STUDY ON WEAR PROPRTIES OF RICE HUSK ASH AND FLY ASH REINFORCEMENT IN ALUMINIUM (AL 6061) METAL MATRIX COMPOSITES

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Abstract
The applications of Aluminum metal matrix composites are growing rapidly in various engineering fields due to their good mechanical properties. In the present study it is proposed to fabrication of aluminum alloy metal matrix reinforce with locally available inexpensive rice husk and fly ash. A rice husk and fly ash particles of 5%, 10% and 15% each by weight are proposed to develop metal matrix composites using stir casting technique. The mechanical properties like tensile strength, hardness, and percentage elongations are to be studied for aluminum metal matrix composites.

Key words: Aluminum 6061, Rice Husk, Fly Ash, Stir Casting.

I INTRODUCTION

In the present work, fly-ash which mainly consists of refractory oxides like silica, alumina, and Iron oxide is used as reinforcing phase. Composite was produced with rice husk ash 5%, 10%, 15% and 5%, 10%, 15% fly-ash as reinforcing phase, Commercially pure aluminum was also melted and casted. Then particle size and chemical composition analysis for Rice husk ash and fly-ash were done. Mechanical, physical and wear properties of the composite were evaluated and compared with the commercially pure aluminum.

Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. Burning the husk under controlled temperature below 800 °C can produce ash with silica mainly in amorphous form. Recently, Nair et al. reported an investigation on the pozzolanic activity of RHA by using various techniques in order to verify the effect of incineration temperature and burning duration. He stated that the samples burnt at 500 or 700 °C and burned for more than 12 hours produced ashes with high reactivity with no significant amount of crystalline material. The short burning durations (15 - 360 minutes) resulted in high carbon content for the produced RHA even with high incinerating temperatures of 500 to 700 °C.

1.1. MATERIALS:

The matrix material used in the experiment investigation was commercially AL6061. The fly ash was collected from M/S Lakshmi casting, Balanagar, Hyderabad, India. The particle size of the fly as received condition lies in the range from (0.1-100 μm). Rice husk ash used was obtained from local rice mill .The Specific gravity of rice husk ash is 2.10 and bulk density is 0.781 g/cc RHA, produced after burning of Rice husk (RH) has high reactivity and pozzolanic property. Indian Standard code of practice for plain and reinforced concrete, IS 456- 2000, recommends use of RHA in concrete but does not specify quantities. Chemical compositions of RHA are affected due to burning process and temperature. Silica content in the ash increases with higher the burning temperature.

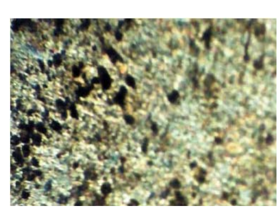


Fig.1 Fly-Ash

Fig.2 Rice –Husk

Composite mixing by volume:

- RICE HUSK ASH---5, 10, 15%
- FLY ASH---5, 10, 15%.
- Percentage volumes of aluminum alloy 71%.
  Other substances and add mixtures to improve casting quality.
  Al_2O_3-3%
  Hexa chloro-methane-4%
  Magnesium -2%.

II. METAL MATRIX COMPONENT (MMC) PREPARATION PROCEDURE

The systematic procedure involved on the stir casting technique is as below.

1. Heat the 3 kg of Al6061alloy pieces in the furnace and it will get melt at 750^0 C. and care is taken to achieve 100% melting.
2. Slag is removed using scum powder to avoid the bad quality of casting.
3. Measure the 15% of fly ash (reinforcement) by weight, the same quantity of husk ash has been added and is pre heated to 450^0C-600°C and maintained at the same temperature for about 20 minutes to remove the moisture content.
4. Measure the 3% of alumina (Al_2O_3) by weight and is also preheated.
5. Take less than 5% weight of solid dry hexa-chloro-Methane tablets to degas the molten metal at a temperature of 780°C.
6. Now start stirring the molten metal to create a vortex. Add slowly pre heated fly ash and alumina to the molten metal with temperature maintained at more than720°C.
7. Add magnesium about more than 2% of weight to ensure good wettability with continuous stirring at a speed of 350-500 rpm to a time of 6-8 minutes.
8. At the same time preheat the mould to avoid shrinkage of casting material.
9. Then the melted matrix with the reinforced particles is poured into the preheated moulds 160x40x25 size and the pouring temperature should be maintained at 680°C.

Finally withdraw the specimens from the mould after 3 to 4 hours. And confirm the solidification of casting before removing from the mould.

2.1 MELTING AND CASTING

The aluminum fly ash metal matrix composite was prepared by stir casting route. For this we took 380gm of commercially pure aluminum and desired amount of fly ash particles. The fly ash particle was preheated to 300^0C for three hour to remove moisture. Commercially pure aluminum was melted in a resistance furnace. The melt temperature was raised up to 720^0C and it was degassed by purging hexa chloro-ethane tablets. Then the melt was stirred with the help of a mild steel turbine stirrer. The stirring was maintained between 5 to 7 min at an impeller speed of 200 rpm .The melt temperature was maintained 700^0C during addition of fly ash particles. The dispersion of fly ash particles were achieved by the vortex method. The melt with reinforced particulates were poured into the preheated permanent metalic mold. The pouring temperature was maintained at 680^0C.The melt was then allow to solidify the moulds. The composites were made with a different amount of fly-ash (i.e.5, 10, 15, wt %), Magnesium and silicon were added to increase the wettability of fly ash particles.

The influence of rice husk ash (RHA) and silicon carbide (SiC) weight ratio on the mechanical behavior of Al-Mg-Si alloy matrix hybrid composites. RHA and SiC mixed in weight ratios 0:1, 1:3, 1:1, 3:1, and 1:0 were utilized to prepare 5, 10 and 15% wt of the reinforcing phase with Al-Mg-Si alloy as matrix using two-step stir casting method. The husk was allowed to burn completely and the ashes removed 24 hours later. The ash was then heat-treated at a temperature of 650^oC for 180 minutes to reduce its carbonaceous and volatile constituents. Two step stir casting process was utilized to produce the composites. The process started with the determination of the quantities of rice husk ash (RHA) and silicon carbide (SiC) required to produce 5, 7.5, and 10 wt% reinforcement consisting of RHA and SiC in weight ratios 0:1,1:3, 1:1, 3:1, and 1:0 respectively (which amounts to 0, 25, 50, 75, and 100% RHA in the reinforcement phase). The rice husk ash and silicon carbide particles were initially preheated separately at a temperature of 250^oC to eliminate dampness and improve wettability with the molten Al6061alloy. The Al6061alloy billets were charged into a gas-fired crucible furnace (fitted with a temperature probe), and heated to a temperature of 750$^oC \pm 30^oC$ (above the liquid temperature of the alloy) to ensure the alloy melts completely. The liquid alloy was then cooled in the furnace to a semi solid state at a temperature of about 600^oC.

III MICROSTRUCTURAL ANALYSIS (O.M)

1st sample with 15%fly ash and 5%rha

Fig.3. 1st Sample With 15%Fly Ash And 5%Rha

2nd sample with 10%fly ash and 10%rha

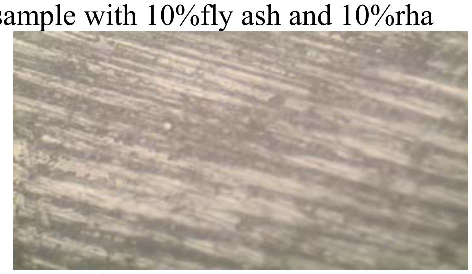


Fig.4. 2nd Sample With 10%Fly Ash And 10%Rha

3rd sample with 5%fly ash and 15%rha

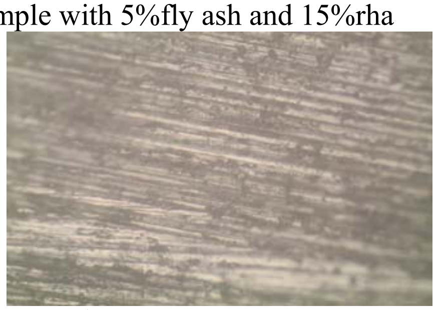


Fig.5. 3rd Sample With 5%Fly Ash And 15%Rha

IV MICRO STRUCTURE ANALYSIS (SEM)

1st sample with 15%fly ash and 5%rha

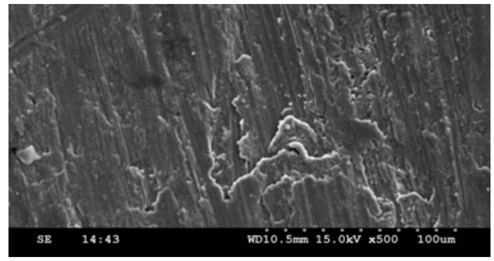


Fig.6. 1st Sample With 15%Fly Ash And 5%Rh

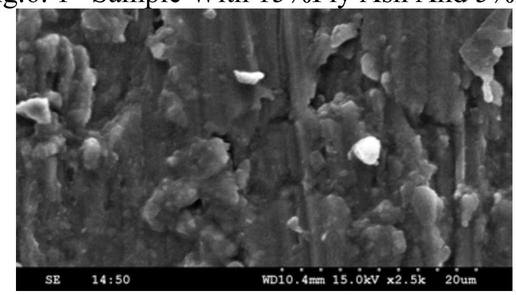


Fig.7. 1st Sample With 15%Fly Ash And 5%Rha

2nd sample with 10%fly ash and 10%rha

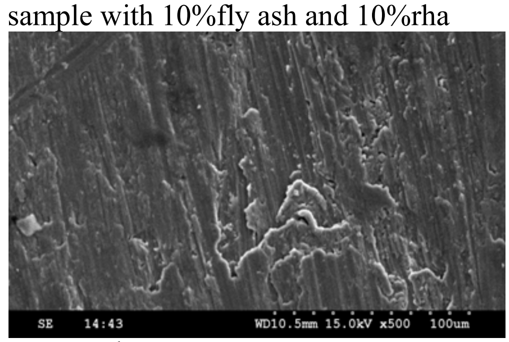


Fig.8. 2nd Sample With 10%Fly Ash And 10%Rha

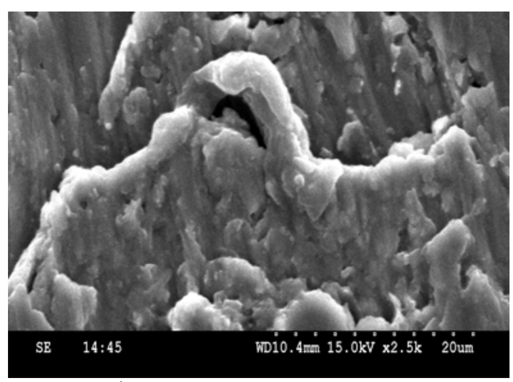


Fig.9. 2nd Sample With 10%Fly Ash And 10%Rha

3rd sample with 5%fly ash and 15%rha

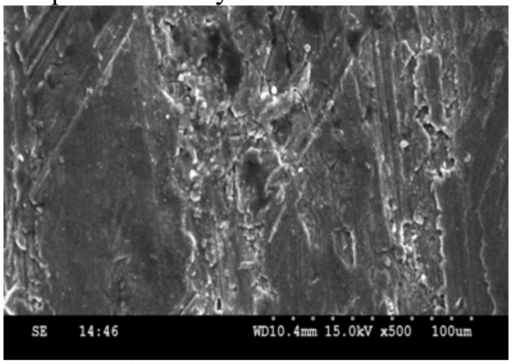


Fig.10. 3rd Sample With 5%Fly Ash And 15%Rha

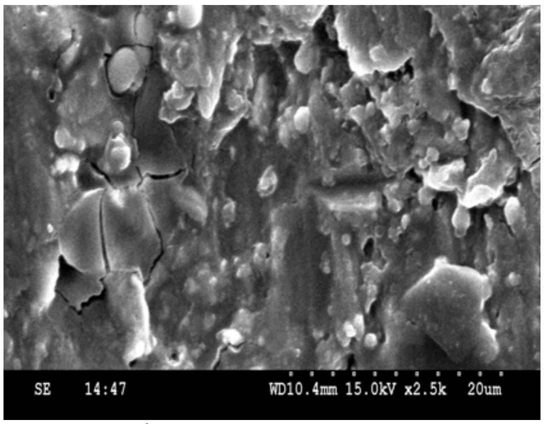
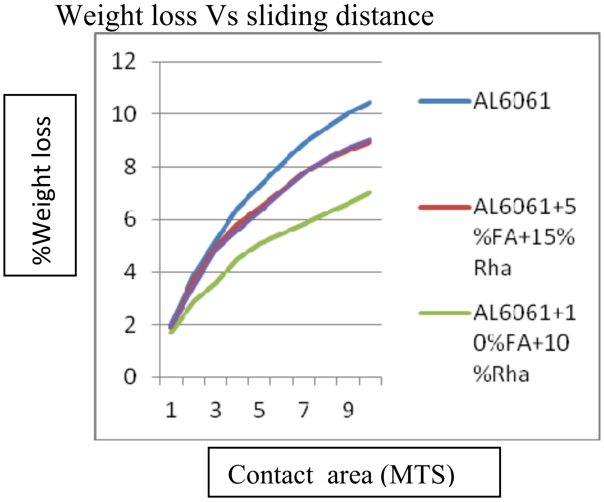


Fig.11. 3rd Sample With 5%Fly Ash And 15%Rha

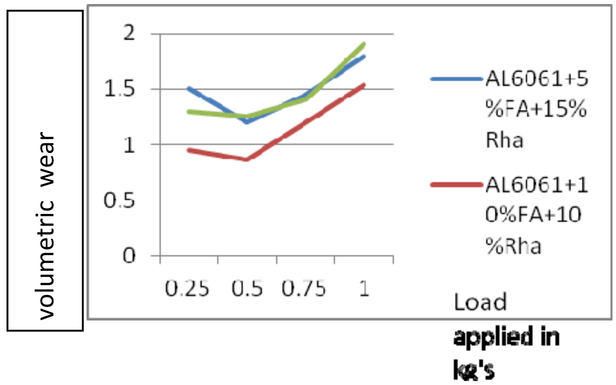
V WEAR RESISTANCE RESULTS

Weight loss Vs sliding distance



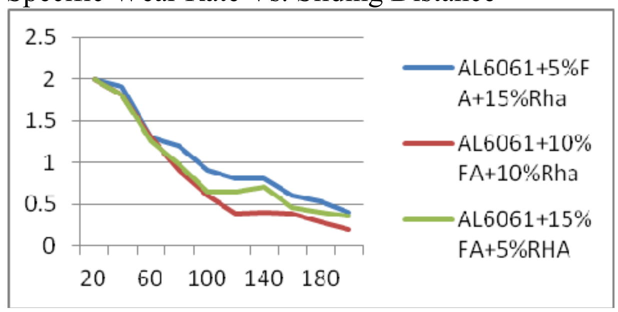
Graph 1.Weight Loss Vs Sliding Distance

Volumetric wear rate Vs Applied load.



Graph 2.Volumetric Wear Rate Vs Applied Load

Specific Wear Rate Vs. Sliding Distance



Graph 3.Specific Wear Rate Vs. Sliding Distance

CONCLUSIONS

1. It can be seen clearly that the weight loss of 3% AL6061 is maximum as compare to the other two composition of casted nano composite.
2. With increasing sliding distance, weight loss of casted nano composite first increases.
3. It is also noticed that with increasing the % of reinforcement in nano composite, weight loss increases.

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