“Tribological behavior of AL-lm25 and SiC”

Prof.Jalees Ahemad[1], Dr..R.A.Kapgate[2],Prof.N.D.Sadaphal[3] , Prof.Y.H.Ahire[4]

[1 3 4]Assistant Professor,Mechanical Engineering,SRES COE, Kopargaon Maharashtra,India
[2] Principal, Mechanical, K.B.P.Polytechnic, Kopargaon Maharashtra,India.

---***---

Abstract – *Aluminium and its alloys occupy third place among the commercially used engineering materials. In commercial aluminium casting alloys, Al–Sic base alloys are perhaps most common particularly due to very attractive characteristics such as high strength to weight ratio, good workability, excellent castability, good thermal conductivity and corrosion resistance. In this paper Aluminium LM25+SiC composites containing three different weight percentages 5%, 10%, and 15% of Sic have been fabricated by casting method. Friction and wear characteristics of Al LM25+SiC composites have been investigated under dry sliding conditions and compared with those observed in pure aluminium LM25. Dry sliding wear tests have been carried out using pin-on-disk machine at normal loads of 1, 2 and 3 Kg and analysis is done by using Design Expert 7 Software. Pins of Alloy are prepared in sizes of diameter 8mm and length 30mm. The testing is done on above material by varying load, speed and sliding distance. It appears that the pin-on-disc test can give considerably useful and informative friction and wear results .it was observed that the wear rate varies linearly with normal load but lower in composite compared to that in base material. Further it was found from experimentation that the wear rate decreases linearly with increasing weight fraction of SiC. The best results have been obtained at 10% weight fraction of SiC.*

Keywords: Design of Expert (DOE), Silicon Carbide SiC.

1. INTRODUCTION-

Composite material is composed of more than one material. It is a combination of two or more micro constituents which differ in form/chemical composition. Also those materials are essentially insoluble when mixed with each other. Development of metal matrix composites has been the major innovations in materials in the past 30 years. The particle reinforced light metals are attracting the attention of producers of materials, end users because of outstanding mechanical and physical properties. The main attractions for their use in the automotive industry can be shortlisted as follows: mass reduction, especially in engine parts, high wear resistance or their lubrication characteristics, improved material properties, especially stiffness and strength, giving either enhanced component durability or permitting high service conditions, lowered thermal expansion coefficient. More and more demand for light weight, inexpensive, energy saving, stiff, strong material in aero plane, space, defense, military service and automotive uses has provided a steadily growing effort for a developed composite material. Like all the composites, aluminum matrix composites are not a only material but it is a group of materials whose properties like stiffness/strength/density/ thermal and electrical properties can be tailored. The matrix alloy [MMC], reinforcement material, volume, reinforcement shape, enforcement location and fabrication method, all can be varied to achieve required properties.

Most commonly encountered industrial problems which lead to the components replacements and assemblies in engineering are wear. Hence, many efforts have been made for producing durable materials and techniques for reduction in the wear of tools and engineering components. It includes modification for bulk properties of the materials, their surface treatments and application of coating etc. Over the last 10 years, lots of efforts have been made for understanding the wear behavior of the surfaces in sliding contact between teo material and the mechanism responsible for wear. The applications for aluminium and their alloys for the machine components are day to day increasing in the industry. But, little has been researched on the wear behavior of aluminium and its alloys after the addition of refiner of grain and modifier.[1]

2.0 EXPERIMENTAL PROCEDURE-

The standard samples pins of cylindrical shape were prepared in size of (Ø8mm X 30 mm) with different weight % of SiC.

Fig.1- Pin-On-Disc Machine

Fig.2 Monitor for Wear and Friction

2.1 WEAR TEST FOR EXPERIMENTATION-

Dry sliding wear tests was conducted for aluminum LM25 & composites by the use of pin-on-disc machine model TR – 20. This model was supplied by M/S Ducom , Bangalore (India). The tests were conducted in air. Wear tests was conducted using cylindrical samples of size (Ø8mm X 30 mm) which had flat surfaces in the region of contact and the their corner was rounded. The counter face of a 160mm diameter rotating metal disc made of En-24 steel with a hardness of HRC65 which is provided on pin-on-disc machine. The wear tests were conducted under the three normal loads 10N, 20N and 30N. Each and every wear test has been carried out for a varying sliding distance of 1, 1.5,2 km and with the speed of 200,400 and 600 rpm. Tangential force was monitored continuously. Frictional force along with wear is measured by digital display of pin on disc machine tester. This machine also provides study of friction and wear characteristics in sliding contacts with desired conditions. Sliding takes place between the stationary pin and a rotating disc. Normal load, rotational speed and wear track diameter can be varied for suiting the test conditions. Tangential frictional force and wear were monitored with electronic sensors and recorded on PC. Also, these parameters are available as functions of load and speed. The friction coefficients were determined from the friction force and normal load.

2.2 DESIGN OFEXPERIMENT –

It is methodology which is based on statistics and other discipline to arrive at an efficient, effective planning of experiments to obtain valid results and conclusions from the analysis of experimental data. It (DOE) determines the pattern of observations to be made with a minimum of experimental efforts. Specifically, it offers a systematic approach for studying the effects of multiple variables, factors on products, process performance by providing a structural set of analysis, in a design matrix. More and more specifically, the use of orthogonal Arrays (OA) for DOE gives an efficient and effective method to determine the significant factors and interactions in a given design problem provided.

3. DISCUSSIONS AND RESULTS-

The experimental results were analyzed using DOE software. Fig.2 (a-c) shows variation of wear with velocity, load and sliding distance for pure aluminum lm25. It is found that the wear rate increases linearly for load and velocity, while the effect of sliding distance on wear is normal. But, the wear of composite (Al LM25+10SiC) is lower than that was observed in pure Al LM25 which is shown in fig.3 (a-c). The experimental results of composite material and pure material are given in following Table 1.

Table1- Effect after addition of SiC in Al-LM25 on wear

Speed= 200 rpm & Load= 10N

Sliding Distance (m)	Wear (LM25) (micron)	Wear (LM25+10%SiC) (micron)
200	139.201	107.212
400	248.591	120.632
600	300.461	137.032
800	351.351	151.651
1000	451.141	165.651

Fig 4 and 5 shows interaction effect of load and velocity on wear for pure material and composite respectively. Wear rate increases as we increase load and velocity. It has been observed that wear loss is maximum for aluminium LM25 and then it goes on decreasing as the SiC increases up to 10%. Again this trend changes for 15%SiC content because of non-uniform mixing of materials.

Taguchi's Method- The experiments design used for investigation of friction and wear characteristics was Taguchi's approach of orthogonal arrays. Hence, a fractional design using orthogonal array (OA) was used for finding out the relation between three variables/factors (W, V, COF and S) on wear and friction. Each factor was kept at three levels.

Table 2- Layout for L_9 (3^4) Orthogonal Array for Experimentations

Trial no.	A Load in (Kg)	B Velocity (m/s)	C SD (Km)
1	1	1.047	1
2	1	2.094	1.5
3	1	3.14	2
4	2	1.047	1.5
5	2	2.094	2
6	2	3.14	1
7	3	1.047	2
8	3	2.094	1
9	3	3.14	1.5

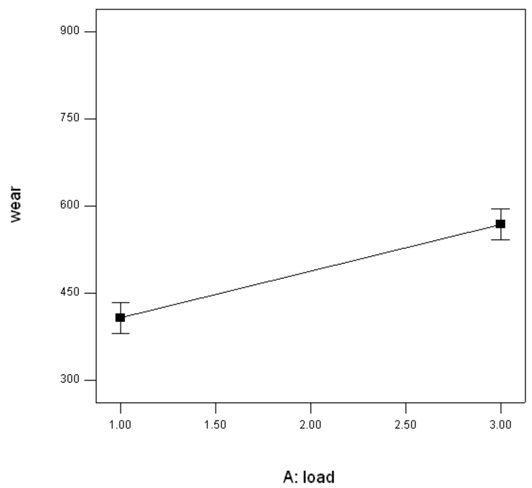

Fig.2 (a) Variation of wear with load for Al-Im25

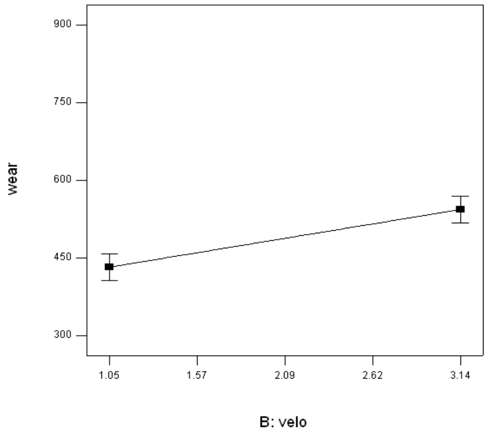

Fig. 2(b)- Variation of wear with velocity for Al-Im25

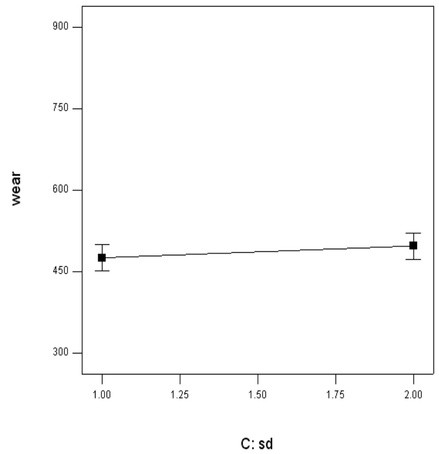

Fig 2(c)-Variation of wear with sd. for Al-Im25

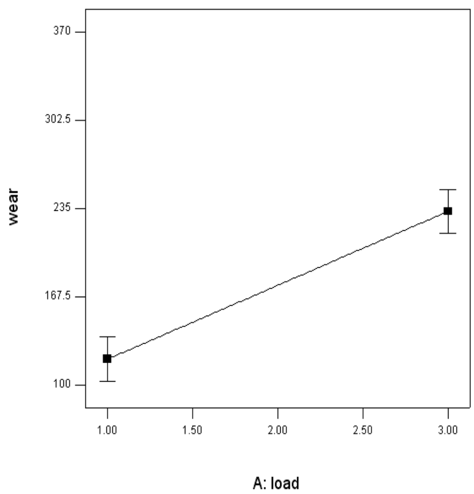

Fig.3 (a)- Wear v/s load for Al-Im25+10%SiC

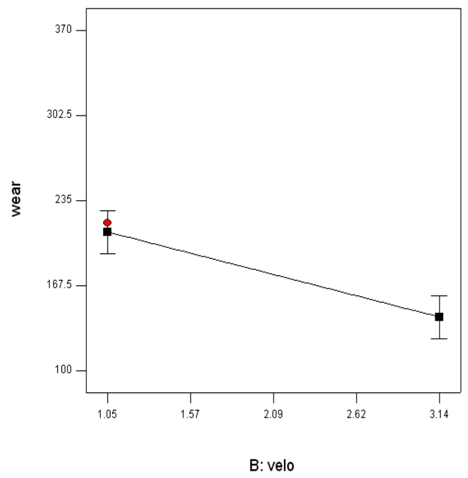

Fig.3(b) Wear v/s vel. for Al-lm25+10%SiC

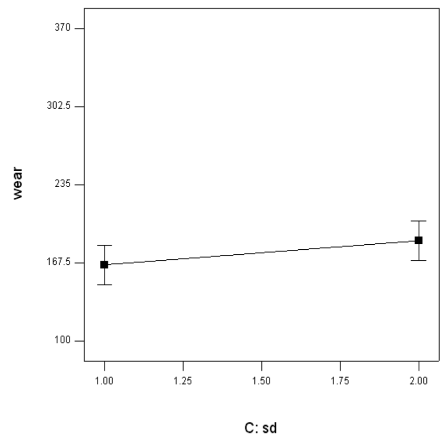

Fig.3(c) Wear v/s sd. for Al-lm25+10%SiC

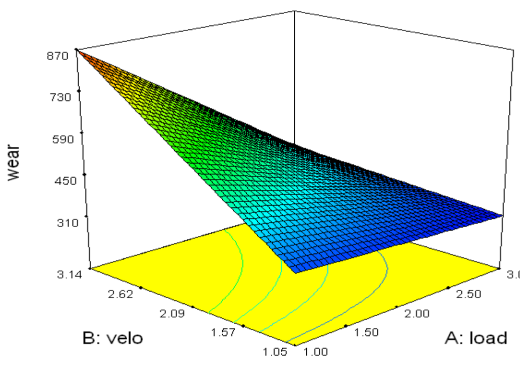

Fig.4- Interaction effect for velocity and load on wear for Al-lm25

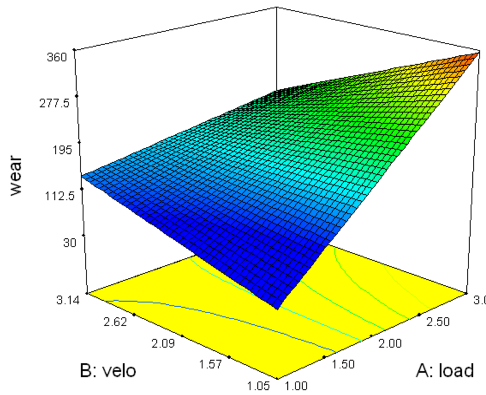

Fig 5 Interaction effect of load and velocity on wear for Al-lm25 +SiC

3. CONCLUSIONS-

The experimental study revealed out following important conclusions:

1. For a given load provided , the wear rate of pure material and composites pins, increases linearly with velocity under dry sliding.
2. Also, the wear rate goes on increasing linearly as the normal load increases. But, the composites have shown a lower rate of wear (up to 10% SiC) as compared to that was observed in pure aluminium LM25.
3. The wear rate again increases with a composite of 15% of SiC, because of non-uniform mixing of materials.

REFERENCES

[1] ManojSingla, VikasChawla, "Study of wear Properties of Al-SiC Composites", Journal of Minerals & Materials Characterization & Engg., Vol. 8, No.10, pp. 812-819, 2009.

[2] D. Deepak Dwivedi, Lakhvir Singh, VikasChawla,"Development of Aluminium based Silicon Carbide Particulate Metal Matrix Composite", Journal of minerals & materials Characterization & Engineering, Vol. 8, No.6, pp 455-467, 2009.

[3] Akul Patel, Vipul Patel, "A Review on effect of grain refinement and modification on the dry sliding wear behavior of eutectic Al– Si alloys", International Journal of Engg. Research and Applications (IJERA), Vol. 2, Issue 3, May- 2012, pp.417-2421.

[4] A. Chennakesava R, "Matrix of Al-alloys for silicon carbide particle reinforced MMC",Indian Journal of Science and Tech., Vol. 3 No. 12 (Dec 2010).

[5] K.M.Shorowordi,J.P.Celis,"Chemical and structural nature of trio-surface for aluminium–SiC composites at nanometre and micrometre length scales", Materials Science and Engineering A 425 (2006) 213–218.