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Study of Mechanical Properties of A356 Reinforced with Bottom Ash for Automotive Application.

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ABSTRACT

In the present investigation, the Aluminium Matrix Composites (AMCs) A356 are Reinforcement with the Bottom Ash (BA) particulate through the stir casting process, here for As-cast material through which we can fruitfully obtained the Hardness, Corrosion and Microstructure mechanical properties for automotive and industrial Applications. This paper also describes the fabrication and testing of Aluminium (A356) metal matrix composites (MMCs) and reinforced with the bottom ash particulate with different (0% to 10%) wt%. Bottom Ash reinforcement particulate in Aluminium (A356) not only promotes the use of by product and also increases the mechanical properties of A356. Significant improvements in Hardness and Corrosion are easily seen as the wt% of the bottom ash amount with the unreinforced matrix.

Key words: A356 alloy, Bottom Ash, BHN, Corrosion, Micro Structure ,Stir Casting.

1. INTRODUCTION

Aluminium (A356) is well-liked matrix for the metal matrix composites (MMCs). The aluminium alloys are good – looking due to their high vibration damping capacity, good corrosion resistance, high electrical and thermal conductivity, low density and their ability will become stronger by precipitation. They offer a great variety of mechanical properties depending on the Aluminium matrix chemical composition. They are usually reinforced by silicon dioxide, silicon carbide, aluminium oxide, graphite, boron carbide, boron nitride etc. In the 1980s, transportation Industries are began to develop discontinuously reinforced with aluminium matrix composites .They are quite attractive for their low costs and for their isotropic, mechanical properties. These properties are naturally a compromise between the properties of the reinforcement and matrix phases. It is shown that the properties and composition of the matrix phase are affects the properties of the composites both directly by normal strengthening mechanisms, and indirectly by chemical composition at the matrix / reinforcement interface. Aluminium based composites, are reinforced with the ceramic particles, offer improvements for the matrix alloys, an elastic modulus greater than that of aluminium, a co- efficient of thermal expansion which is closer to that of cast iron (or) of steel, a higher resistance to wear and shows an improvement in rapture stress especially high temperatures and possibly improvements in resistance to thermal fatigue.A356 aluminium alloys are widely used in the applications for tribological and mechanical components of IC engines,

such as pistons, cylindrical heads, cylindrical blocks etc. owing to their high corrosion resistance, low density and good cast ability. However, they exhibit poor seizure resistance, which don't allow to uses in mechanical and tribological environments. The wear resistance of these alloys can be improved by addition of a ceramic phase in the aluminium alloy matrix. Discontinuous bottom ash particles reinforced with the MMCs are quite attractive because they show very good specific properties and can be shown by conventional metal working processes. Hence they are widely used in the automotive Industry as materials for brake rotors, pistons, liner and calipers.

2. LITERATURE SURVEY

Grigories Itskoset et. al (2011) In this report the author has studied about the A356 alloy and Fly ash reinforcement were proceed by using the pressure Infiltration technique, by utilizing metal matrix composites (MMCs) and class C Fly ash (FA) has a good combination of physical , tribological and mechanical properties and their usage remains limited on the amount of their large production cost. The fly ashes were separated for different sizes by manually, by using the different sieves. It was found that the fine fly ash particles have low friction co-efficient .It was finally found that the Fly ash particles have strong advantage to the properties of the composites.Shashi Prakash Dwivedi et .al (2014) In this report the author reveals about the Electromagnetic Stir casting process of A356 alloy and SiC reinforced composites. In this paper ,A356/SiC aluminium matrix composites with different wt% of reinforcements (15%, 10% and 5%) through the Electro Magnetic stirrer and shows the significant increases in the mechanical properties such as fatigue, microstructure homogeneity etc.,H.R Ezatpour et.al (2013) In this report the research scientists deals with the various tribological and mechanical properties like yield strength, ultimate Tensile strength, Hardness with mass fraction of Aluminium (Al_2O_3) .The Composites were prepared by using stir casting process, In this report the author also gives information about the various parameters like speed, time etc., considered during stir casting method .Anil Kumar et.al (2013) In this paper the author has studied about the tribological and mechanical behaviour of reinforced Aluminium Metal Composites (AMC) by varying with the Fly ash particle size. Three sets of Fly ash particle sizes 4-25 µm, 45- 50 µm, 75-100 µm was prepared and made comparison study aluminium. The results show that decrease in mechanical properties like hardness, Tensile strength, Compressive strength with increase in the Fly ash particle size. Sridhar H.S et.al (2017) In this paper the author has studied about the mechanical behaviour of Aluminium Metal Composites (AMCs) reinforced with Bottom Ash .The Composites were prepared by using stir casting process. In this paper the author also gives information about the various parameters like speed, Injection time etc., considered during stir casting process. The results show that Increase in mechanical properties like hardness, Tensile strength, and microstructure.Dinaharan et.al (2016) In this paper author has studied about the different characteristics of Aluminium Metal Composites (AMCs) reinforced with the Fly ash particulate and author deals with the friction Stir casting methods such as scanning electron microscopy ,optical microscopy and Electron backscattered diagram. The results obtained from the composites shows the significant increase in wear resistance and micro hardness.

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3. MATERIALS AND METHODOLOGY

3.1 A356 alloys

Among various series of aluminium alloys, A356 alloys are more popularly used alloys because of its good properties. Basically A356 is an alloy of aluminium, silicon and magnesium, which exhibits moderate strength, has excellent extruability and highly resistant to corrosion. A356 aluminium alloys are more popular used in the field of automotive, construction and marine applications. A356 aluminium alloys are prepared by considering strength, ductility, hardness, elongation and toughness in as- caste state at room temperature.

Table 3.1.1 Chemical Composition of A356 alloys, wt%

Elements	Al	Cu	Mg	Mn	Fe	Si	Ti	Zn	AI
Percentages	93.3	0.2	0.35	0.1	0.33	7.4	0.2	0.1	REM

Fig 3.1.1 A356 alloy grains

3.2 Bottom Ash

Bottom ash is a part of the non –combustible residue of combustion in a furnace. It is one of the low density and inexpensive reinforcement available in very large quantities as solid waste by – product obtained during burning of a coal in thermal power plant Raichur. Hence, A356 composites with bottom ash reinforcement are like to overcome a cost barrier for wide spread applications in aircraft, automotive space craft military and marine applications.

Table 3.2.1 Chemical composition of Bottom Ah, wt%

Elements	Fe_2o_3	Sio_2	Al_2O_3	CaO	TiO2	MgO	CuO	ZnO	MnO	P_2O_5	LOI
percentage	4.90	65.50	16.21	2.80	1.20	0.75	0.040	0.020	0.12	0.080	REM

Figure 3.2.1 Bottom Ash

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3.3 Mechanical Stir Casting Process

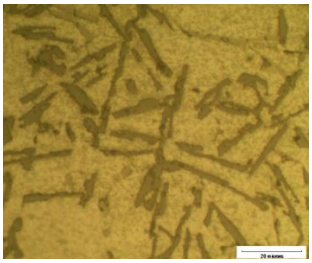
Figure 3.3.1 Mechanical Stir Casting

Crucible which is made up of mild steel, should be clean, preheat the mould up to 580c.Put the A356 alloy grains in to the crucible and maintain the furnace temperature around 750- 800c. Once A356 alloy grains in the molten form, add degassing metal scum powder to it. Degasing tablet (EXO-CHLORO ETHANE) is used to remove the unwanted gasses and Scum powder is used to remove slag, flux from the molten metal. Pre-heat the reinforcement particles up to 500c and pour the reinforcements in to the metal mould with (10%8%, 6%, 4%, 2%, and 0 %) each trail. Using a mechanical stirrer, reinforcements are stirred well in a molten metal for about 15 mins with a speed of 550 RPM. Then the molten metal mixture is poured in to a mould and allowed to cold.

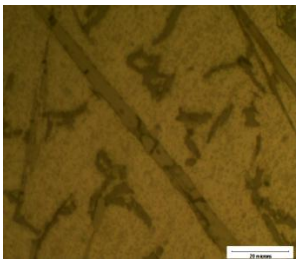
4 RESULTS AND DISCUSSION

4.1Micro Structure

The Metallurgical Microscope has been used for the microstructure test. The study of microstructure can conclude that there is a homogeneous sharing of reinforcements in the alloy metal matrix .The bonding between particulates is satisfactory and finer grains of alloy matrix are found below .



A1



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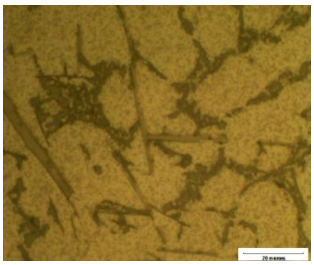

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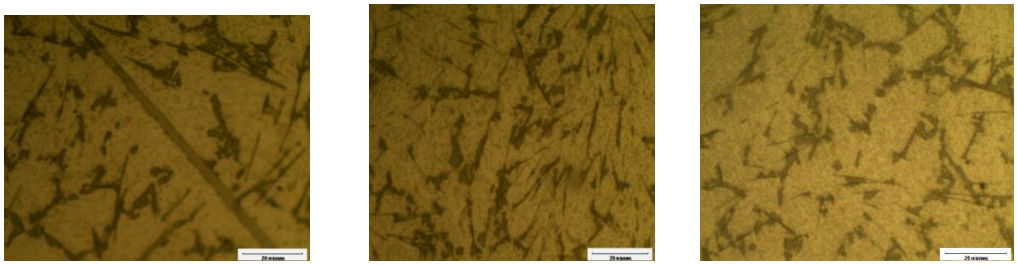

A4 **A5** **A6**

Fig 4.2.1 Microstructure of A356 composites for As- Cast

4.2Addition of Bottom Ash Reinforced Particle on the Hardness

The Brinell hardness tester was used to carry out the hardness test. In this test a permanent indentation is made on the material using a hardened steel ball of specified , diameter under a standard loading .The hardness is expressed as the ratio of the applied load to the area of the indentation. It was shown that the hardness of aluminium metal matrix composites can be developed with the increase in bottom ash wt%, reaches a maximum value and then they decreases.

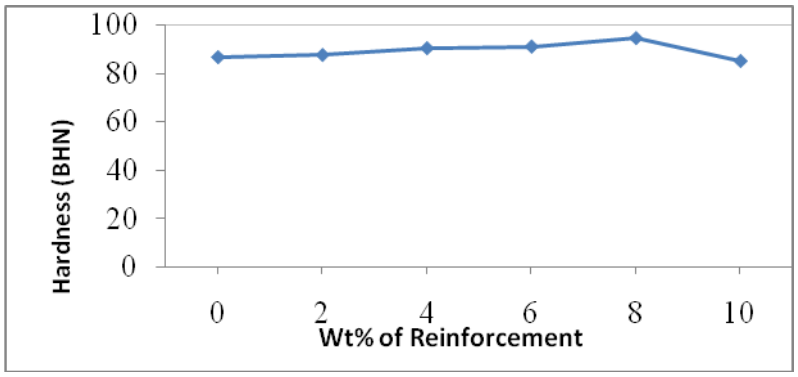

Fig 4.2.1 Evaluation of Hardness with different wt% of Bottom ash for various samples

4.3 Corrosion Test by Weight Loss Method

When the metals are put in to the glass breakers with Nacl solution up to the 50ml in the breakers. For each trial we want to check the weight of the metals by the timings of the 24, 48, 72, hrs etc… up to the weight reduces by the weight loss method. It was shown that the corrosion rate of aluminium metal matrix composites can be developed with the increase in bottom ash wt%, reaches a maximum value and then they decreases.

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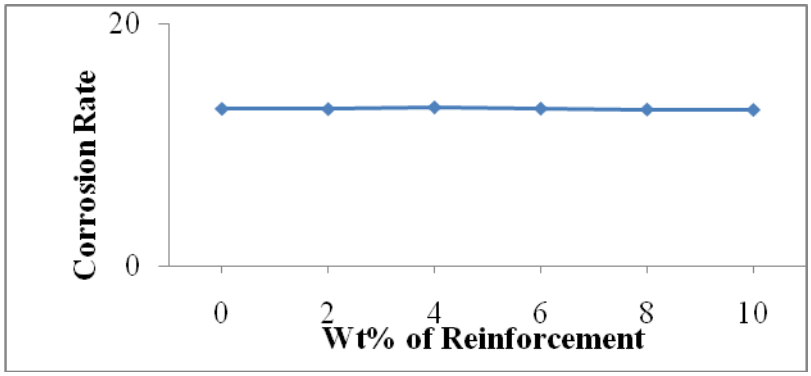

Fig 4.3.1 Evaluation of corrosion rate with different wt% of Bottom ash for various samples

5. CONCLUSION

The present study is an overview of latest research works on A356 .This paper will give brief information about recent research about development of Bottom Ash (BA) obtained from Raichur thermal power plant, the researches, result and discussion shows that huge potential in the market to reduce the weight and low cost by addition of Bottom Ash (BA) reinforced particulate.

- Aluminum (A356) and its alloys reinforcing with Bottom Ash (BA) particulate shown an appreciable increase in its mechanical properties.
- Aluminium (A356) alloy with reinforcement Bottom Ash (BA) particulate was fruitfully manufactured by stir casting process.
- Micro structural observation shows the addition of Bottom Ash leads to accumulation.
- Addition of Reinforcement till 8% wt increases mechanical properties and then we found decrease.
- Hardness of the composites was determined by Brinell Hardness Testing Machine as we found increase in the BHN at 8% wt.

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