

A Study on Dry Sliding Wear Behaviour of Al-6061 Redmud Composite

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ABSTRACT: Aluminium mainly used in the applications of aerospace and aeronautic industries because of its good mechanical properties. The main objectives of all composite materials are to reduce the cost. In this paper the wear rate is characterised and studied based on the load and velocity with composite material prepared by using aluminium reinforced with Red mud and weight fraction (3% 6% 9%). The aim is to reduce the cost of production MMCs. In order achieve the required aim stir casting method is selected. the obtained results reveals that the selected method (stir casting) to develop MMCs is successful and the wear rate is lesser than pure alloy. From results it shows that wear rate of pure alloy is high compared to Al6061-Redmud, the wear rate will be low when Redmud weight percentage at 3% and it is optimum. 9% composition wear rate little lesser than pure alloy, it indicates that in order to have lesser wear rate 3-6% redmud to be used.

KEYWORDS: Al6061, stir casting, wear and Redmud

I. INTRODUCTION

Composite materials are the materials which are developed by mixing two or more materials with the base material, which results in improved properties like tensile, wear resistance etc. A base metal(aluminium 6061) reinforced with the material (Redmud) using the stir casting method. In order to reduce the cost of production stir casting method is adopted in which the reinforcement material added to base metal (molten).

Aluminium 6061 is the most commonly for heat treatable aluminium alloy for commercial use. Al 6061 alloy is mainly composed of aluminium, magnesium and silicon [1]. And have good mechanical properties like structural strength and toughness, good surface finish, good corrosion resistance to atmosphere and sea water, its machinability and its ability to be easily welded and joined. Aluminium 6061 mainly used in the applications of aerospace and aeronautical industries.

In order to get the optimum performance of the composite material it is very important to select the reinforcing material. Red mud is the caustic insoluble waste residue generated by alumina production from bauxite by the Bayer's process, which is available at low cost and it also contains the oxides of iron, aluminum, titanium and silica along with some other minor constituents[2].

The main objective of the this work is to study the wear resistance and wear rate of Al 6061(base metal) when it is reinforced with Redmud as reinforcing material by stir casting method.

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II. EXPERIMENTAL DETAILS

A. MATERIAL COMPOSITION

Aluminium 6061 contains aluminum, magnesium and silicon which are having good mechanical properties.

Table.1 The chemical composition of Aluminium 6061

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

Red mud emerges as the waste material during the production of alumina from bauxite in Bayer's process. It contains materials like oxides of iron, aluminium, titanium and silica along with some other minor constituents.

B. MATERIAL PREPARATION

In order to produce the MMCs, Al 6061 used as base material and the weight percentage (0%, 3%, 6% and 9%) of Redmud used as reinforcement material. The chemical composition of the Al 6061 shown in the table 1.

C. SPECIMEN PREPARATION

In order to prepare the metal matrix composite Stir casting method is used. the obtained specimens have the dimension of 26mm diameter and 260mm length. For the wear test on pin on disc machine the cast composites are machined to 8mm diameter and 30mm.

D. WEAR TEST

Wear is the loss of material on the surface due to the rubbing action with the other hard material. It is mainly depend on the hardness of the material surface, disc material, sliding velocity and the normal load which is put on the specimen..

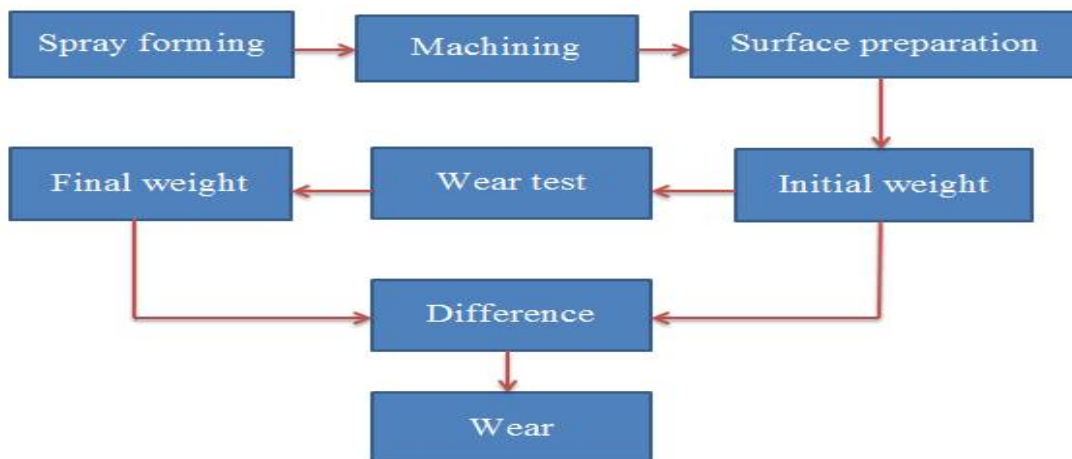


Fig.1. Flow chart of step by step procedure to carry out wear test

Wear rate is calculated by taking difference between initial and final mass of the specimen. Fig.1 shows the steps involved the wear test, all experiments carried under dry conditions

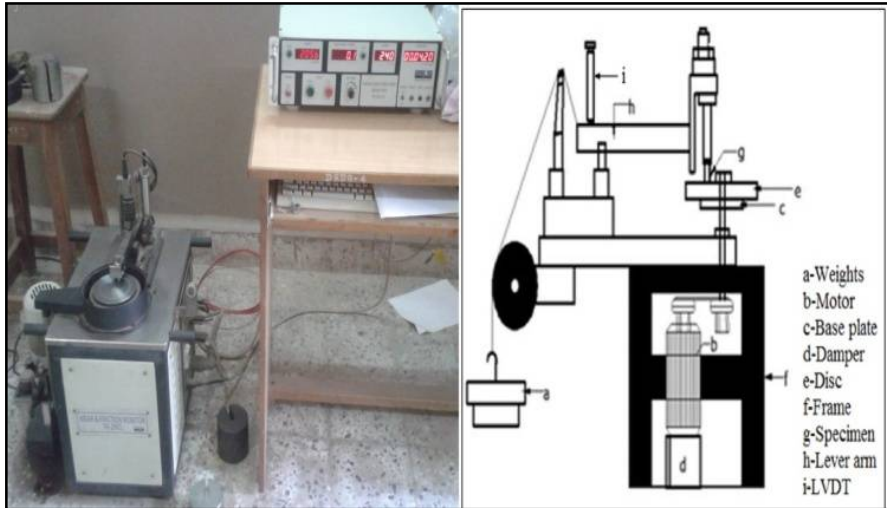


Fig.2. schematic diagram of wear testing machine

The wear test is carried out on pin on disc wear testing machine with sliding distance 1000m and track diameter 80mm (TR-20, DUCOM) as shown in figure 2.

Initially the mass of the specimen is measured using electronic balance machine and it is mounted in the pin holder, the frictional on sliding surface was measured with the help of load cell attached to the lever arm in terms of Newton. The test is done by varying velocity 1, 1.5, 2m/s with respect to rpm 238, 358 and 447.40. After the end of machine time the specimen is taken to measure the mass which will be final mass of the sample. By taking difference between initial and final mass wear rate is calculated.

III. RESULTS AND DISCUSSION

The wear rate is calculated by taking difference between initial and final mass of the test specimen. As the increase velocity and load wear rate also increases.

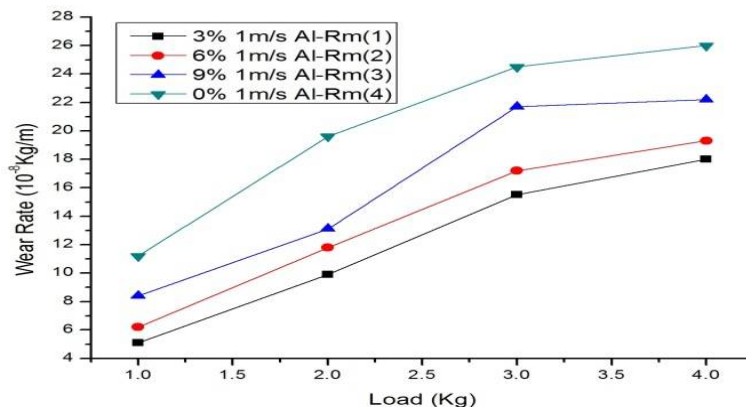


Fig.3. Wear Rate Vs Load at 1m/s Velocity

Fig.3 shows the variation of wear rate with increase in weight at 1m/s velocity. From fig.3 Al 6061 wear rate is high compared to Al 6061-Redmud composite and the wear rate is very less at 3% composition compared 0%, 6% and 9% composition. It shows that increase in the load increases the wear rate but less rate compared to pure alloy.

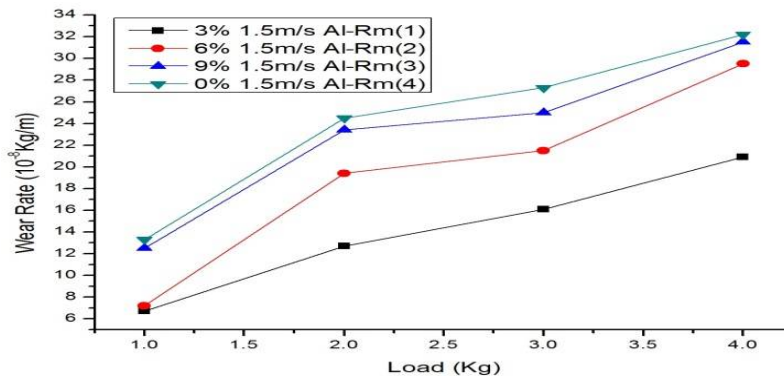


Fig.4. Wear Rate Vs Load at 1.5m/s Velocity

From fig.4 Al 6061 wear rate is high compared to Al 6061-Redmud composite and the wear rate is very less at 3% composition compared 0%, 6% and 9% composition at 1.5m/s velocity, and 9% composition is near wear rate as 0% composition.

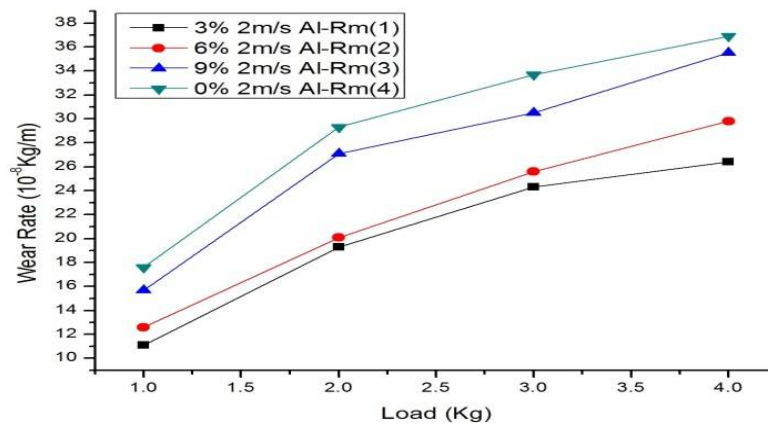


Fig.5. Wear Rate Vs Load at 2m/s Velocity

From fig.5 wear rate is also increases as the velocity increases and Al 6061 wear rate is high compared to Al 6061-Redmud composite and the wear rate is very less at 3% composition compared 0%, 6% and 9% composition at 2m/s velocity, and 9% composition is near wear rate as 0% composition and 3% and 6% are near wear rate when 3kg load applied.

A. WEAR BEHAVIOUR

After the wear rate calculated each specimen surfaces are observed in optical microscope in order to observe the wear rate which causes the change in surface unevenness/surface finish. As the weight percentage of redmud increased in the base metal there was decline in wear rate which resulted in higher wear resistance of material

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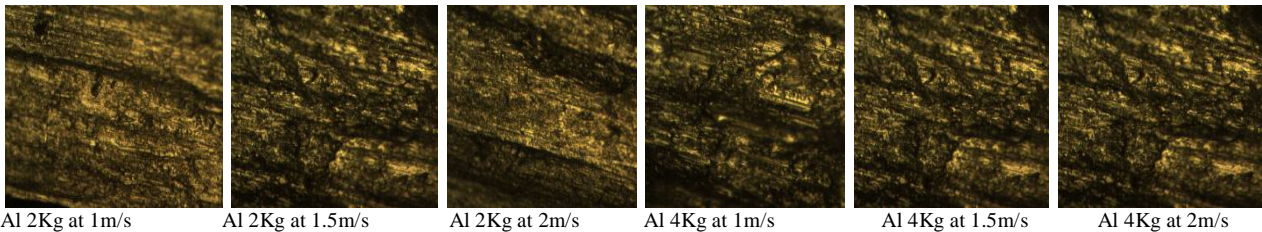


Fig.6. Microphotographs of pure Al 6061 after wear

From fig 6. It can be observed that at lower loads and lower velocity, the wear rate is minimum. As load and speed increased deeper grooves and scratches are formed due to plastic deformation as a result of higher temperature developed between surface contact of pin and disc.

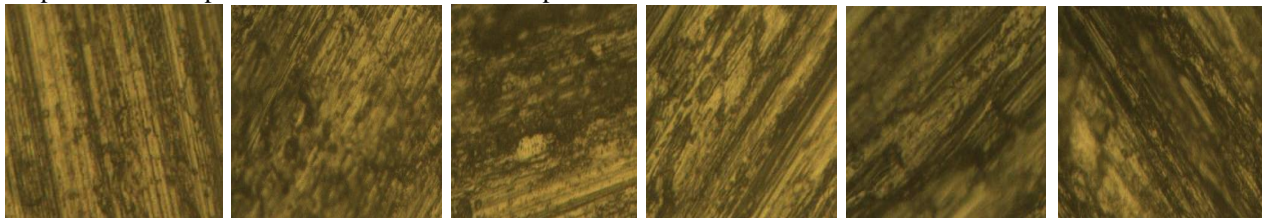


Fig.7. Microphotographs of Al 6061-3%Redmud after wear

From the fig 7. (Al-3%redmud) it can be observed in the images that groove formation and cracking of material reduced due to reinforcement particle as the redmud made a strong bondage with metal matrix. When it is compared to pure Al 6061 wear rate is very less.

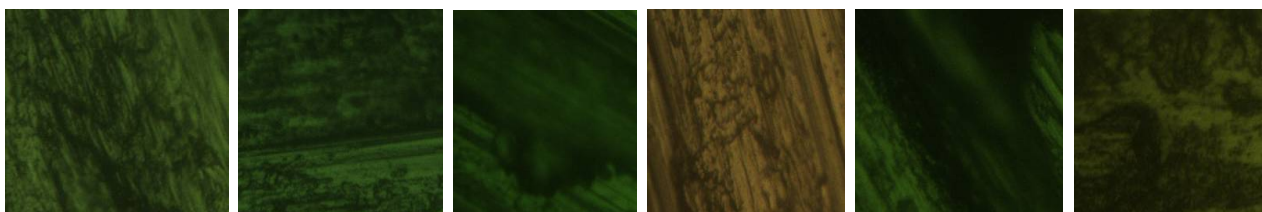


Fig.8. Microphotographs of Al6061-6%Redmud after wear

From fig 8. As the percentage of redmud increases the wear rate has to be decrease but the more addition of redmud tends to increase the wear rate, which shows higher wear rate when compared to 3% redmud and less wear rate compared to pure Al6061

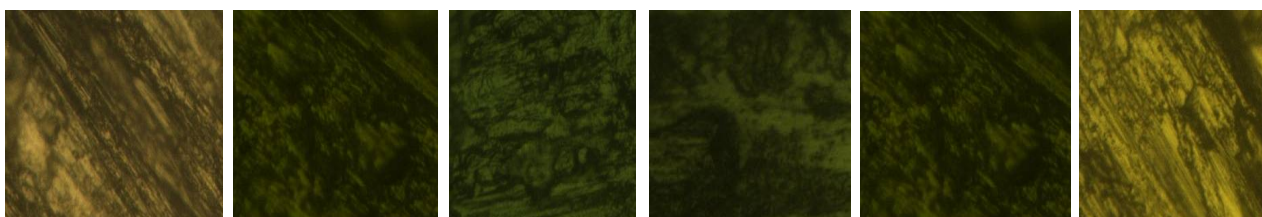


Fig.9. Microphotographs of Al-9%Redmud after wear.

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From fig 9. It indicates that the wear rate is near to pure Al 6061; on the contrary as weight percentage of redmud increases the wear rate again increased which can be seen in fig 8. And fig 9. (Al-6%redmud and Al-9%redmud). Al-3%rdmud gave the optimum value compared to other composition.

IV. CONCLUSION

- The adopted method (stir casting) in order to prepare the aluminium based MMCs were successful and achieved uniform distribution of reinforcement material (Redmud) in to the aluminium.
- Wear rate of Al-Redmud (3%, 6% and 9%) is low compared to pure alloy(Al6061)
- From results(fig.3,4 and 5) It is clear that as the velocity and load increase the wear rate also increases due to severe plastic deformation
- At velocity 2m/s the 9% Al-redmud composite the wear rate is nearer to pure alloy (Al6061)
- From results at 3% Redmud wear rate is lower than 6%, 9% redmud and pure Al6061 at velocity 1, 1.5, 2m/s with respect to rpm 238, 358 and 447.40.
- Al-3%redmud gave the optimum value compared to other composition (pure Al6061, Al-6%redmud and Al-9%redmud)

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