

Effect of Heat Treatment on Tribological properties of A356 Reinforced with bottom ash Metal Matrix Particulate Composite

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ABSTRACT: The effect of mechanical properties of A356 reinforced with bottom ash after heat treatment was studied in this article. Including the bottom ash reinforcement in the metal matrix displayed furthermore decreased in wear rate and thereby improving the wear resistance. The permanent mould, gravity cast (A356 reinforced with bottom ash) alloys obtained from stir casting were heat treated for varied heat treatment parameters such as solutionising, and natural ageing, which spurred further improvement in the microstructure and the mechanical properties. The precipitation increased the hardness of the alloy/composite proportional to the solutionising temperature and natural ageing was found to enhance the hardness. Therefore, effect of heat treatment variables viz, bottom ash reinforced A356 alloys/composites has resulted in a more wear resistant material with improved mechanical properties. In case of MMC's, aluminum matrix composite due their high strength to weight ratio, low cost and high wear resistance are widely manufactured and used in structural applications along with aerospace and automobile industry. Also a uncomplicated and cost effective process for manufacturing of the composites is very necessary for expanding their application. Reinforcements like particulate alumina, silicon carbide, graphite, fly ash and bottom ash etc can easily be incorporated in the melt using cheap and widely available stir casting method.

KEYWORDS: Aluminium alloy A356, Bottom ash, Natural Ageing, Heat treatment, economic alternative.

I. INTRODUCTION

A356-T6 was conducted by using precipitation hardening process. Enhancing the strength and hardness of metal Effect of Heat Treatment and Natural Ageing on Microstructure and Mechanical Properties of A3566 Reinforced with Bottom ash Composites alloys by the formation of extremely uniformly dispersed small particle of a second phase within the existing phase. Matrix is termed as Precipitation hardening. The diffusion of solute atoms into it from the matrix phase permits the precipitated particle to nucleate and grow [1].

Today's the world has been looking for the maximum optimization as possible in every field. Engineering is not an exception. Engineers are looking for creating the extreme best from the best. During these developments some way or the other much affected is the environment. The development of low cost metal matrix composites reinforced with eco-friendly material has been one of the major innovations in the field of materials in the past few decades. Aluminum alloys reinforced with ceramic particles exhibit superior mechanical properties to unreinforced Al alloys and hence are candidate for engineering applications. Now the most of the research work carried out to develop composites using various recycled wastes [1,2], especially in developing composites using most environmentally friendly agro-wastes (lignocellulosic materials) as reinforcing fillers. Therefore, composites with bottom ash as reinforcement are probable to overcome the cost fence for wide spread applications in automotive and small engine applications. It is therefore expected that the integration of bottom ash particles in aluminium alloy will encourage yet another use of this low-cost waste by-product and, at the same time, has the prospective for conserving energy rigorous aluminium and thereby, reducing the cost of aluminium products. A356 based alloys have been developed with significant ductility, strength, elongation, hardness and toughness at room temperature in as-cast state. A356 alloys are ever more accepted in aircraft and automobile due to their lofty strength-to-weight relation and its thixotropic arrangement, its specific

tensile strength and rigidity are superior to other Aluminum alloys. These qualities lead to less vehicle and aircraft weight and better fuel economy [5].

Composite material is one of the reliable solutions for such obligation. In composites, materials are united in such a way as to enable us to make better use of their parent material while minimizing to some extent the effects of their deficiencies Aluminium matrix composites (AMCs) are potential materials for various applications due to their good corporal and mechanical properties. The addition of reinforcements into the metallic matrix improve the stiffness, specific strength, wear, creep and fatigue properties compared to the conventional engineering materials. In recent decades, aluminum alloy based metal matrix composites are gaining important role in several engineering applications [1]. A356 alloy has been used as the matrix material because of its good formability, excellent mechanical properties and manufacturing properties. wide range of the applications in the industrial sectors. A356 based alloys have been developed with significant ductility, strength, elongation, hardness and toughness at room temperature in as-cast state[2]. Aluminium and its alloys outstretches its applications in the Automobile components, Aerospace and Marine industries on account of their durability, light weight, supreme surface finish, wear resistance and corrosion resistance and high strength to weight ratio. Complex geometries are produced with ease and are cost effective, they find enhanced utility in Aerospace sectors. Whereas in Automobile sector, due to its low density it can offer increased load capacity, superior mileage and concentrated pollution and higher profit to manufacturers. The low melting point, ease of formability, castability, handling and recycling has led to increased demand for aluminium composite components making more versatile for engineering and construction material.[9] Current investigations in this work with the improvement of mechanical properties and microstructure of aluminium alloy pertaining typically to the advancement in collection of alloys, synthesis of alloys, improvement of selection of modifiers, additives and reduction of impurities and slag and implementing a modern heat treatment technology has spurred their application by additional improvement in their properties[2].

II. LITERATURE SURVEY

K.P.Reddy et.al.(2016) In this report the author has studied about The effect of natural ageing on microstructure and mechanical properties of A356 reinforced with boron carbide, after and before heat treatment. In this investigation,

The permanent mold, gravity cast AGRM (A356 reinforced with B4C) alloys obtained from stir casting were heat treated for varied heat treatment parameters such as solution sing, and natural ageing, which spurred further improvement in the microstructure and the mechanical properties and concluded that Sound and dense castings were produced by Stir casting by means of pre-heated permanent mold. Heat treatment to a higher temperature resulted in Spherodisation of needle shaped Silicon particles leading to decreased aspect ratio, also natural ageing spurred further improvement in the microstructure and the mechanical properties. Heat treatment enhanced wear resistance and fine dispersion of second phases resulted in blocking dislocation slip leading to improved wear resistance and Improved Hardness, high strength to weight ratio, tensile and wear resistance was achieved in AGRM and reinforced B4C from heat treatment and natural ageing.

ShashiPrakash Dwivedi et.al. (2014) In this report the author has studied about Electromagnetic stirring process of A356/SiC composites. In this investigation, A356/SiC metal matrix composite with different weight percent of reinforcements (5%, 10% and 15%) were made-up by electromagnetic stir casting and showed significant increase in its mechanical properties such as microstructure homogeneity, fatigue etc.,

Dinaharan et.al. (2016)The paper reveals about the various characteristic of AMC reinforced fly ash produced by friction stir casting process such as optical microscopy, scanning electron microscopy and electron backscattered diagram. Homogeneous of FA is observed in the AMC produced by friction stir hardness. The result obtained from composite showed significant increase in micro hardness and wear resistance.

H. R.Ezatpour et.al.(2013) In this paper the research scientists studied about various mechanical properties like Hardness, Yield strength, Ultimate Tensile strength with mass fraction of Al₂O₃ in Aluminium. The Composite was manufactured by stir casting process. In this process the author also reviled about the various parameters like rpm, injection time, speed etc., considered for stir casting process.

Grigorios Itskoset et al (2011) In this report A356 Al-Fly ash composites were synthesized using pressure infiltration technique, by utilizing class C fly ash (FA) Metal Matrix Composites (MMCs) has excellent combination of physical, mechanical and tribological properties and their usage remains limited on account of their high production cost ,The fly

ashes were separated into their different size fractions by manual screening, by using the respective sieves. It was found that the finer the FA-particles, lower the friction coefficient. It was said finally that fine Fly Ash particles can strongly advantage the properties of composites and that grinding of fly ash facilitates MMCs-Manufacturing by pressure infiltration and it also advantages their wear properties.

III. MATERIALS & METHODOLOGY

3.1 A356 alloy

A356 alloy has been selected as the matrix material because of its good formability, outstanding mechanical properties and mechanized properties. wide variety of the applications in the industrial sectors. A356 based alloys have been urbanized with substantial ductility, strength, elongation, hardness and toughness at room temperature in as-cast state. A356 alloys are ever more accepted in aircraft and automobile due to their high strength-to-weight ratio. In general, stiffer and lighter designs can be achieved with A356 alloys than is possible with steels. Aluminum alloy A356 was selected as matrix material.

Table 3.1.1 Chemical composition of A356 Aluminium alloy, wt. Percentage

Element	Cu	Mg	Si	Fe	Mn	Ni	Pb	Sn	Ti	Zn	Al
Percentage	0.051	0.730	7.761	0.500	0.116	0.030	0.024	0.015	0.027	0.042	REM

3.2 Bottom Ash

Bottom ash is one of the most inexpensive and low density reinforcement obtainable in large quantities as solid squander by-product during flaming of coal in thermal power plants. Hence, composites with bottom ash as reinforcement are likely to overcome the cost obstacle for wide spread applications in automotive & space craft, aircraft, military, marine Applications. Bottom ash is coarser than fly ash, with a sandy texture and particles ranging from about 0.1 mm to 50 mm in diameter. Bottom ash from dry-bottom boilers is generally dull black in appearance. It typically has the consistency of coarse sand to gravel and superior carbon content than fly ash. Bottom ash is the innate Particulate reinforcement.

Table 2: Chemical composition of Bottom ash, wt. Percentage.

Element	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	CaO	MnO	ZnO	CuO	P ₂ O ₅	LOI
Percentage	65.50	16.21	4.90	1.20	0.75	2.80	0.12	0.020	0.040	0.080	REM

3.3 Mechanical Stir Casting Process Parameter

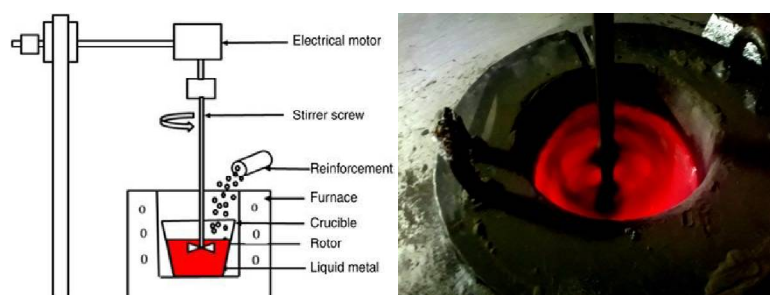


Figure 3.31: Schematic diagram of mechanical stir casting route

Clean the crucible which is made up of Graphite and Preheat the mould, Place the A356 metal pieces into the crucible, Maintain the furnace temperature around 750-800°C. Once A356 gains molten form add scum powder degassing tablet to it scum powder is used to remove slag, flux from the molten metal. degassing tablet [exo-chloro ethane] is used to remove unwanted gases from the molten metal, Preheat the reinforcements Pour this reinforcements into the molten metal with 2, 4, 6, 8, 10%wt each trail Using a Stirrer the reinforcements are stirred well in molten metal for about 10mins with approximate speed of 150-250rpm Then the molten mixture is poured into mould & left for cooling. Discontinuous reinforcement is stirred into molten metal, which is allowed to solidify. 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. In stir casting, molten metal is stirred with the help of mechanical stirrer. This action disperses the reinforcing phase, which is added to the surface of the melt in the molten metal, and solidifies the composite.

IV. EXPERIMENTAL RESULTS

4.1 Microstructure

The metallurgical microscope has been used for microstructure observation of matrix material. Some qualitative evidences of particulate distribution of combined Bottom excellence of bonding between two particulates and the matrix are obtained.

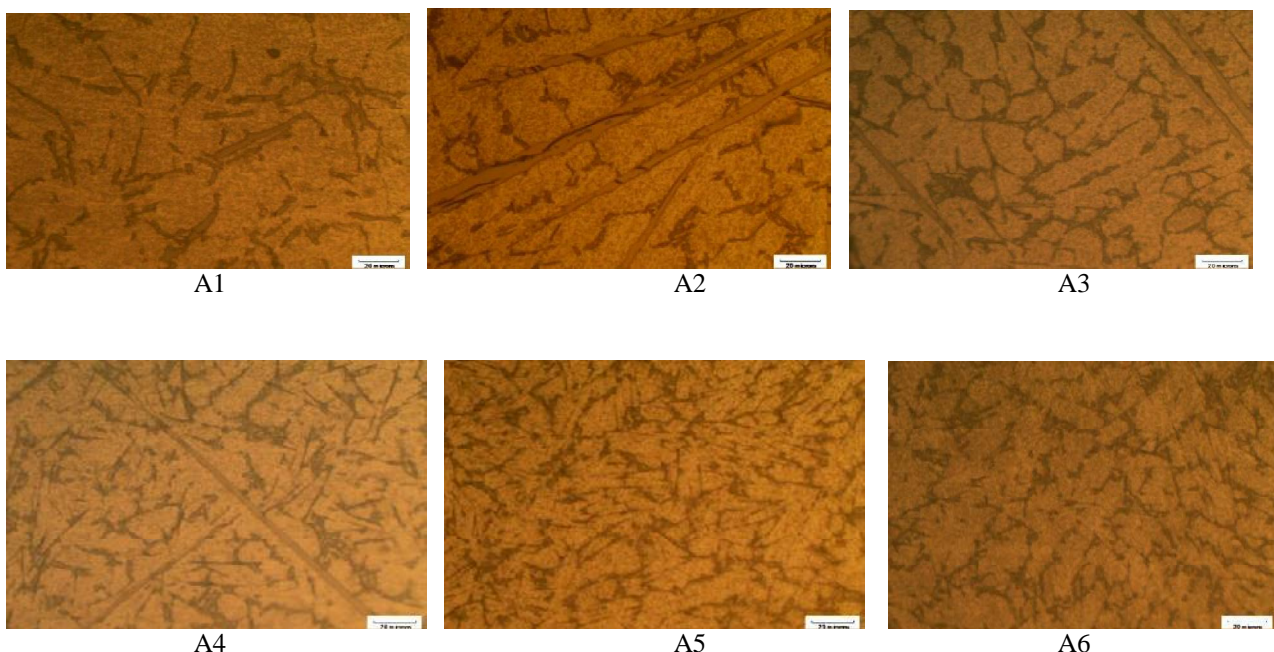


Figure 4.1.1: Microstructure of As-cast A356 composite (A1,A2,A3,A4,A5,A6)

The study of microstructure we can conclude that there is a homogeneous sharing of reinforcements in the alloy matrix. The bonding between particulates is satisfactory and finer grains of alloy matrix are found

4.2 Effect of wear rate at varying load at room temperature

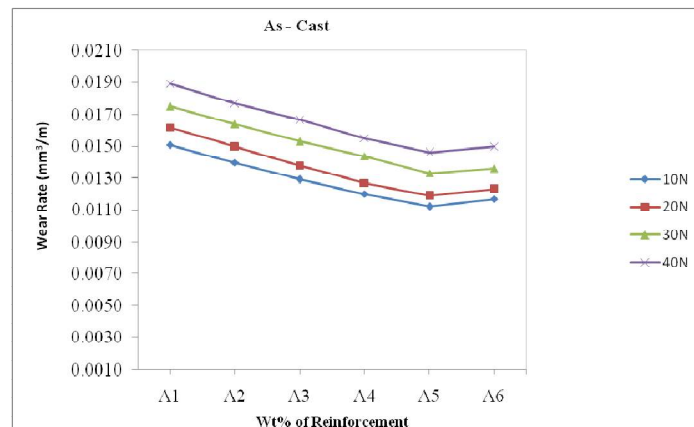


Fig. 4.2.1: Effect of wear rate at varying load

The variation of wear rate of A356 alloy and the composites with loads of 10,20,30 and 40N where as other parameter are speed 400 rpm and sliding distance 1.6m/s kept constant was shown in figure 4.2.1. It clearly show that at all load condition the addition of bottom ash particles to A356 alloy result in less wear rate under different load condition & at a sliding speed 400rpm for room temp condition. In this case also wear rate is maximum for A356 and minimum for 8% of bottom ash particles. At higher applied loads, high wear rates are observed.

4.2 Effect of wear rate at varying speed at room temperature

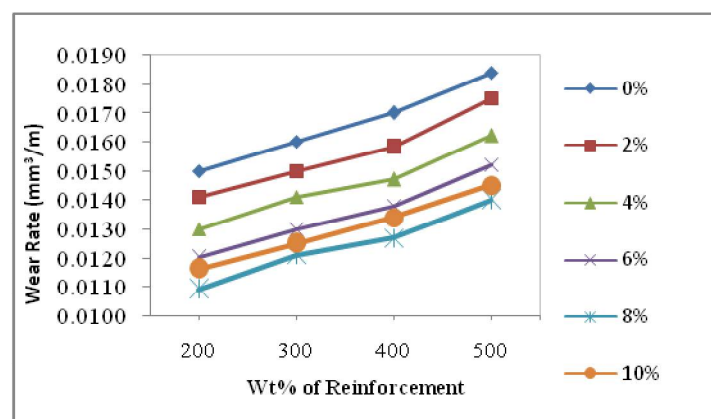


Fig. 4.2.1: Effect of wear rate at varying speed

In figure evidently show that at constant load condition the addition of bottom ash particles to A356 alloy result in less wear rate under different speed condition 200rpm, 300rpm, 400rpm and 500rpm and other parameter load 30N and sliding distance 1500m kept constant for room temp state. The wear rate is more for A356 alloy & less for prepared composites. In this case also wear rate is maximum for A356 and minimum for 8% of bottom ash particles. In case of prepared composite the hard bottom ash particles oppose the applied pressure avoids removal of material which reduces wear rate prepared composites.

V. CONCLUSION

The present study is an overview of latest research works on Abrasive Wear. It will give you brief information about the Abrasive Wear, its parameters and about the techniques used to optimize the parameters and wear resistance of aluminium alloys.

[1] Microstructural observation shows that addition of Bottom ash leads to agglomeration.

[2] Reinforcing Aluminum & its alloys with bottom ash composites have been successfully produced by vortex Method.

[3] Metal matrix composite of A356 reinforced with Bottom ash particulates is found to have improved wear resistance property.

Form results we uncover the optimal wear resistance value at A5 wt% of bottom ash having a good wear resistance compared A356 alloys without reinforcement

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