(12), pp. 395-398, 2013.
[8] Kumar, R. S., Alexis, J., & Thangarasu, V. S. (2017). Optimization of high speed CNC end milling process of BSL 168 Aluminium composite for aeronautical applications. Transactions of the Canadian Society for Mechanical Engineering, 41(4), 609-625
[9] Kumar, S. R., Alexis, J. S., & Thangarasu, V. S. (2017). Experimental Investigation of Influential Parameters in High Speed Machining of AMS 4205. Asian Journal of Research in Social Sciences and Humanities, 7(2), 508-523.
[10] Ganesh Kumar, S., Thirunavukkarasu, V., Sureshkumar, R., Venkatesh, S., & Ramakrishnan, T. Investigation of wear behaviour of silicon carbide tool inserts and titanium nitride coated tool inserts in machining of en8 steel.
[11] Kumar, S., Alexis, J., & Thangarasu, V. S. (2016). Prediction of machining parameters for A91060 in end milling. Advances in Natural and Applied Sciences, 10(6 SE), 157-164
[12] Kumar, R. S., Thangarasu, V. S., & Alexis, S. J. (2016). Adaptive control systems in CNC machining processes--a review. Advances in Natural and Applied Sciences, 10(6 SE), 120-130.
[13] Kumar, s., alexis, j., & dhanabalakrishnank.p (2015). Application of ga & ann for the optimization of cutting parameters for end milling operation- a comparison. International journal of applied engineering research, 10(20), 18092-18107.
[14] Ramakrishnan, T., & Pavayee Subramani, S. (2018). Investigation of Physico-Mechanical and Moisture Absorption Characteristics of Raw and Alkali Treated New Agave Angustifolia Marginata (AAM) Fiber. Materials Science, 24(1), 53-58. [SCI & Scopus IF: 0.593]
[15] Ramakrishnan, T., & Sampath, P. S. (2017). Dry Sliding Wear Characteristics of New Short Agave Angustifolia Marginata (AAM) Fiber-Reinforced Polymer Matrix Composite Material. Journal of Biobased Materials and Bioenergy, 11(5), 391-399. [Scopus & SCI, IF: 2.993]
[16] Jeyakumar, R., Sampath, P. S., Ramamoorthi, R., & Ramakrishnan, T. (2017). Structural, morphological and mechanical behaviour of glass fibre reinforced epoxy nanoclay composites. The International Journal of Advanced Manufacturing Technology, 93(1-4), 527-535. [Scopus & SCI, IF: 2.663]
[17] Ramakrishnan, T., & Sampath, P. S. (2017). Experimental investigation of mechanical properties of untreated new Agave Angustifolia Marginata fiber reinforced epoxy polymer matrix composite material. Journal of Advances in Chemistry, 13(4), 6120-6126. [Scopus & IF: 1.131]
[18] Ramamoorthi, R., Jeyakumar.R, & Ramakrishnan,T. (2017). Effect of Nanoparticles on the Improvement of Mechanical Properties of Epoxy Based Fiber – Reinforced Composites - A Review. International Journal for Science and Advance Research in Technology, 3(11), 1251- 1256.
[19] Ramakrishnan, T., Sampath, P. S., & Ramamoorthi, R. (2016). Investigation of Mechanical Properties and Morphological Study of the Alkali Treated Agave Angustifolia Marginata Fiber Reinforced Epoxy Polymer Composites. Asian Journal of Research in Social Sciences and Humanities, 6(9), 461-472.
[20] Ramakrishnan, T & Sampath, P.S. (2016). Thermogravimetric Analysis (TGA) and the Effect of Moisture Absorption on the Mechanical Properties of New Agave Angustifolia Marginata 3 Fiber (AAMF) Reinforced Epoxy Polymer Composite Material, International Journal of Printing, Packaging & Allied Sciences, 4(5), 3245-3256. [Global IF: 0.12]
[21] Ramakrishnan, T., Sathish, K., Sampath, P. S., & Anandkumar, S. (2016). Experimental investigation and optimization of surface roughness of AISI 52100 alloy steel material by using Taguchi method. Advances in Natural and Applied Sciences, 10(6 SE), 130-138.
[22] Sathish, K., Ramakrishnan, T., & Sathishkumar, S. (2016). Optimization of turning parameters to improve surface finish of 16 Mn Cr 5 material. Advances in Natural and Applied Sciences, 10(6 SE), 151-157.
[23] S. Karthik Raja S.Balasubramani, S.Venkatesh, T.Ramakrishnan (2015). Effect Of Cryogenic Tempering On Steel,International Journal of Mechanical and Civil Engineering, 2 (6), 98-113.
[24] Venkatesh, S., &Sakthivel, M. (2017). 'Numerical Investigation and Optimization for Performance Analysis in Venturi Inlet Cyclone Separator', Desalination and Water treatment, Vol. 90, No. 9, pp. 168-179. [Desalination publication, Impact Factor: 1.631, Scopus].
[25] Venkatesh, S., Sakthivel, M., Sudhagar, S.,&Ajith Arul Daniel, S.(2018). 'Modification of the cyclone separator geometry for improving the performance using Taguchi and CFD approach', Particulate Science and Technology, Doi:10.1080/02726351.2018.1458354. [Taylor & Francis publication, Impact Factor: 0.785, Scopus].
[26] Venkatesh, S., Bruno Clement, I., Avinasilingam, M., &Arulkumar, E. (2017). "Design of Experiment Technique for Improving the Performance of Stirling Engine", International Research Journal of Engineering and Technology,Vol. 4, No. 5, pp. 62-65.
[27] Venkatesh, S., Balasubramani, S., Venkatramanan, S., &Gokulraj, L. "Standardization of hpx spool for lead time reduction of string test", Journal of Mechanical and Civil Engineering,Vol. 2, No. 6, pp. 62-79.
[28] Kousalya Devi, S., Venkatesh, S., &Chandrasekaran. P. (2015). "Performance Improvement of Venturi Wet Scrubber,"Journal of Mechanical and Civil Engineering, Vol. 2, No. 4, pp. 1-9.
[29] Arunkumar, P., Dhachinamoorthi, P., Saravanakumar, K., &Venkatesh, S. (2014)."Analysis and Investigation of Centrifugal Pump Impellers Using CFD," Engineering Science and Technology: An International Journal, Vol. 4, No. 4, pp. 112-117.
[30] Dhanabalakrishnan,K.P., Abuthakir, J., Subramanian, R., Venkatesh, S. (2015)."Evaluation of Tensile Properties of Particulate Reinforced Al-Metal Matrix Composites," Engineering Science and Technology: An International Journal, Vol. 5, No. 1, pp. 173-175.
[31] F. Justin Dhiraviam, V.Naveenprabhu, M.Santhosh," Study the Effects of Solar Assisted Vapour Compression Air Conditioning System for Winter Applications", International Journal for Scientific Research & Development|, Vol 4(11),(2017), pp. 505-508
[32] V. NaveenPrabhu, K. SaravanaKumar, T. Suresh and M. Suresh," Experimental investigation on tube-in-tube heat exchanger using nanofluids", Advances in Natural and Applied Sciences, , Vol 10(7),(2016), pp. 272-278
[33] V Naveenprabhu, D Mugeshkumaar, KB Pravin, V Ranjith, S Sanjay Arthanari Swamy," A Review of Evaporative Cooling of Finned and Non-Finned Heat Exchanger on Condenser", International Journal for Scientific Research & Development, Vol 6(2),(2018), pp. 459-461.
[34] V.Naveenprabhu ,F.JustinDhiraviam, A.Vimal, K.Kumarrathinam," Design Of Common Header Line For Reduction Of Process Time In Pump Testing", International Research Journal of Engineering and Technology, Vol 4(1),(2017), pp. 969-975.
[35] B.Santhosh Kumar, et.al," Effect of Load on Joint Efficiency and Hardness in Friction Stir Welding of AA6061 & AA6063 Aluminium Alloys.", International Journal for Scientific Research & Development|, Vol 6(2),(2018), pp. 2669-2771.
[36] Ganesh Kumar, S & Thirunavukkarasu, V 2016, Investigation of Tool Wear and Optimization of Process Parameters in Turning of EN8 and EN 36 Steels, Asian Journal of Research In Social Sciences And Humanities. vol. 6, no.11, pp. 237 - 243, Impact Factor: 0.315.
[37] Kumar, S. D., Kumar, S. S., & Kumar, K. A. (2018). Investigation of Forced Frequency in a Commercial Vehicle Suspension System. Mechanics and Mechanical Engineering, 22(4), 967-974
[38] Balasubramani, S., & Balaji, N. (2016). Investigations of vision inspection method for surface defects in image processing techniques-a review. Advances in Natural and Applied Sciences, 10(6 SE), 115-120.
[39] Balasubramani, S., Dhanabalakrishnan K.P.,Balaji, N. (2015) Optimization of Machining parameters in Aluminium HMMC using Response Surface Methodology. International journal of applied engineering research, 10(20), 19736-19739.
[40] Subramaniam, B., Natarajan, B., Kaliyaperumal, B., & Chelladurai, S. J. S. (2018). Investigation on mechanical properties of aluminium 7075-

boron carbide-coconut shell fly ash reinforced hybrid metal matrix composites. China Foundry, 15(6), 449-456.

[41] Suresh Babu, Y., & Ashoka Varthanan, P. Study the emission characteristics of catalytic coated piston and combustion chamber of a four stroke spark ignition (SI) engine. Journal of Chemical and Pharmaceutical Sciences, 974, 2115.

[42] Sureshbabu, Y., & Ashoka Varthanan, P. (2018) Study the emission characteristics of catalytic coated piston and combustion chamber of a four stroke spark ignition (SI) engine. International Journal for Scientific Research & Development, 6(02), 1981-1983.