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Tribological Behavior of Al 6061 Alloy Reinforced with Fly Ash Particles

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Abstract – The tests are carried out to study the tribological properties such as wear rate of the specimens. Wear rate shows that for different load conditions wear rate of composites varies. Variation of wear rate at different speeds for varying weight fraction of fly ash at different load of 1kg-4kg and speed of 1m/s^2 to 3m/s^{2}of wear were investigated.

Keywords— Al6061 MMCs, Fly Ash, Stir Casting, Pin on disk.

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1. INTRODUCTION

The present day of investigation, Aluminium is used as the matrix material due to its higher strength and ductility of the aluminium alloys. Aluminium alloy exhibits excellent mechanical properties like mach inability and good bearing and wear properties.[2] Metal Matrix Composites is used to disperse or spread the reinforcing material into a matrix of metal, and which implies the name as ductile metal. Reinforcement improves the strength of the material, better thermal properties, specific weight and strength of the material, stiffness property and all mechanical properties holds good. By using these materials may aim at higher temperature service than the base metal parts [1].The main aim is involved in designing the metal composite materials as matrix in order to incorporate the desirable qualities of metals and ceramics. [NAYANA D A, et al.] This paper is to evaluate Tribological and Mechanical properties of composites with different volume fraction from their results. MMCs give better results for Hardness and Tensile properties.

Table 1: Chemical composition of Al 6061 alloy

Material	Percentage %
Iron	0.0 - 0.7
Silicon	0.4 - 0.8
Magnesium	0.8 - 1.2
Zinc	0.0 - 0.25
Manganese	0.0 - 0.15
Copper	0.15 - 0.40
Titanium	0.0 - 0.15
Chromium	0.04 - 0.35
Other elements	0.05 - 0.15

Table 2: Chemical composition of fly ash

Component Lignite	Bituminous	Sub bituminous	Lignite
SiO2 (%)	20 - 60	40 - 60	15 - 45
Al2O3 (%)	5 - 35	20 - 30	20 - 25
Fe2O3 (%)	10 - 40	4 - 10	4 - 15
CaO (%)	1 - 12	5 - 30	15 - 40
LOI (%)	0 - 15	0 - 3	0 - 5

2. METHODOLOGY

Fly ash is a by product of thermal power plant and it is used as reinforcement material with aluminium alloy (Al6061). It is processed by stir casting method to prepare the specimen. Fly ash of 0%, 2%, 4%, 6%, 8% were taken in the form of fine powder to prepare the specimen.

Wear Test

Preparation of wear specimen

The material should be turned to the diameter of 8mm and a length of 30mm in lathe machine and the end faces of specimen should be smooth. One end of the specimen should be polished smoothly by using emery paper of different grades. The shape of the pin is in cylindrical form which is equal to diameter of 8mm and length of 30mm. The disc has diameter of 180mm and 12mm of thickness.

3. RESULTS AND DISCUSSIONS OF WEAR TEST

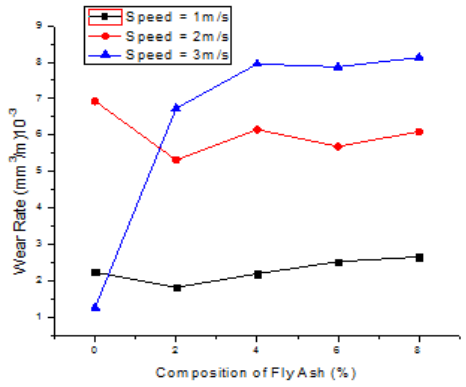


Fig 1 Variation of wear rate verses fly ash at constant load 1kg

The above fig 1 shows the experimental results of wear test. Wear rate is plotted on y axis and composition of fly ash is plotted on x axis which is shown in the above graph. In first case wear of the specimen has increased at 0% of fly ash and then decreased at 2% of fly ash then again wear rate of the specimen increased gradually at 4%, 6% and 8%of fly ash is added for the speed of 1m/s. In second case wear of the specimen has increased at 0% of fly ash then decreased at 2% again increased at 4% then again decreases at 6% and then increased at 8% for a speed of 2m/s. In third case wear of the specimen has increased gradually as the % of fly ash has increased for a speed of 3m/s.

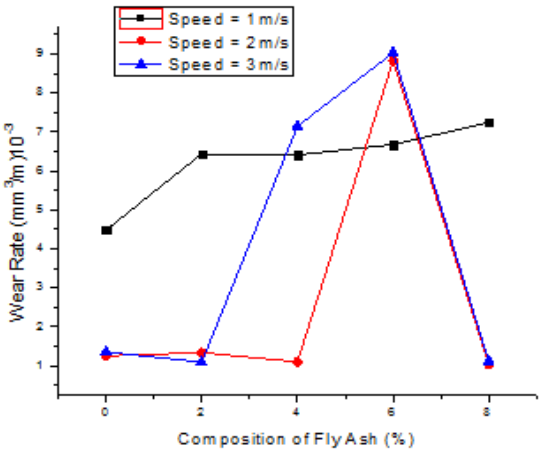


Fig 2 Variation of wear rate verses fly ash at constant load 2kg

The fig 2 shows that the, at 0% and 2% of fly ash wear of the specimen increases and decreases at 4% again then increased at 6% and 8% for a speed of 1m/s at constant load of 2kg as shown in above graph. For a speed of 2m/s wear rate increases as the fly ash increases. At speed of 3m/s wear of the specimen increases at 0%, 2%, 4%, 6% and gradually decreases at 8%.

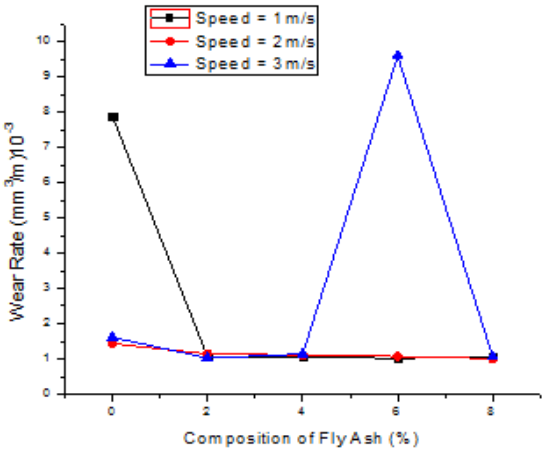


Fig 3 Variation of wear rate verses fly ash at constant load 3kg

The above fig 3 shows that the wear of the specimen increases at 0% and gradually decreases at 2% to 8% for velocity of 1m/s at a constant load of 3kg. At 0% wear rate of the sample increases and gradually decreases at 2%, 4%, 6%, and 8% for a speed of 2m/s at a load of 3kg.

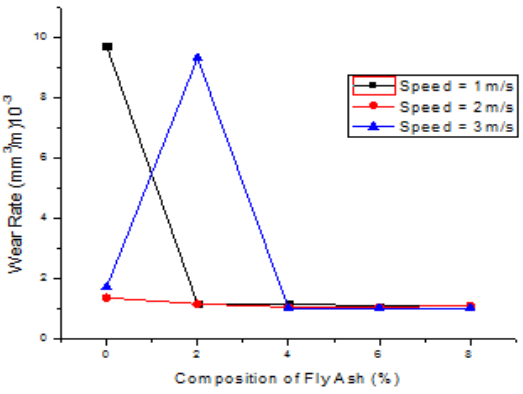


Fig 4 Variation of wear rate verses fly ash at constant load 4kg

Fig 4 shows that, wear of the specimen increased at 0% and gradually decreases in the weight fraction of fly ash of 2% to 8% for a speed of 1m/s at constant load of 4kg. In second case the wear increases at 0% and remains decreased at varying % of fly ash. Wear rate increase as the weight percentage of fly ash particles increases at 0% and decreases as the weight % of fly ash is increases and again decreases at 4% to 8% with a speed of 3m/s at constant load of 4kg.

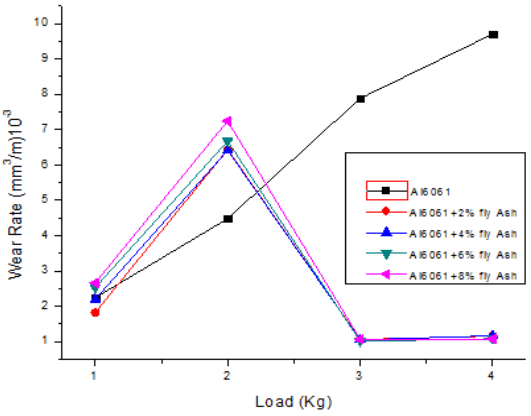


Fig 5 Wear rate Vs speed = 1m/s

The above fig 5 shows the results of wear test. The wear rate is more in ductile material is more compared to brittle material. By addition of fly ash in ductile material increases the ductility of material for some extent. As the fly ash increases wear rate of the specimen also increases with increase in load at 2%. Further addition of fly ash in Al 6061 composite wear rate is reduced at constant speed of 1m/s.

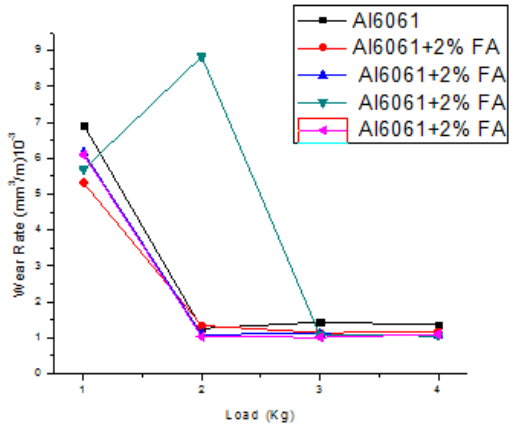


Fig 6 wear rate Vs speed = 2m/s

Fig 6 shows that as the load increases at a speed of 2m/s Wear rate of the specimen also increases at 2kg load and wear rate gradually decreases as the load increases for a constant speed of 2m/sec.

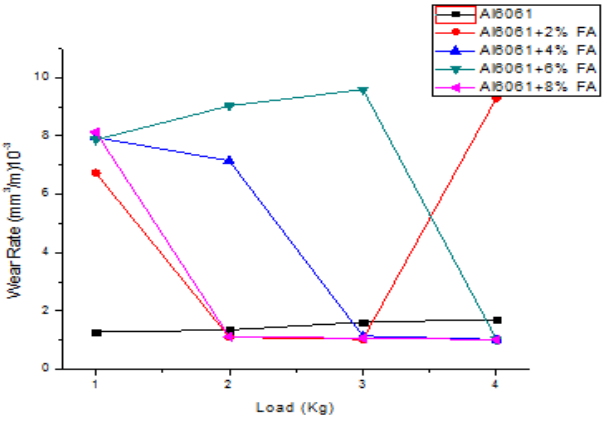
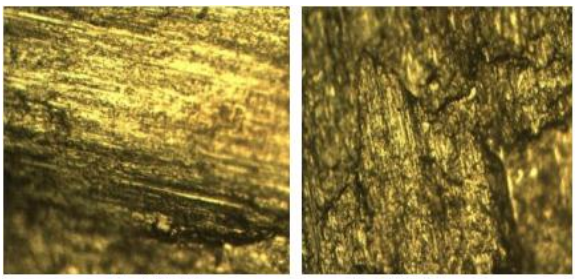


Fig 7 wear rate Vs speed = 3 m/s

From the above fig 7 it shows that, as the load increases wear of Al increases but in the same way decreases with the addition of fly ash it is because of load is increased and it is due to friction at the contact surface and rotating disc increases.

Microstructure Results of wear



Al+0%FA Al+2%FA

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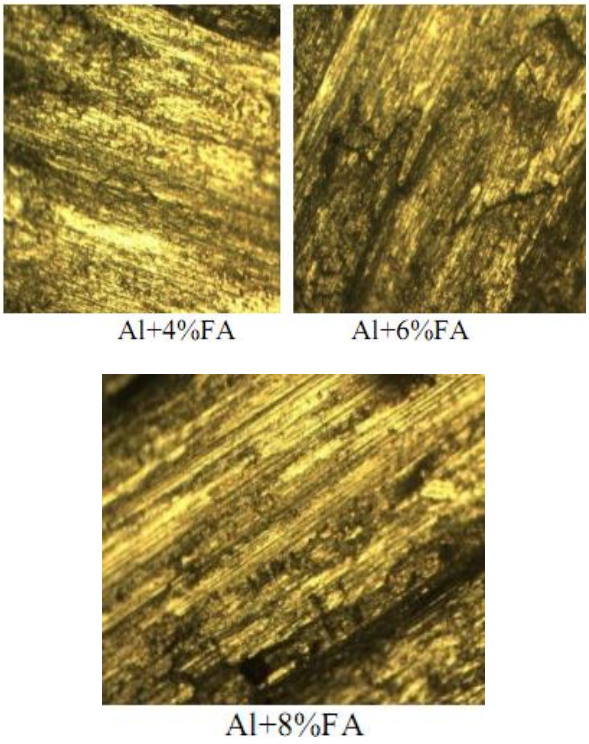

Fig 8 Microstructure study of Al 6061 and Fly ash of wear test

The above fig 8 clearly shows the micrograph of wear test. The removal of material by impact, cracks which are generated along by particle pull at the outer surface can be observed clearly. Worn surfaces can also be viewed by this study. It also reveals the presence of a large number of narrow cut over the whole surface.

4. CONCLUSIONS

Aluminium metal matrix had been fabricated successfully with the uniform dispersion of fly ash particles.

Distribution of fly ash particles improves the wear behaviour of composites.

Wear rate decreases as the speed and load increases.

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