Effect of Dispersoid Size on the Sliding Wear Behavior of Al-2014-10% SiC Composites

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Abstract -***In the present study Al-2014-SiC composite was prepared by liquid metallurgy (stir casting) technique with two different dispersoid size i.e. 20µm and 40µm size of SiC particles. These samples of Al-2014-SiC composite of different SiC particle size have different properties and mechanical behaviour. To evaluate its surface morphology SEM and optical microscopy also have been done. It was observed that composite with bigger size o particle have better sliding wear resistance than the smaller one.***

Key Words: *Al-2014 alloy, Composite, Sliding Wear, Dispersoid Size Effect.etc…*

1. INTRODUCTION

MMCs are very important, useful and attractive material for aerospace and automobile industries applications due to its unique properties such as high stiffness, strength and light weight. [1-3]
It is clear from the literature of MMCs that many researchers have been done on these materials regarding to its topological properties and microstructural features. In early days researches were focused on the microstructure and surface morphology of the metal matrix composites. They found that the micro structure and surface properties of aluminium metal matrix composite were mostly affected and varied due to heat treatment and machining parameters like time, load, feed etc. They also found that these properties also altered usen we change the volume fraction of the reinforcement this was proved in case of SiC dispersion in Al matrix. The basic reason of changing the properties due to heat treatment was the nucleation and growth of simultaneously finely and coarsely dispersed phases at the grain boundary of matrix reinforcement interface because heat treatments improve the uniformity of the material [4-8].
There is a wide space of researches which have been done to evaluate the properties o Aluminium metal matrix composites. If we move towards the synthesis o Al-MMCs than it is fully understood from the literatures the Al-MMCs have been previously prepared and synthesized by powder metallurgy routs, metal injection moulding, squeeze casting and stir casting routs, But powder metallurgy and stir casting are more popular and widely used method to synthesize Al-MMCs due to the simplicity and vary low processing cost included. [9-10]
Wear rate also depends upon the size o particulate ad its volume percentage in the matrix. Many investigators have to prove this statement. According to which if we increase the size and volume fraction of the particulate in the matrix than its wear resistance will increase and simultaneously its wear rate will decrease. Dispersoid size and volume fraction in matrix greatly affect other properties also like its corrosion resistance, hardness, tensile strength, fatigue resistance, tool wear and its microstructure. Al-MMCs with larger size of particulate were found to be more wear resistance than those with smaller particulate size. In previous articles of Al-SiC MMCs so far the volume fraction upto 15% was used. It has been also rereleased from the previous works and investigation that on decreasing the size of SiC particle and/or increasing its volume fraction the corrosion rate as reduced. Composite always shows better corrosion resistance than the pure matrix. If we talk about the hardness then on increasing the size of SiC particulate it will increase. Same as corrosion resistance the fatigue resistance also increase on increasing the volume percent and decreasing the size of SiC particulate. Similarly tool wear is less when the particle size is less and will increase on increasing the particle size. From the above discussion and the literatures we can conclude that reduced size of reinforcement and its increased volume fraction in MMCs is beneficial and better for production purposes [11-16].

Secondary processing of the Al-MMCs also greatly affect the properties of material this statement supported by many researchers. Some investigation reported that after extrusion of materials some of its properties will improve and enhanced. Extruded alloy and composite have better and enhanced mechanical properties than the cast alloy and composite and if we compare extruded alloy and composite than the composite is better than alloy. Al- alloy MMCs show increased micro and macro hardness, tensile properties and wear resistance. Extrusion of MMCs depends upon pressing pressure and billet soaking temperature. Extruded Al-MMCs exhibit less volume loss than cast Al-MMCs [17-23].

In the present study, different sizes of SiC particles have been reinforced in an Al-2014 alloy. The properties attained have been compared between the base alloy, cast composites on the basis of its microstructure and sliding wear resistance. This study will help in rehabilishing the property improvement attained which can in future help in commercializing such composites.

2. EXPERIMENTAL

The Chemical composition of Al-2014 alloy is shown in table1. Al-2014 SiC composites used in the present study were prepared by the liquid metallurgy technique having different particulate size 20µm and 40µm. For preparing the composites, constituents in appropriate proportions conforming to 2014 alloy system consisting of Al-4.4 Cu-0.5 Mg-0.8 Si-0.8 was melt in a gas fired furnace in a graphite crucible. Weighed and preheated dispersoids of size between 20 and 40 μm and 10 weight% as optimized earlier was poured into the melt after passing through a sieve. During insertion of the dispersoid, the melt was stirred constantly by means of a stirrer placed in the melt operated by a motor. The stirrer speed was controlled as required. After complete insertion of the dispersoids in the molten alloy, the alloy was simultaneously stirred and heated for some time for uniform mixing and temperature. The melt with the dispersoids were then poured into preheated permanent moulds of required size and shape. The chemical composition of the alloy was analysed using SPARKMET optical spectrometer (Model: SPECTRA) for confirmation. Heat Treatment of alloys and composites were carried out in muffle furnace heated to 495ºC maintained at that for 8 hour for solutionising then some sample quenched in water and some were furnace cooled. Samples cut from the cast and heat treated alloys and composites were used for metallographically polishing and etching in Kellar's reagent for metallographic studies. The samples were polished as per conventional polishing techniques after polished the sample metallographic etching was used to highlight features of samples at microscopic levels. Kellar's reagent used as etchant composition given in Table 6.1 The microstructures were observed in the optical microscope and/or JEOL scanning electron microscope operating at 20 kV in mode of electron transmission setup for SEM analysis.

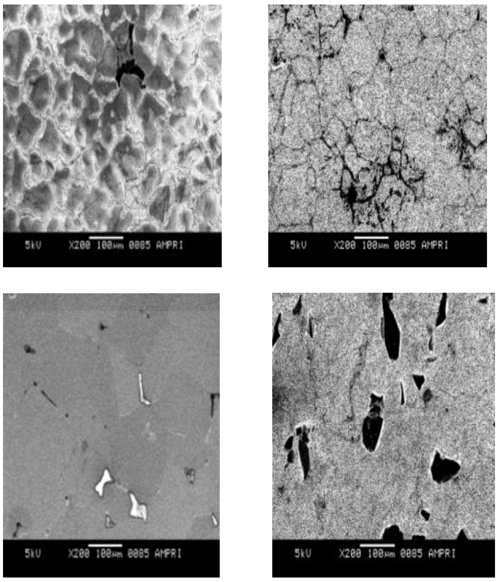
Table: 1

HF (ml)	HCl (ml)	HNO_3 (ml)	H_2O (ml)
2	3	5	190

Sliding wear properties of cast alloys and composite were evaluated on pin on disk wear testing machine, in which the pin was placed vertically. The pin was made to slide against a rotating stainless steel disc at predetermined speeds of rotation. . The 20mm diameter and 30mm length pin form samples were used for test at the end corners of sample small hole were produce to place the thermocouple pin. Test were carried out at loads of 1, 3 and 5 Kg and sliding speeds of 200, 400 and 640 rpm upto sliding distance 12,000m.

3. RESULT AND DISCUSSION

The different microstructural features of Cast 2014 Alloy and 2014-SiC composite as prepared, Heat Treated and Quenched condition are shown in Figure 1. In cast conditions the microstructure of alloy shows homogenous precipitate in the grain boundary and grain boundaries reveal bright. After the heat treatment dissolution of grain boundaries was observed and shows a granular structure with uneven size of grains and fine black deposit of CuMg. After Quenching of heat treated sample the bigger size of grains appear and the CuMg precipitate dissolved out and the structure seems to be uniform. The Cast composite of size show a near uniform distribution of the particulates and dendritic structure seen. After heat treatment grains were appearing but agglomeration of SiC particulates could be observed. On quenching the composite it has been observed that the particulate was uniform distributed along with the uneven large grain size.



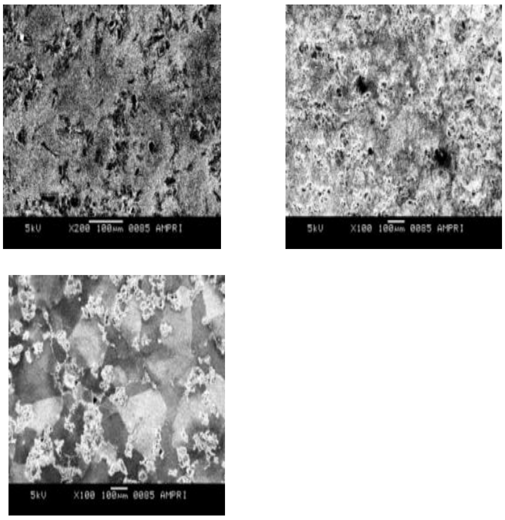
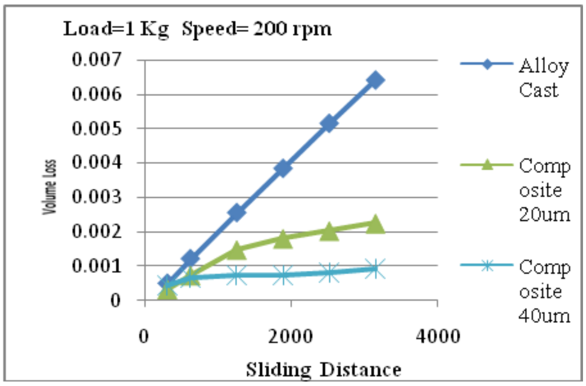
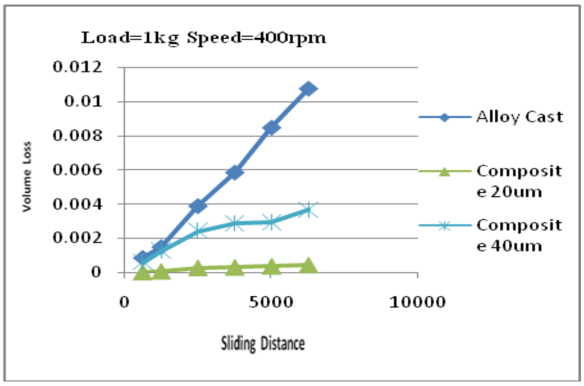
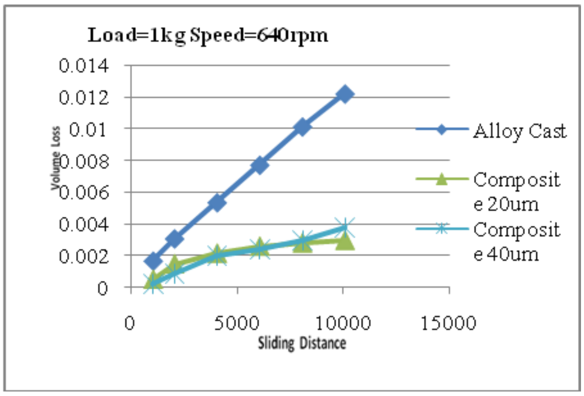


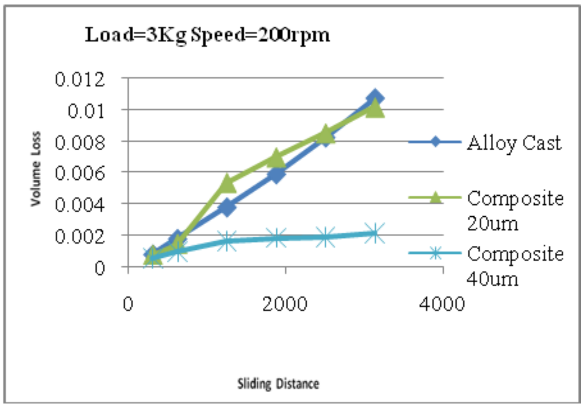
Figure1 Microscopic Images of Al-2014 Alloy and Al-2014-SiC Composite at Different Conditions: (i)Cast Alloy (ii)Heat Treated Alloy (iii) Quenched (iv)Composite (20μm) (v) Composite Heat Treated (vi) Composite Quenched (vii) Composite (40μm)

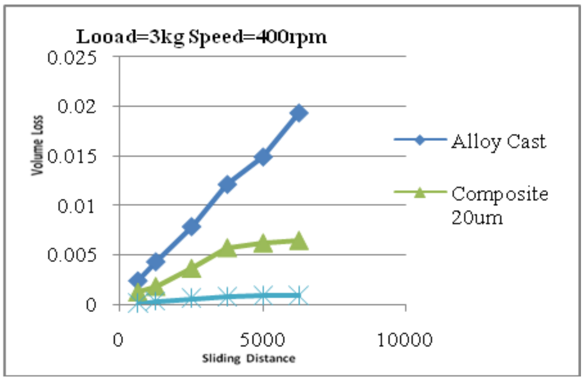
Sliding wear test carried out on cast alloy and composite under different load 1, 3, 5 Kg and different speed 200, 400, 640 RPM on pin on disk wear testing machine. Volume loss v/s sliding distance graph were plotted as shown in Figure5 for various condition. It is observed that the composite has lesser volume loss as compared to alloy due to SiC particle inclusion. On comparison of dispersoid size effect the observation shows that on increasing the size of dispersoid from 20μm to 40μm the volume loss slightly decreased because in this condition more surface is covered by bigger size of SiC particle which does not wear easily. Wear mechanism is very difficult to understand due to inclusion of verity of parameters like wear rate, fraction force, temperature, sliding distance, volume loss, speed and load. From the result we see that composite show better wear resistance than alloy under all the experimental conditions it is due to presence of SiC particle the SiC particles being very hard and remains spreaded over the specimen surface protect the matrix alloy from wear. Upto 3kg volume loss was directly proportional to load but at 5kg load sample experience less volume loss from previous loads. At higher speed of rotation lesser volume los is observed it is due to less slide time against the surface. Greater size of particulate composite show better wear resistance and very less volume loss in all experimental conditions, when comparison with all materials i.e. (cast alloy and composites of smaller particulate size) its show less volume loss. From above discussion we conclude that bigger size of particulate increase the wear performance of the composite materials.

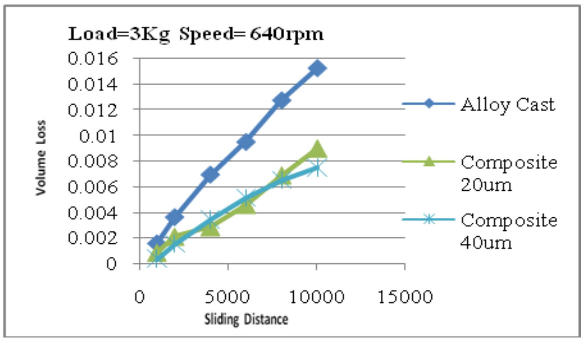


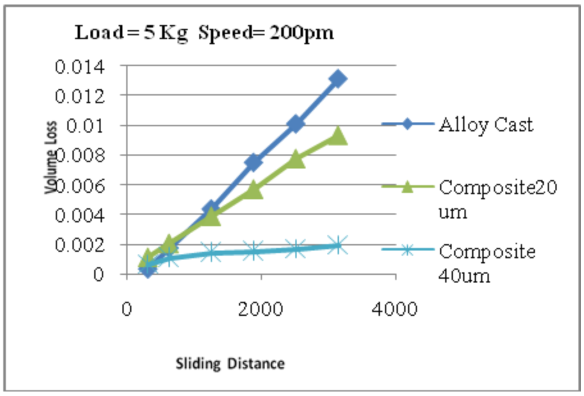


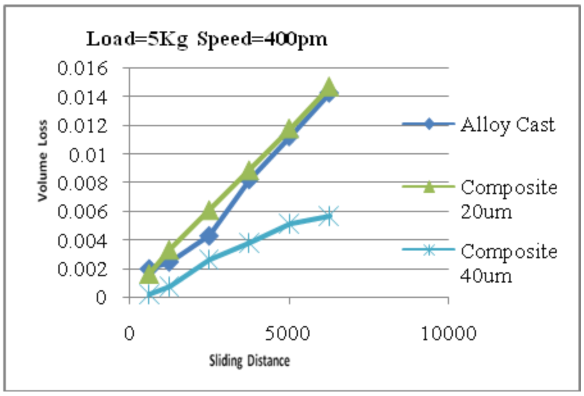












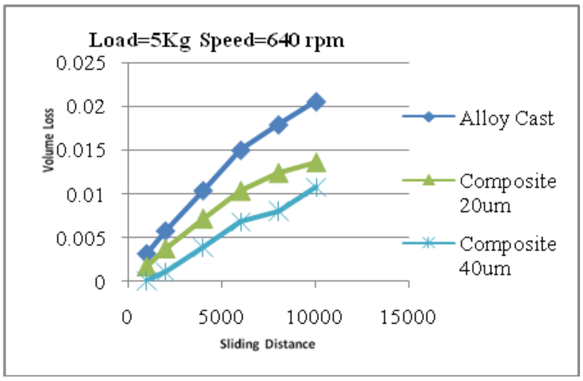


Figure 2: Comparison of volume loss with sliding distance between alloy and composite under different condition

4. CONCLUSION

In this work we observe the effect of particulate size and secondary processing on the properties of Al2014-SiC Composites. According to test observation we can conclude that:

1. The Microstructure of Composite shows homogeneous and uniform structure after quenching.
2. Composite exhibits increased wear resistance than alloy. Composite offer less volume loss.
3. When we discuss about effect of particulate size then the results reveals that on increasing the particulate size wear resistance are also increasing in Al 2014 SiC composite. This enhancement of properties is probably due to high mechanical strength and other properties of SiC particulate.

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