

Wear Behaviour of Al-Flyash Composite by Stir Casting

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ABSTRACT: The experiment is conducted to test the wear behavior tested on pin on disc machine. The specimen is produced by using stir casting. The composite material is made up of matrix material aluminium 6061 and reinforcement material flyash. The results obtained from the test say that the wear rate increases with increase in sliding speed and load. Wear resistance is minimal in 3%al-fa composite, moderate in 6%al-fa and maximum in 9%al-fa. But comparing to base metal the wear resistance is more in all the composite.

KEYWORDS: Aluminium; metal matrix composite; stir casting; flyash

I. INTRODUCTION

The composite materials are materials which possess high specific weight and specific modulus, better thermal stability, wear compared to other metals and alloys. By using continuous fibers reinforcement and aluminium, zinc, titanium alloys matrices and alumina fibers lead to high manufacturing cost. The use of low cost and low density reinforcement flyash leads to low manufacturing cost, improved hardness and wear resistance[1]. The size of flyash particle varies from 0-100 μ m which are the end product of combustion coal used in thermal power plants. The unique nature of the flyash is good wet ability with the matrix[2]. The experiment conducted by G. Prabhu et al. at normal loads 5-15 N and sliding speed 0.5-1.0m/s. the result obtained from them are wear resistance is less compared to as cast aluminium. With the addition of 20wt% fly ash the wear loss is less[3]. In the manufacture of AMCs the matrix material is aluminium 6061 and reinforcement material is non-mettalic such as flyash, SiC, redmud, etc aluminium alloy possess good corrosion resistance, high damping capacity, low density, good electrical and thermal conductivity[4].

II. EXPERIMENTAL DETAILS

Material selection

Aluminium6061 is precipitation hardening Aluminium alloy containing magnesium and silicon as its major alloying elements. It has good mechanical properties and exhibits good weld ability. It is one of the most common alloys of Aluminium for general purpose use [1].

Table No. 1
Chemical composition of Al6061

Element	Al	Cr	Cu	Fe	Mg	Mn	Si	Tn	Zn	Other
Wt%	Balance	0.04	0.15	0.2	0.8	0.15	0.4	0.15	0.25	0.15

Fly ash is the most cheap and low density reinforcement available in abundant quantities as waste by product during combustion of coal in thermal power plants. Composite with fly ash as a reinforcement material are less costly and can be used to manufacture automobile spares [2].

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Table No. 2
Chemical composition of Fly ash

Element	LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO
Wt%	19.0	56.0	13.21	4.79	5.60	1.20

Material composition

Experiment was carried out on four varying compositions of reinforced with aluminium alloy. Composition details are mentioned in the table

Table 2: Addition of flyash to Al 6061 alloy

Sl. No	Composition	Al 6061 (gm)	flyash (gm)
1	Aluminium 6061	2000	--
2	Aluminium6061 + 3% flyash	1940	60
3	Aluminium6061 + 6% flyash	1880	120
4	Aluminium6061 + 9% flyash	1820	180

Manufacturing of Al-flyash by stir casting.

By using stir casting process the base metal Al6061 and reinforcing material fly ash is mixed with the help of stirrer and a composite material is produced. 2 kg of Aluminium and 20gms of Fly ash , 4kg Aluminium 80gms of Fly ash and 6kg Aluminium ,160gms of fly ash is mixed. Aluminium 6061 is taken in crucible and kept it for melting in electric furnace. Set the temperature to 770°C. close the furnace and wait for 3 hours. After that remove the crucible from furnace and add the reinforcement material which is already preheated in the heat treatment furnace. By using stirrer setup mix the reinforcement material while mixing add degasifying agent nitrogen to remove the gases and to avoid oxidation. The stirrer is rotated at 100-300rpm for 1-2 min and pour the molten metal in to the pre heated die at constant rate of pouring at room temperature. Allow the mould to cool until it reaches the room temperature. Remove the mould box and detach the specimen from the mould. The entire procedure is repeated for the different percentage of reinforcement material and base metal [3].



Fig.1. Resistance furnace



Fig.2. Portable electrical motor stirrer.

WEAR BEHAVIOUR

The material is turned to required dimensions on lathe machine which is 8mm dia and 30 mm length. The surface should be smooth for the test and it is obtained by using emery paper. The specimen is thoroughly cleaned and burrs should be removed, check the electrical connections to the set up, weigh the specimen before putting it into the machine, set the time, speed on the digital indicator and put the load as required for the test. Carry out the test for particular variable like load, speed and rpm. After that weigh the specimen , take the average of two weights and take

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the friction force acted on the specimen for each 30 sec , the average of that will be the total friction force. The test is conducted at various speed and time. Repeat it for the other composition [4].

The test parameters used as follows:

Normal load: 1-4kg.

Sliding velocity: 1,1.5,2m/s.



Fig.3.pin on disc machine



Fig.4. wear specimen

III. RESULTS AND DISCUSSION

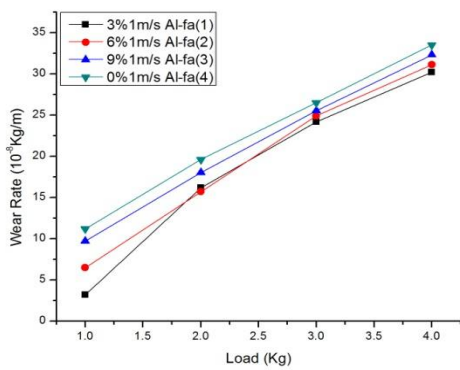


Fig.5. Variation of wear rate against load V=1m/s.

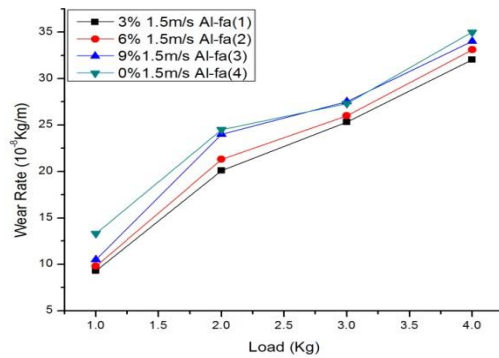


Fig.6. Variation of wear rate against load V=1.5m/s.

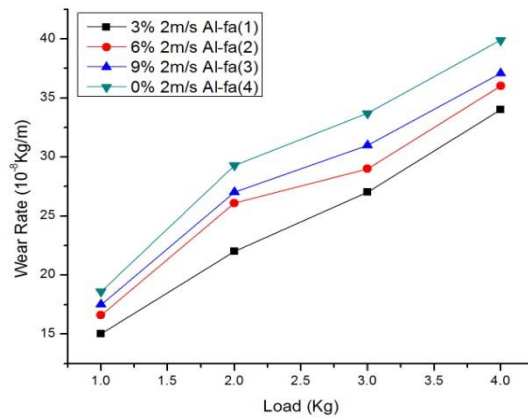


Fig.6. Variation of wear against load V=2m/s.

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On pin on disc machine the track diameter is set to 80mm. The experiment is conducted by setting variables like sliding velocities from 1,1.5,2m/s, the rpm 238,358,447.40 respectively. The load is varied from 1kg to 4kg. Four readings were noted for each specimen of different composition and friction force is noted down for each 30 seconds of time. The average value of friction force is taken to calculate the coefficient of friction and wear rate is calculated.

When the composite pin is subjected to different loads and speeds there is loss of weight due to the wear, wear takes place due to formation of ferrous oxide (Fe_3O_4) and aluminium oxide (Al_2O_3). Due to the sliding work hardening takes place and formation of iron oxide (Fe_3O_4) results in lower the wear rate. From the Fig.5. we can say that the wear rate of aluminium 6061 is comparatively more than the composite pin. Same results were obtained when the percentage of reinforcement increased. The microstructure of the worn out surfaces say, the wear resistance is more with increase in load, velocity and percentage of composition increases. As the load and velocity is more the wear rate is more.

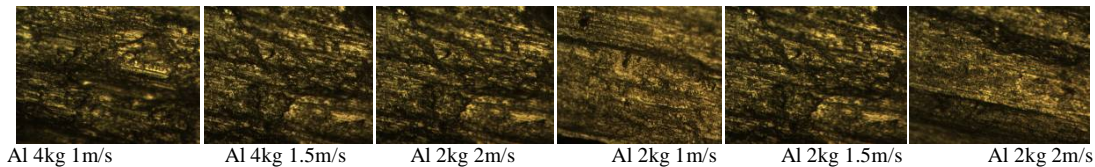


Fig.7. Microstructure of pure aluminium

Above figure shows the microstructure of Aluminium 6061 with variation in the load as well as in the velocity. As the load and velocity increases the wear rate is increased and the wear resistance less compared to Al-Flyash composite maerial.

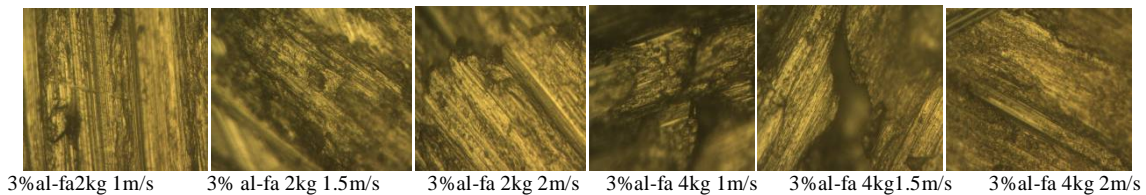


Fig.8. Microstructure of 3%Al-flyash

The figure 8 shows the wear behaviour of the composite material. The load is varied from 2Kg to 4Kg, and the velocity is varied from 1 m/s to 2m/s. The wear resistance is more compared to the aluminium alloy.

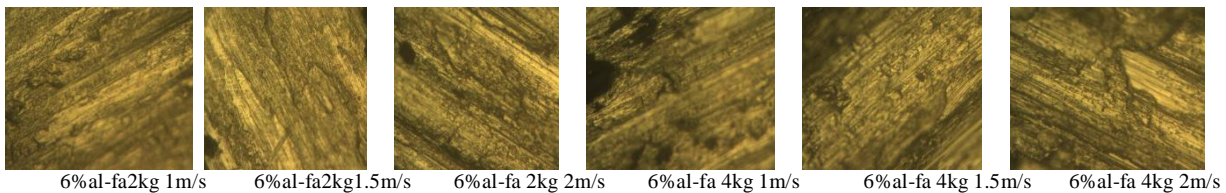


Fig.9. Microstructure of 6%Al-flyash

The figure 9 shows the variation in the wear compared to 3% weight fraction. As the percentage of reinforcement material increases the wear rate is increased. The uneven surface is seen on the top of the pin.

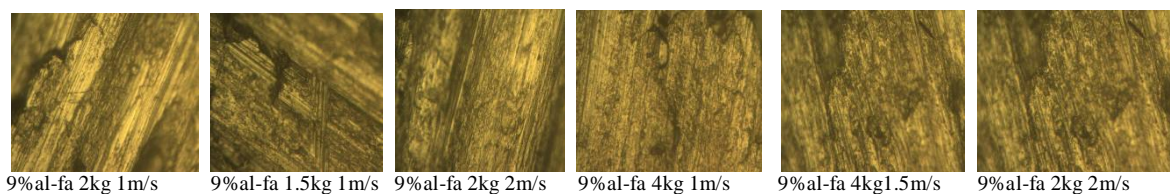


Fig.10. Microstructure of 9% Al-flyash

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The wear resistance is more in the highest weight percentage of reinforcement material. As the addition reinforcement material increases the material will give more hardness number as a result there is increase in wear resistance.

V. CONCLUSION

The specimen is prepared by using stir casting set up. The reinforced material used is flyash a weight percentage of 3,6,9 with the base metal aluminium 6061. The casted material is machined on the lathe machine to get required dimensions of 8mm diameter and 30mm length. The experiment is conducted on pin on disc machine (TR-20, DUCOM). From the experimental study conducted on the wear test we can conclude that the wear rate is directly proportional to the increase in load, increase in sliding velocity, and increase in the percentage of reinforcement material.

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