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Evaluation of Mechanical Properties of A356 Alloy Reinforced with Bottom Ash Metal Matrix Particulate Composite

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ABSTRACT

In the present investigation, the characteristics of A356 alloy including with Bottom ash as Particulate Reinforcement process is carried out by stir casting method , methods through which we can achieve required hardness, Microstructure Mechanical Properties and life extension of a automotive parts, A356 based metal matrix composite is responsible for room temperature

strengthening effect and their high strength-to-weight ratio and thixotropic structure. This paper describes the Chemical Composition of A356 alloy & bottom ash and also an economic alternative to the use of traditional materials, the use of bottom ash shows a great influence input to waste minimization as well as resources Preservation, But from the literature survey, it was found that a modest amount of study have been carried out on Bottom ash.

KeyWords: *A356 alloy, Bottom Ash, stir Casting, economic alternative*.

1. INTRODUCTION

Composite material is one of the reliable solutions for such requirement. 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. A356 alloys are ever more accepted in aircraft and automobile due to their high strength-to-weight ratio and its thixotropic structure, 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]. Nowadays the particulate reinforced aluminium composites are gaining importance because of their low cost with advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components. Cast

aluminium matrix particle reinforced composites have higher specific strength, specific modulus and good wear resistance as compared to unreinforced alloys. Generally, a Metal Matrix Composite (MMC's) is composed of reinforcement (fibers, particles, flakes) embedded in a matrix (metals). The matrix is monolithic material into which reinforcement is implanted & which is completely nonstop. The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, bottom ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion.

2. LITERATURE SURVEY

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. Anilkumar et.al. (2013)This paper studies about the mechanical and tribological behaviour of reinforced AMC composite by varying Fly ash particle size. Three sets of composite with fly ash particle size 75-100µm, 45-50µm and 4-25 µm was prepared and comparison study was made with Aluminum . The result showed significance decrease in mechanical behaviour such as compressive strength, tensile strength and hardness with increase in particle size of fly ash in AMCs composite with uniform distribution of fly ash. 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.

3. 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 spectrum of the applications in the industrial sectors. A356 based alloys have been developed with considerable 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.

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

Element	Cu	Mg	Si	Fe	Mn	Ni	Pb	Sn	Ti	zn	AI
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 available in large quantities as solid waste by-product during burning of coal in thermal power plants. Hence, composites with bottom ash as reinforcement are likely to overcome the cost barrier for wide spread applications in automotive & space craft, aircraft, military, marine Applications.

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

Element	SiO2	Al2O3	Fe2O3	TiO2	MgO	CaO	MnO	ZnO	CuO	P2O5	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

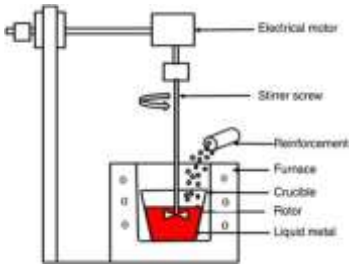


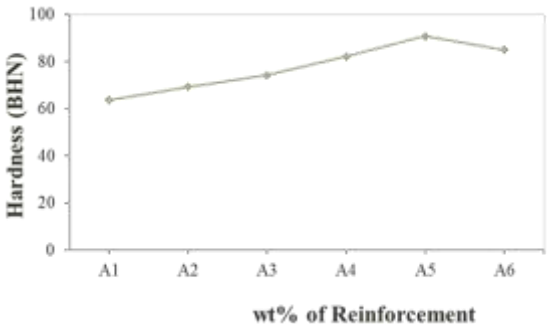
Figure 3.31: Schematic diagram of mechanical stir casting route

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^{o} C. Once A356 gains molten form add scum powder degasing tablet to it scum powder is used to remove slag, flux from the molten metal. degasing 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.

4. RESULTS AND DISCUSSION

4.1 Effect of Bottom Ash Particle Addition on the Hardness

The Brinell hardness tester was used to carry out the hardness tests. The Binell hardness tester was used to carry out the hardness tests. The average value of the tests done at three different locations was considered as the hardness value of the composite specimens.



Graph -4.1.1: Evaluation of Hardness for samples with various Wt % of bottom ash.

It was observed that the hardness of aluminium matrix composites can be improved with the increase in Bottom Ash Content, reaches a maximum value of Bottom ash and then hardness decreases.

4.2 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.

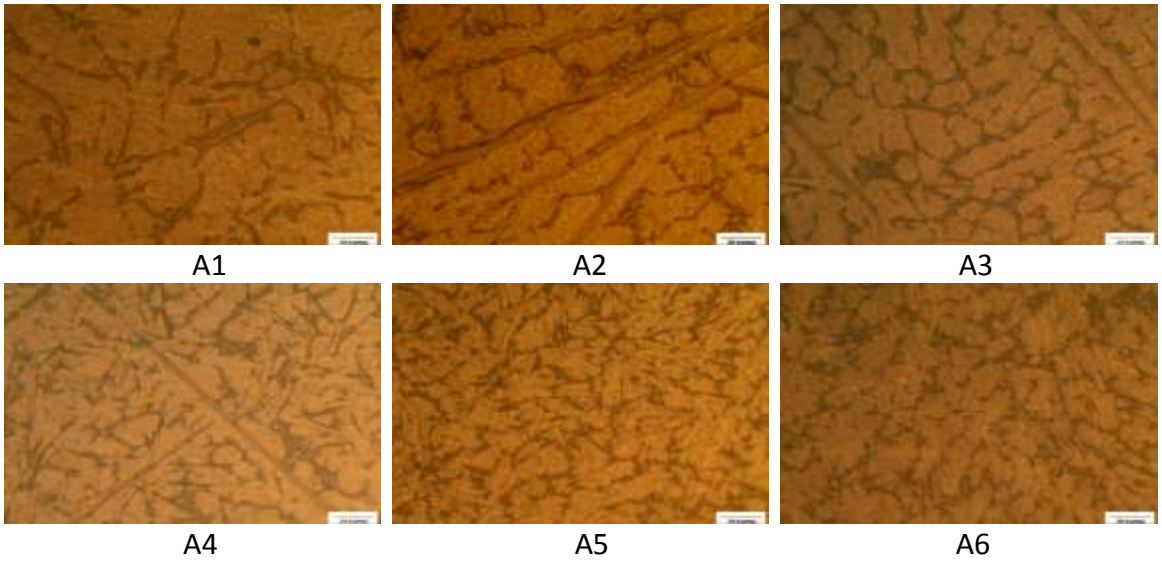
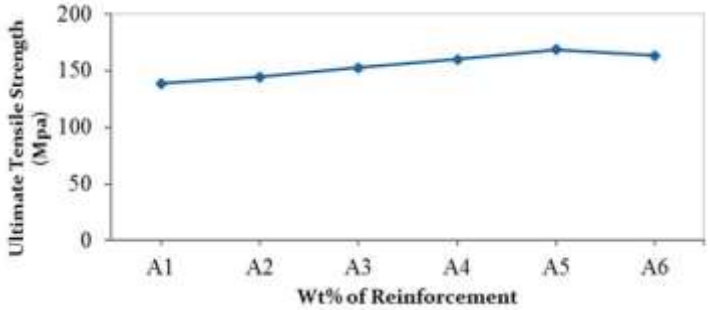


Figure 4.2.1: Microstructure of As-cast A356 composite (A1,A2,A3,A4,A5,A6)

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

4.3 Tensile test

The set of specimens were loaded in uni-axial tensile testing machine as per ASTM E8 standards and loaded until the failure of the sample occurs.



Graph 4.3.1: Evaluation of UTS for samples with various Bottom ash Compositions

It is noticeable from Graph 2 the ultimate tensile strength(UTS) gradually increases with increase in weight % bottom ash reinforcement particles. Reaches a maximum value of Bottom ash and then decreases.

5. CONCLUSION

The present study is an overview of latest research works on A356. This paper will give a brief information about recent research and development of Bottom ash (BA) obtained from coal power plant, the result and discussion made by scientist and researches shows huge potential in the market to decrease the weight and cost by adding Bottom ash.

1. Reinforcing Aluminum & its alloys with bottom ash may show an appreciable increase in its mechanical properties.

2. Hardness of the composites was determined by using brinell hardness testing machine as we found increased in the BHN at A6 wt%.
3. Microstructural observation shows that addition of Bottom ash leads to agglomeration.
4. Addition of bottom ash in aluminum may improve the yield strength; tensile strength, etc… while ductility decrease.

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