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Comparison of Mechanical Properties of Al-5%Si Alloy Reinforced with Cow dung ash and Rice husk ash

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ABSTRACT: To satisfy the global need of material with reduced weight, high strength, low cost, research in the field of materials has shifted from monolithic to composite materials. The present work discusses thedevelopment of a newer metal matrix composite material using Al-5%Si alloy as base material and reinforcing it with cow dung and ricehusk ash. Both the ashes are added separately with the varying volume percentageof 2%, 4% and 6 % and fabricated using stir casting process. Microstructure and Hardness of the fabricated composite are beenStudied and compared.

KEY WORDS: Cow dung ash,hypoeutectic aluminum silicon alloy,MMC, Mechanical properties, Rice husk Ash.

I. INTRODUCTION

InAutomotive industries, aluminum based alloys and its MMCs are widely used mainly due to its low weight leading to low fuel consumption. Aluminumbased MMCs are gaining huge industrial significance because of theiroutstanding combination of mechanical, physical and Tribological properties over thebase alloys. These properties include high specific strength, high wear and highstiffness, better high temperature strength, controlled thermal expansion coefficient and improved damping capacity. In recent years, interest to carry out research is in the field of MMCs is focused on use of low density and low cost reinforcements. Many reinforcements like SiC, Al_2O_3, glass,graphite, fly ash, rice husk ash etc., are commonly used.Butrice husk ash [1-3] is one of the solid waste byproduct obtained as a residue from the rice mill, whichhas lowdensity, isinexpensive and available in large quantities. Therefore Rice husk ash is utilized as most economical reinforcement.Many researchers have worked using RHA as reinforcement varying the volume of particulate added as well as the size of the particulate. Al based MMCs are been fabricated using powder metallurgy technique [4], stir casting [5], squeeze casting [6] etc. The economical route for producing aluminum based MMCs is stir casting method. But the main problem in stir casting process is non-uniform mixing and distribution of the reinforcement particles in the matrix, and this is due to reduced wettability of the reinforcing particles with the melt and this can be overcome by adding Mg powder during the process. In the present work cow dung ash (CWA) and Rice husk ash (RHA) is used as reinforcements for Al-5%Si alloy base material. Stir casting technique is used for fabricating the MMCs. From literature it is seen that, using RHA as reinforcement enhances the Mechanical properties [7], wear[8]and corrosion resistance [9].

Purpose of using Cow dung ash as reinforcement material

Earlier in olden days, cow dung wascaked and dried and theobtained solid was used as fuel. Dung is used to produce biogas which can be further used to generate electricity and heat. Recently Cow dung is used to manufacture of adobe mud brick housing and in cold places, cow dung is used to line the walls of rustic houses as a cheap thermal insulator. In this work an effort has been made to explore the advantage of using CWA as reinforcement on the mechanical properties of Al-5%Si based MMCs and obtained results are been compared with the properties of Al-5%Si alloy reinforced with RHA.

II. EXPERIMENTAL DETAILS

The base material, Al-Si alloy with 5%Si is prepared by melting commercially pure aluminum (99.7%) and commercially pure silicon (99.5%) in a graphite crucible in a high frequency induction furnace and the melt was held at 720 °C in order to attain homogeneous composition. After degassing with 1% solid hexachloroethane, 0.1% Al-Ti master alloy was added to the melt for modification of microstructure. Melt was stirred for 30s after the addition of the modifier, held for 5 min and then poured into a cubical graphite mould surrounded by fireclay bricks. The raw cow dung and rice husk were bought and burned with help of kerosene for complete combustion and after the combustion ashes were collected in a polythene cover. The base material and the RHA and CWA used in the work are shown in the Fig.1.

(a) (b) (c)

Figure.1 (a) Al-5%Si base material (b) Rice husk ash (c) Cow dung ash

Cow dung ash is filtered with the help swirling machine and grain sizes of 300- 800 microns were collected. Ashes were given to the chemical analysis to get the chemical composition. The chemical composition of Cow dung and Rice husk ashes is given below in the table 1

Table 1 Chemical composition of Cow dung and Rice husk ash

Compound/element (constituent)	RHA wt.%	CWAwt. %
Silica (SiO_2)	94.04	69.65
Aluminum oxide (Al_2O_3)	0.249	4.27
Calcium oxide(CaO)	0.622	12.55
Magnesium oxide(MgO)	0.442	2.22
Potassium oxide (K_2O)	2.49	2.94
Hematite(Fe_2O_3)	0.21	-
Silver (Ag)	trace	-

The stir casting machine and electric induction furnace used for fabricating the MMCs is shown in the Fig. 2.maximum temperature of the furnace is 1500^0c and graphite crucible of capacity of 1.5 kg is used for melting

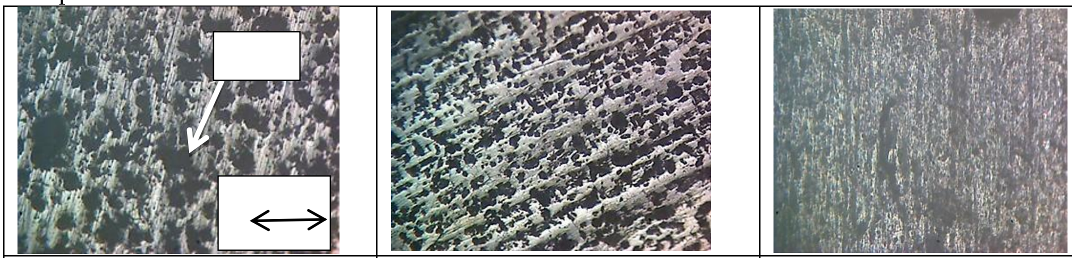
Figure 2 Stir casting setup with furnace

During melting 800^0c was maintained as super heat temperature, once the temperature is reached and maintained the slag is removed with the help of slag remover.Stirrer is then adjusted for stirring action.Stirrer is then switched on and set for a required speed.Cow dung and Rice husk ashes is added individually at varying percentage of 2%, 4%, 6% to get six testing samples. Later allowed for stirring action to complete 30-45sec approx. Magnesium is added to increase the wettability of a molten metal and to get uniform distribution of ash.After 30-45sec of stirring action, stirrer is switched off and stirrer is removed from the crucible, and molten metal is poured to metal mould and allowed it to cool under normal atmospheric air.From the cast obtained,test specimens to carry out wear, microstructural studies, measuring hardness, tensile strength are prepared using ASTM standards.

III. RESULTS AND DISCUSSIONS

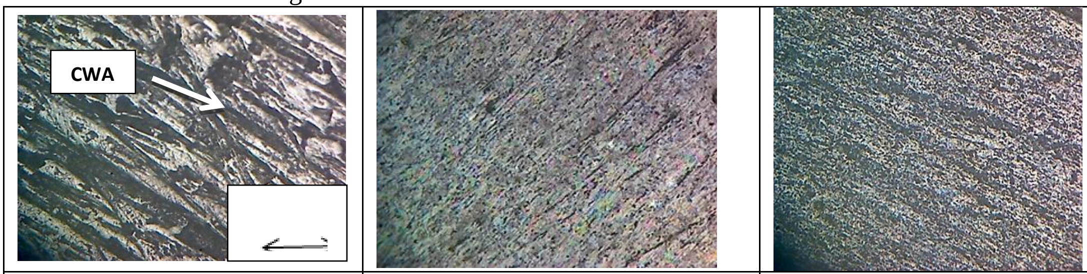
3.1 MICROSTRUCTURE

The microstructure of the composite after casting was examined to study the effect of Rice husk and cow dung ash with varying percentage on polished section of each sample. The specimens were prepared for metallographic examinations using emery papers varying from 220 to 3000 grit followed by polishing with diamond paste.



(a) 2%RHA	(b)4%RHA	(C) 6%RHA

Figure 3 Microstructure of Al+5%Si with rice husk ash



(a) 2%CWA	(b) 4%CWA	(c) 6%CWA

Figure 4 Microstructure of Al+5%Si with cow dung ash

From the Fig. 3 and Fig. 4, it can be seen that there is good dispersion of the particulates in the Al-5%Si base material and reinforced particulates of RHA and CWA particulates are visible respectively. From Fig. (b) and Fig. (c), it can be seen that volume of particulates increases as the percentage of addition increases from 2% to 4% and 6%. Comparing the microstructure in Fig. 3(a) and 4 (a), it is seen that RHA is more granular in shape compared to CWA and since density of CWA (1000kg/m^3) is less than RHA(1063kg/m^3),maximum quantity of the ash is seen on the top surface of the specimen.

3.2 HARDNESS MEASUREMENT

Hardness measurement was carried out using a Vickers hardness tester. Before testing, specimen surfaces were polished using emery papers of 1000 mesh. Two reading was taken on horizontal surface of the specimen and two on the vertical surface. The results obtained for Al+5% Si alloy with varying percentage of rice husk ash is shown in Fig.5 and for Al+5% Si alloy with varying percentage of cowdung ash is shown in Fig. 6.Hardness values are almost same on the horizontal and vertical surface indicating that mixing of reinforcement with base melt is uniform. For RHA maximum hardness is seen in 6% reinforcement compared with 2% and 4%, this may be due to high percentage of SiO_2 present in the ash. But with CWA reinforced specimen, hardness Value is maximum at 2% reinforcement; even though the porosity is high 84.3%,this indicates that cow dung ash can be used for metal foaming. CWA can be used for making metal foam as it reduces the density at the same time gives better mechanical properties as it can be seen with the higher hardness values.

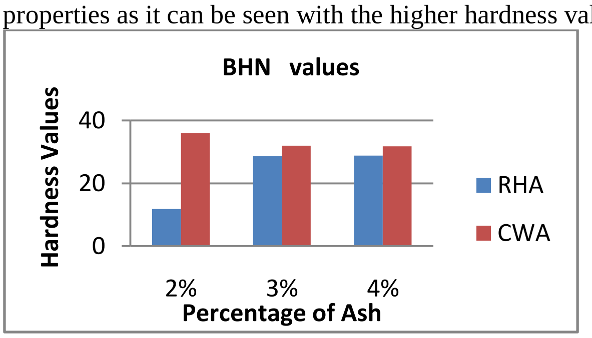


Figure 5 BHN values for RHA and CWA along the horizontal surface

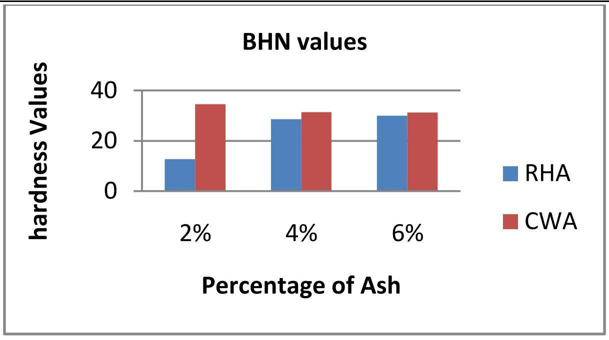


Figure 6 BHN values for RHA and CWA along the Vertical surface

IV. CONCLUSION

From past research work, it is observed that different types of ashes can be successfully used as reinforcement material in making of MMCs. In the present work two types of ashes are been used i.e. Rice Husk Ash(RHA) and Cow Dung Ash(CWA) as reinforcement material with base material as Al+5%Si alloy and following results can be concluded .

- Hardness value obtained for CWA reinforced specimen is higher than that of specimen reinforced with RHA. So CWA is a better reinforcement material than RHA.
- With 2% CWA, hardness value and porosity percentage is high compared with other specimen
- Specimen reinforced with 2% CWA showed better hardness value with higher porosity level, so this can be used for metal foaming, as it reduces the density with better mechanical properties.

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