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Dry Sliding Wear Behaviour of Aluminium Alloy 6061-Redmud Metal Matrix Composites by Stir Casting Method

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ABSTRACT

This research work deals with the performance of Aluminium6061-redmud particulate reinforced Metal Matrix Composites (MMC) prepared by Stir Casting technique. Pin on disc machine has been utilized for carrying out the wear test on MMCs underneath the load variety of 10-60 N, sliding velocity of 1.256 m/s, in addition to sliding distance of 2 km. The experimental results are finding out for the sliding wear rate, friction co efficient, frictional force, and temperature rise depending upon the mechanical load and various composition of redmud. And the results are tabulated and shown in graphs. The better results for maximum wear resistance at minimum and maximum load of application with respect to the amount of reinforcement are suggested.

1. INTRODUCTION

History is frequently noticeable through materials as well as technology so as to reproduce human ability along with understanding. The acknowledgment of possible savings that can be attained through highly developed composites,

The variety of chill materials has considerable changing its strength [1], The Micro shrinkage be reduced through judicious site of chills. The development in the Tribological properties of Aluminum HMMCs has been effectively attained through introducing ceramic particles [2]. The materials subject to wear testing in a multitribotester by means of block on roller configuration as a plan of trial based through Taguchi orthogonal array for acquiring the wear data in a restricted way [3].

The Mechanical as well as Tribological behaviour of Al matrix composites reinforced with SiC and Gr particulate up to 10% for studying the results of reinforcement, Load, Sliding speed as well as Sliding distance on stir cast Al-SiC and Al-Gr Metal matrix composites [4]. An effort has been completed for studying persuade of wear parameters such as applied load, sliding speed, sliding distance as well as percentage of reinforcement on the dry sliding wear of metal matrix composites (MMCs) [5].

The Volumetric Heat Capacity of various chill materials does considerably influence the strength [6]. The Worn out surfaces of composites has been examined through Scanning Electron Microscope and states that the mechanical properties as well as wear resistance improved depend on the weight percentage of reinforcement [7].

The major aims of this research are for preparing MMC using Red mud as reinforcement as well as aluminium as matrix material. Out of the obtainable manufacturing procedures we have implemented the usual stir casting method for preparing N1MC.

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2. ADHESIVE WEAR

Adhesive wear can be found between surfaces during frictional contact as shown in Fig. 1

Generally unwanted displacement is the attachment of wears debris in addition to material compounds from one surface to another. Two separate mechanisms function between the surfaces**.**

Scanning Electron Microscope (SEM) micrograph of adhesive wear on 52100 steel sample sliding against Al alloy is shown in Fig. 2.

2.1. Abrasive wear

Abrasive wear occurs when a hard rough surface slides across a softer surface as shown in Fig. 3.

It has classified by the kind of contact as well as the contact environment. The type of contact decides the mode of abrasive wear. The two modes of abrasive wear are known as two-body and three-body abrasive wear.

2.2. Surface Fatigue

Surface fatigue is a process by which the surface of a material is weakened by cyclic loading as shown in Fig. 4, which is one type of general material fatigue.

Fatigue wear is formed when the wear particles are detached through cyclic crack growth of micro cracks on the surface. These micro cracks are either superficial cracks or subsurface cracks.

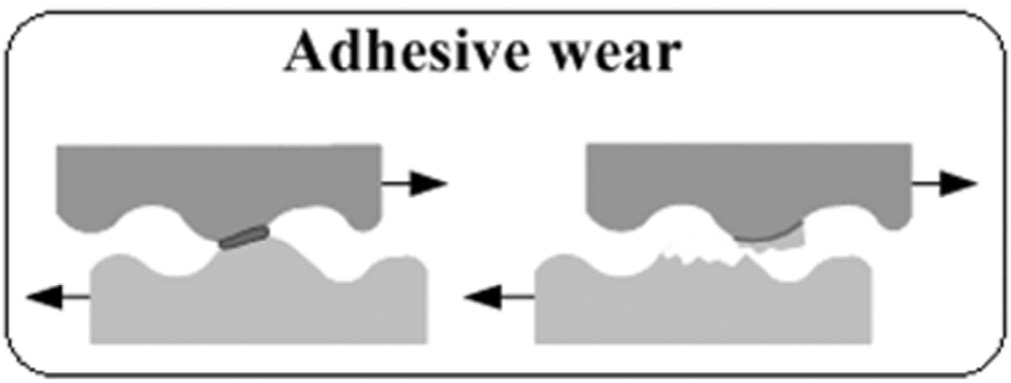

Figure 1: Adhesive wear between surfaces

Figure 2: SEM micrograph of adhesive wear on 52100 steel sample sliding against Al alloy

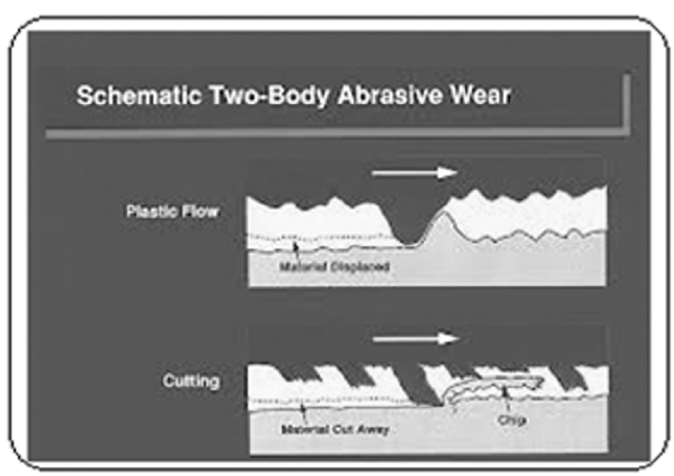

Figure 3: Abrasive wear when a hard rough surface slides across a softer surface

Figure 4: Fatigue Wear by Tangential and Normal Cycling Load

3. EXPERIMENTATION

3.1. Pin-on-Disc Wear Testing Machine

Experiments is conducted in the Pin-on-disc type Friction as well as Wear monitor(DUCOM; TL-20) with data acquisition system as shown in Fig. 5 which is used for evaluating the wear behavior against hardened ground steel disc (En-32) having hardness 65HRC and surface roughness (Ra) 0.5 μm.

It is versatile equipment intended for studying wear under sliding state only. Sliding usually occurs between a stationary Pin as well as a rotating disc.

3.2. Materials Used

3.2.1. Aluminium

Commercially pure aluminium of IE–07 grades from National Aluminium Company (NALCO), Angul of Odisha as well as India composed along with used for experimental purpose. The composition analysis along with other test results such as hardness, density, and tensile strength are presented in Table 1 and Table 2.

Figure 5: Pin-on-disc type Friction and Wear monitor (DUCOM; TL-20) with data acquisition system

3.2.2. Red Mud

The red mud is utilized for the present examination has brought from the aluminum refinery of NALCO located at Damanjodi, Koraput, and Odisha, India. The presence of different elements as confirmed by chemical analysis is presented in Table 3.

3.2.3. Preparations of Test Specimens

The schematic representation of the casting method used in the laboratory is shown in Fig. 6.

After solidification the casting are taken out from the mould and are cut to require shape and sizes as shown in Fig. 7 for wear testing.

The distribution with different volume fraction of red mud particles in the matrix are shown in Fig 8.

It is clear from these figures that the reinforcing particles were distributed uniformly in the aluminium matrix.

4. EXPERIMENTAL RESULTS AND DISCUSSION

The Experimental values of Wear Rate in different Red Mud Composition in different Load with respect of Friction Force, Co efficient of Friction (COP) and Temperature are tabulated in Table 4.

Table 1
Compositional analysis of aluminium

Sl. No.	*Si*	*Fe*	*Ti*	*V*	*Cu*	*Mn*	*Al*
1	0.08	0.15	0.001	0.007	0.001	0.003	99.76

Table 2
Characteristics of aluminium

Density	*2.7 gm/cc*
Hardness	40.8 VHN
Tensile Strength	67 Mpa

Table 3
Chemical analysis of red mud

Al_2O_3	TiO_2	Na_2O	P_2O_5	Ga_2O_3	Zn	Fe_2O_3	SiO_2	CaO
15	3.7	4.8	0.67	0.096	0.018	0.88	54.8	8.44

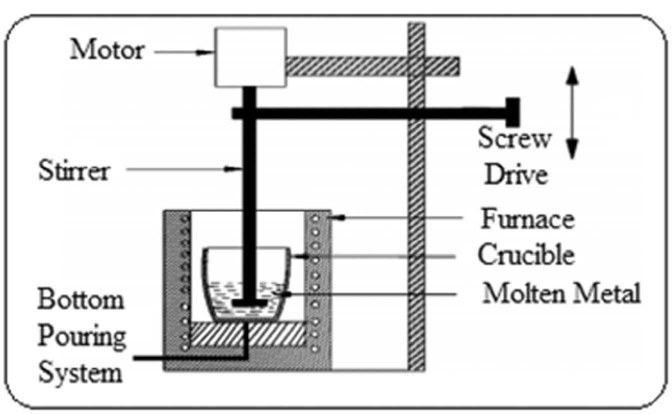

Figure 6: Aluminium matrix composites by Stir Casting Method

Figure 7: Casting (Job Material) for Wear Testing

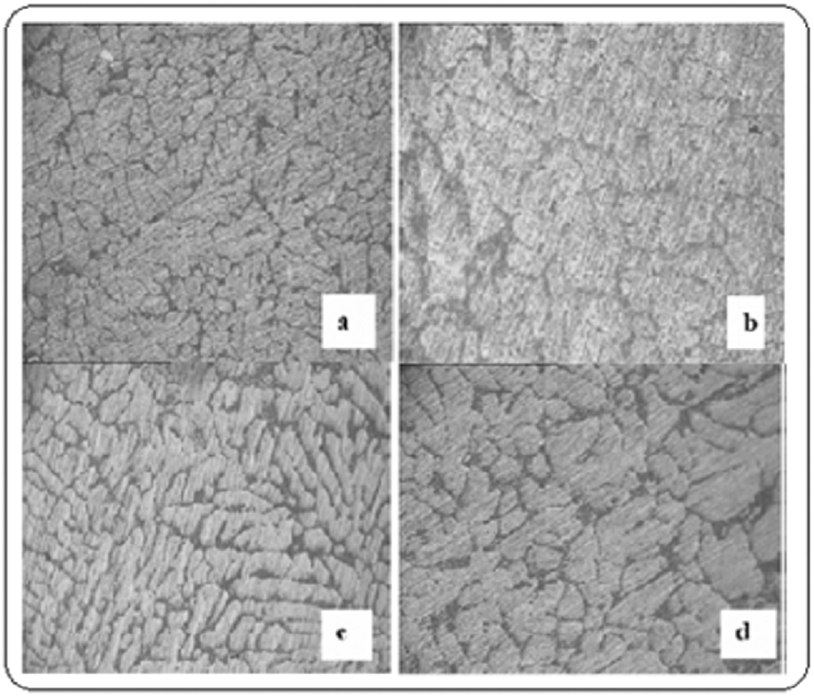

Figure 8: Micrographs showing red mud distribution in the composites of different Volume fractions (a) 10% (b) 15% (c) 20% and (d) 30% at (200 X)

Table 4
Experimental values of Wear Rate in different Red Mud Composition in different Load with respect of Friction Force, Co efficient of Friction (COP) and Temperature

Red Mud Composition	10%	15%	20%	10%	15%	20%	10%	15%	20%	10%	15%	20%
Load (N)	Wear RateMm³/Nm			Friction Force(N)			COF			Temperature(⁰C)		
10	1.3779	0.8933	0.038	6.5	4.5	2.5	0.65	0.45	0.24	57.8	47.25	46.4
20	0.1282	0.7127	0.0159	10.2	3.5	9	0.51	0.27	0.14	46.5	55.75	45.75
40	0.2257	0.3444	0.1663	20	19.7	13	0.54	0.49	0.33	48	64.5	61
60	0.2455	0.5939	0.0712	14.5	30	16	0.25	0.5	0.28	60	78	63.5

Based on the results, various graphs are plotted and presented in Figs. 9, 10, 11 and 12 for different percentage of reinforcement under different test conditions.

Fig. 9 shows the variation in wear rate with the load change (10N, 20N, 40N, 60N) and reinforcement (10%, 15% and 20%) of red mud. From this plot we have seen the wear rate is increased in reinforcement of redmud particles. And the increase in load decrease in the wear rate. For the minimum load of application the better wear resistance is achieved at the maximum amount of reinforcement of particle. And for the maximum load of application the better wear resistance is achieved at the 15% of redmud reinforcement.

Fig. 10 shows the variation in friction coefficient with the load change (10N, 20N, 40N, 60N) and reinforcement (10%, 15%, and 20%) of redmud. From this plot we have seen that friction co efficient decrease with increase in reinforcement of redmud particle. At maximum load of application the 15% and 20% reinforcement of redmud particle gives the maximum friction co efficient. But with the minimum reinforcement (10%) of redmud particle gives the minimum friction co efficient at the maximum load of application.

Fig. 11 shows the variation in frictional force with the load change (10N, 20N, 40N, 60N) and reinforcement (10%, 15%, and 20%) of redmud. From this plot we have seen that frictional force decreases with increase in reinforcement of redmud particles. At the 15% of reinforcement the frictional force get minimized while compared to 10% of reinforcement. But with the 20% of reinforcement the frictional force again get increased. But, at the maximum load the 15% of reinforcement gives the maximum frictional force.

Fig. 12 shows the variation of rise in temperature with the load change (10N, 20N, 40N, 60N) and reinforcement (10%, 15%, and 20%) of redmud. From this plot we have seen that rise in temperature increases with increase in reinforcement of redmud particles. This rise in temperature gets increased while compared the 10% to 15% of reinforcement of redmud particles. But with the maximum amount of reinforcement (20%) the temperature rise get minimized.

5. CONCLUSION

This project highlights the dry sliding wear behavior of Aluminium alloy6061-Redmud MMC's, which were fabricated by the stir casting method. The wear rate and the friction are evaluated as function of sliding distance, applied load, sliding velocity. The final conclusions are,

- Aluminium alloy 6061 matrix composites have been successfully with the fairly uniform distribution of redmud particles.

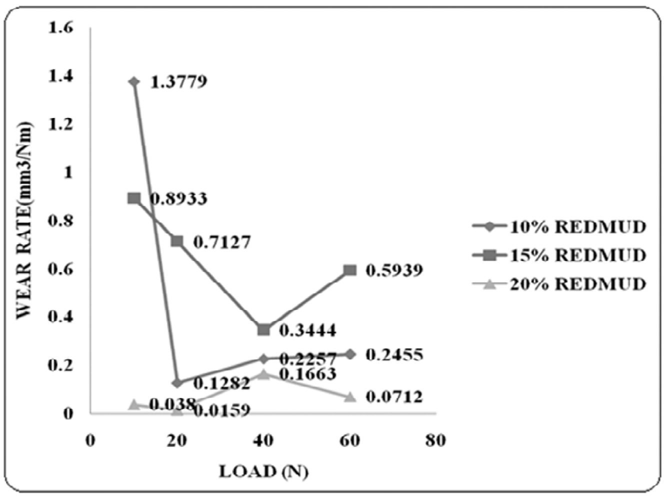

Figure 9: The variation in wear rate with the load change and various reinforcement of redmud

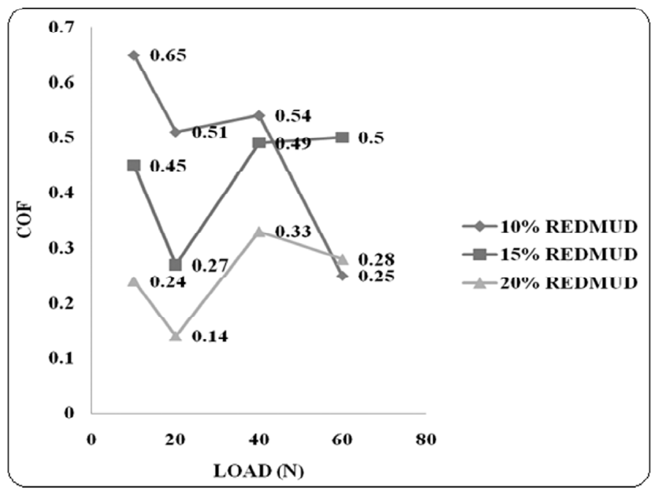

Figure 10: The variation in friction coefficient with the load change and with the various reinforcement of redmud

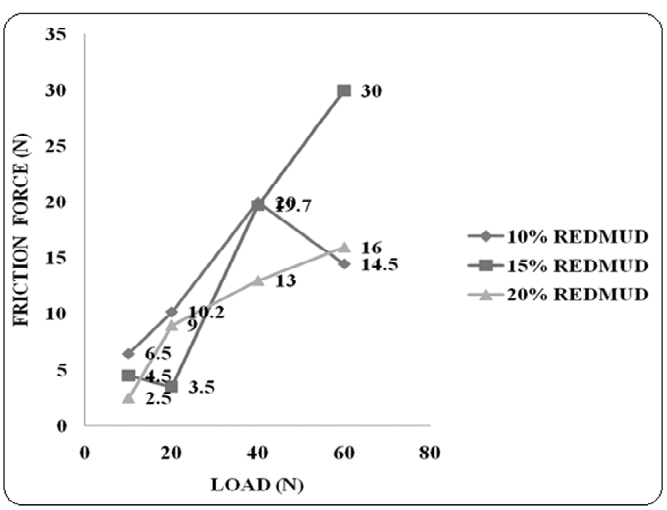

Figure 11: The variation in frictional force with the load change and with the various reinforcement of redmud

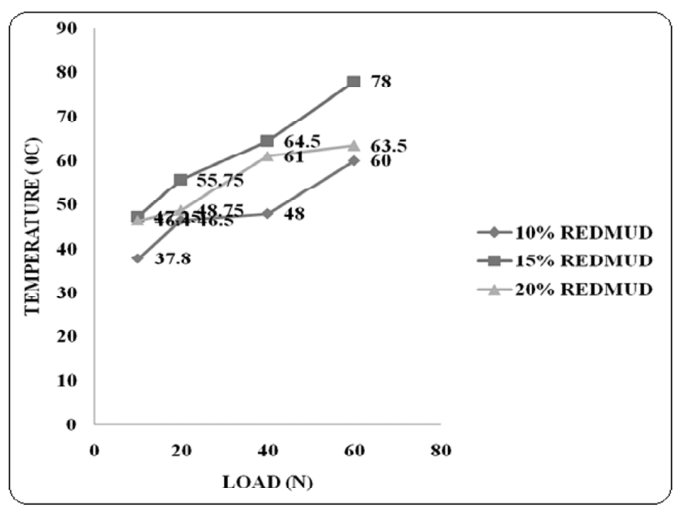

Figure 12: The variation of rise in temperature with the load change and with the various reinforcement of redmud

- Dispersion of redmud particles in Aluminium alloy6061 matrix increases the hardness of the matrix material.
- The wear resistances of aluminium alloy6061 matrix, redmud particulate reinforcement composites are superior to that of unreinforced Aluminium alloy6061.Their wear resistance increases with the wt. % of redmud particles.
- Co efficient of friction decreases with the increase in weight % of redmud reinforcement.
- The wear resistance of Aluminium alloy6061 matrix, redmud particulate reinforcement composite increases with the increase in load.
- For the better wear resistance at the minimum load of application in Aluminium alloy6061 matrix material, the maximum amount (20%) of redmud reinforcement is to suggest.
- For the better wear resistance at the maximum load application in Aluminium alloy6061 matrix material, the minimum amount of (10%) of redmud reinforcement is to be suggested.

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