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Wear and Strength Behaviour of Rolled Hybrid Composites produced by Stir Casting Method

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Abstract: Aluminium Magnesium alloys reveals several specific and attractive properties that qualify them to be used in many automotive and aeronautical applications. Aluminium matrix composites have good mechanical and physical properties, when reinforced with flyash and Graphite particles. In the present work, the number of cast samples of Al6Mg /flyash/Graphite composites was prepared by using stir casting followed by hot rolling. The percentage inclusions is fixed for 2%fly ash and varied Graphite from 2 to 6wt%. The composites prepared with a stirring speed of 400 rpm and stir casted at 740^{0}C. Wear resistance is superior for higher percentage of reinforcement with increase in pull out of rolling. Higher weight percentage of reinforcements with higher reduction results in shrinkage cavities and particle cracking during rolling
Keywords: Aluminium, Flyash, Graphite, Stir Casting, Rolling, SEM

I. INTRODUCTION

In the continuing quest for improved performance, which may be specified by various criteria including less weight, more strength and lower cost the materials being used currently often reach the limit of their usefulness. This resulted in the emergence of composites. The tailor made specific properties of materials for better overall performance is so great and diverse that no one material is able to satisfy the conflicting requirements of constructive properties. This has lead to the research on materials, which is able to satisfy the varying demands from the different industries. This naturally leads to the resurgence of the ancient concept of combining different materials in an integral composite material to satisfy the user requirement. There are more than eighty thousand materials represented in the market, and this figure is rapidly increasing. Advanced materials are being developed to an increasing extent [1]. Among these materials one finds prominently used composite. The development of composites as a new engineering material has been one of the major innovations in the field of materials in the past couple of decades [2]. The MMCs are a new range of advanced materials used in applications where conventional materials and alloys are not suitable for use.

This outstanding benefit of composite materials is that they can be tailored to produce various combinations of stiffness and strength [3, 4]. It is possible to develop new material with a unique combination of properties previously unattainable with conventional materials. This ability to engineer materials with specific properties for specific applications represents a great potential advantage of composites. It is also possible to selectively reinforce particular areas of components, thus providing development of materials properties only in area, which is truly necessary.

In materials science, wear is erosion or sideways displacement of material from its "derivative" and original position on a solid surface performed by the action of another surface. Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. The need for relative motion between two surfaces and initial mechanical contact between asperities is an important distinction between mechanical wear compared to other processes with similar outcomes[5-9]

The tribological behavior of stir casting of Al-Si composites against the automobile brake was studied in pin on disc tribo meter.Al metal matrix composites material was used as disc where as break pad material forms the pin .It has been found that both coefficient and friction vary with applied load ,wear rate has observed increase where coefficient of friction decreases. However both wear rate and coefficients were observed to vary proportionality with the sliding speed. In this during the formation of a tribolayers was observed in presence of which can affect the wear behavior, apart from acting as a source of wear debries.Tribo layer formed over the work disc surfaces was found to be heterogeneous in nature. It has also investigated the morphology and topology of worn surfaces and debris were studied using scanning electron microscope (SEM) [10-13].

This paper deals with the aluminium (A 380) composites containing flyash, fabricated using stir casting technique. Aluminium was reinforced with flyash particles of three different size ranges (50-75μm), (75-103μm) and (103-150μm) in 3, 6, 9 and 12 percentages by weight. Unlubricated pin-on disc tests were conducted to examine the wear behavior of the aluminium alloy and its composites.

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Wear tests were conducted at loads of 20 N, 30 N and 40 N and sliding speeds of 2 m/s, 3 m/s and 4m/s for a constant time period of 10 minutes. Results showed that composites reinforced with coarse flyash particles exhibit superior wear resistance than fine flyash particles. On the other hand, abrasive resistance decreased with increase in load and speed. Wear rate of composites decreased with increase in flyash particles for all size ranges. Worn surfaces of the pins were then analyzed using Scanning Electron Microscope to study the wear mechanisms and to correlate them with the wear test results [14-16].

Many researchers have carried out research work on secondary process for the mechanisms of high temperature deformation of composites. Compared with some exclusive and costly methods such as forging, extrusion, rapid solidification, and equal channel angular pressing (ECAP), rolling process was a common way that can fabricate large dimensioning products [17-19].

Also research is not extended for hot rolling of composites produced by fly ash and Graphite particulates as reinforcement using stir casting technique. Hence, in the present work Al-Mg6 alloy reinforced fly ash and Graphite composite using stir casting method is carried out to obtain castings. A further objective is to investigate wear and tensile properties of hot rolled composites produced.

II. EXPERIMENTAL DETAILS

The fabrication was done in a three-stage resistance sort 12 KW limit furnace. The maximum temperature of the furnace is 1200^0 C with a precision of 10^0 C fitted with seven segmented light emitting diode read out and partially integrated differential digital temperature controller. It is fitted with an alumina melting pot at its inside and it can be angled by 90^0 on its orientation axis empowering pouring of the melt. Muffle furnace was used to preheat the Flyash and Graphite particulates to a maximum temperature of 400°C and the time period for preheating is about 1 hour. The preheating of the reinforcements is vital with a specific end goal to decrease the temperature gradient and to enhance wetting between the liquid metal and the particulate support.

The liquefying temperature of Al-6Mg composite is 550-620^0C. A known amount of the Al-6Mg ingots were cured in 10% NaOH arrangement at room temperature for ten minutes. Surface taints were taken off by pickling. The filth formed was cleared by submerging the ingots for few seconds in a blend of one section Nitric acid and one section water, and then washed in methanol. pickled ingots were dried and placed into the crucible for melting purpose. Melt was heated to a temperature of 720^0 C. Temperatures were recorded using thermocouple.The Molten metal was heated to red hot condition and was continuously stirred using a graphite impeller to create a vortex. Vortex was created in the molten metal due to high speed of the stirrer, the speed was around 500rpm.The graphite rod was immersed to a depth of approximately one third the height of the molten metal from the bottom of the crucible The pre-heated reinforcement particles were introduced into melt.

The wetting of the particles and the matrix was ensured by constant stirring which was carried out for more than 20 minutes to avoid agglomeration. The scum powder was used as slag removing agent and degassing tablet HexaChloroethene was added to completely remove any gases in the molten metal and continued reheating to a super heated temperature (730°C), then it was poured into the pre heated metal mould to reduce the porosity and enhance the mechanical properties, and finally the castings were obtained.

The rolling samples were prepared for a dimension of 180mm length, 25mm width and 25mm thickness. The samples were successively hot rolled with a temperature of 410°C and the thickness reduction of 0.25mm per each cycle into different final reductions of 8%, 16% and 25% with intermediate heat treating process shown in Fig.1 (a). The rolling mill with a loading capacity of 15 tons is used for rolling the samples as shown in Fig. 1(b). The roll diameter was 85mm and roller speed was set to 30rpm. Hardness measurements were performed using a Brinell hardness tester with a load of 10kgf as per ASTM-E10-01 as shown in Fig 3..Tensile test samples having 6mm diameter with a gauge length of 25mm, were prepared for testing in tensometer as per ASTM E-8 standards .

Fig. 1. Rolling of samples (a) Rolling specimen (b) Rolling of composite in a rolling mill

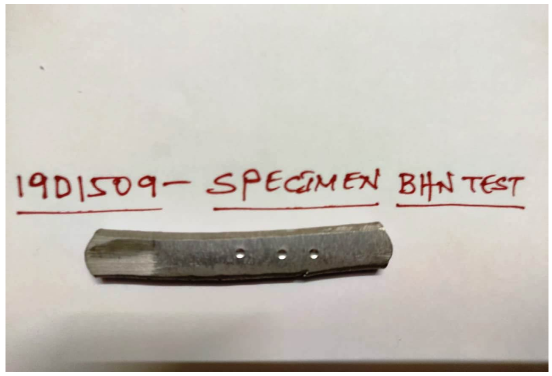


Fig.3 Hardness Test Specimen

Dry sliding wear tests for different number of specimens was conducted by using a pin-on disc machine (Model: Wear & Friction Monitor TR-20) is shown in Fig.4.

Fig.4 Wear testing machine

The pin was held against the counter face of a rotating disc (EN31 steel disc) with wear track diameter 100 mm. The pin was loaded against the disc through a dead weight loading system. The wear test for all specimens was conducted under the normal loads of 10N, 20N, 30N, 40N.

Wear tests were carried out for a total sliding distance of approximately 2000m varying 500m, 1000m, 1500m, 2000m under similar conditions as discussed above. The pin samples were 23mm in length and 10mm in diameter. The surfaces of the pin samples were slides using emery paper (80 grit size) prior to test in order to ensure effective contact of fresh and flat surface with the steel disc. The samples and wear track were cleaned with acetone and weighed (up to an accuracy of 0.01 gm using Weighing machine) prior to and after each test. The wear rate was calculated from the volume loss technique and expressed in terms of wear volume loss per unit sliding distance and unit load.

The various parameters considered in this test are:

A. Load
B. Speed
C. Distance

Specification of Pin on Disc testing machine

1) Normal load range – Upto 200N
2) Frictional Force range – Upto 200N
3) Disc speed range – 100 to 2000 rpm
4) Pre-set timer range – Upto 99hrs:59min:59sec
5) Wear disc - Diameter 120mm and thickness 8mm
6) Wear disc Track Diameter – 10mm to 100mm
7) Specimen pin Diameter – 3 to 10mm
8) Pin length – 20 to 30mm

III.RESULTS AND DISCUSSIONS

The hardness variation of Al-6Mg composite is shown in Fig 56. The hardness of the composite increases marginally with the increase of Reinforcements addition. Owing to higher percentage & densification of the tough particles of Flyash and Graphite in composite. The hardness values varied from 53 BHN to 69 BHN.

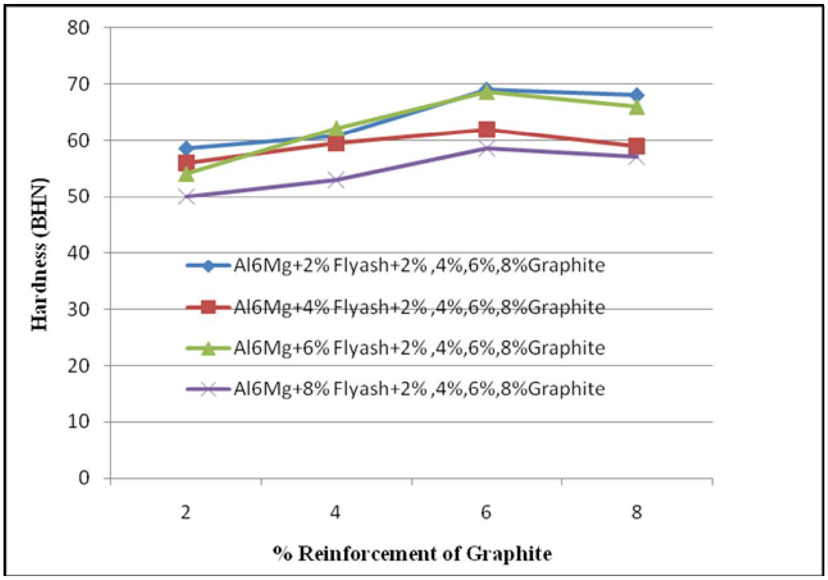
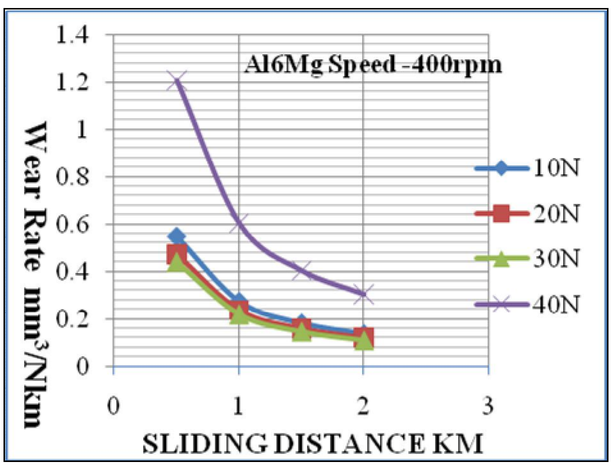
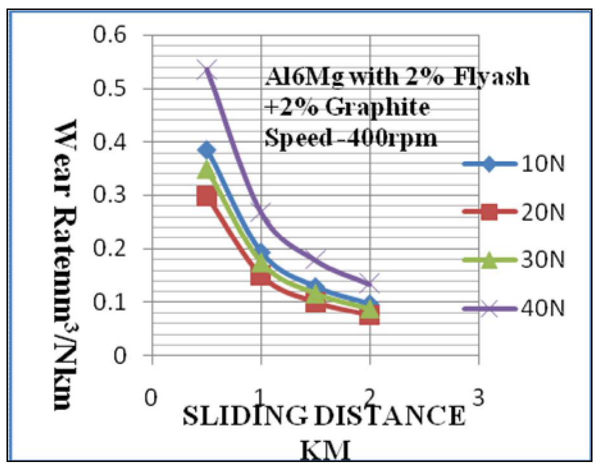


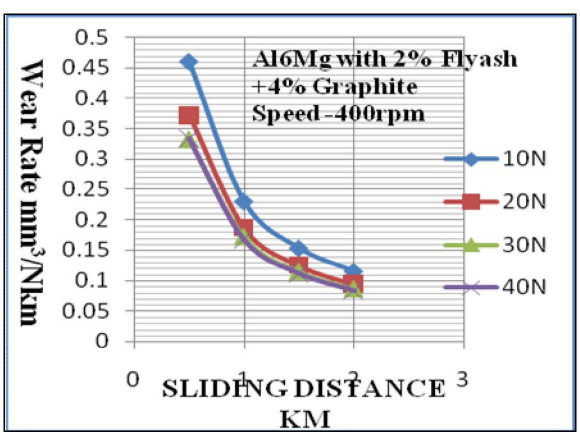
Fig 5 Variation of Hardness with % Reinforcements (For 25mm Dia)



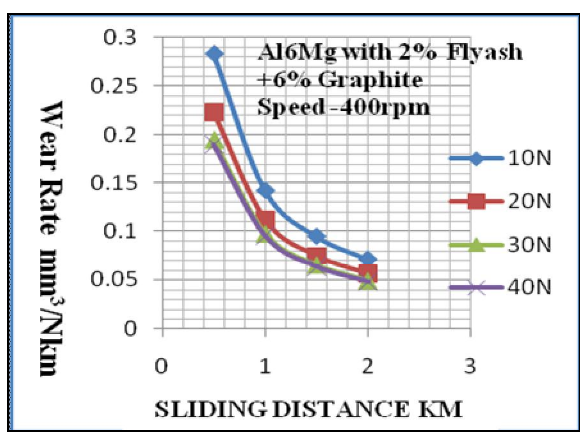
(a)



(b)



(c)



(d)

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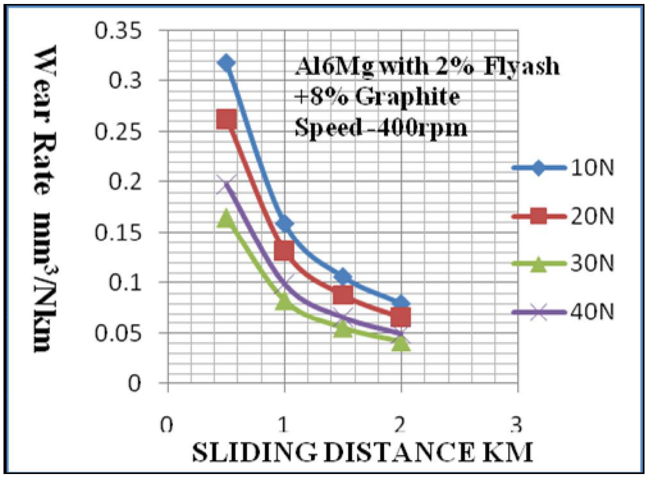


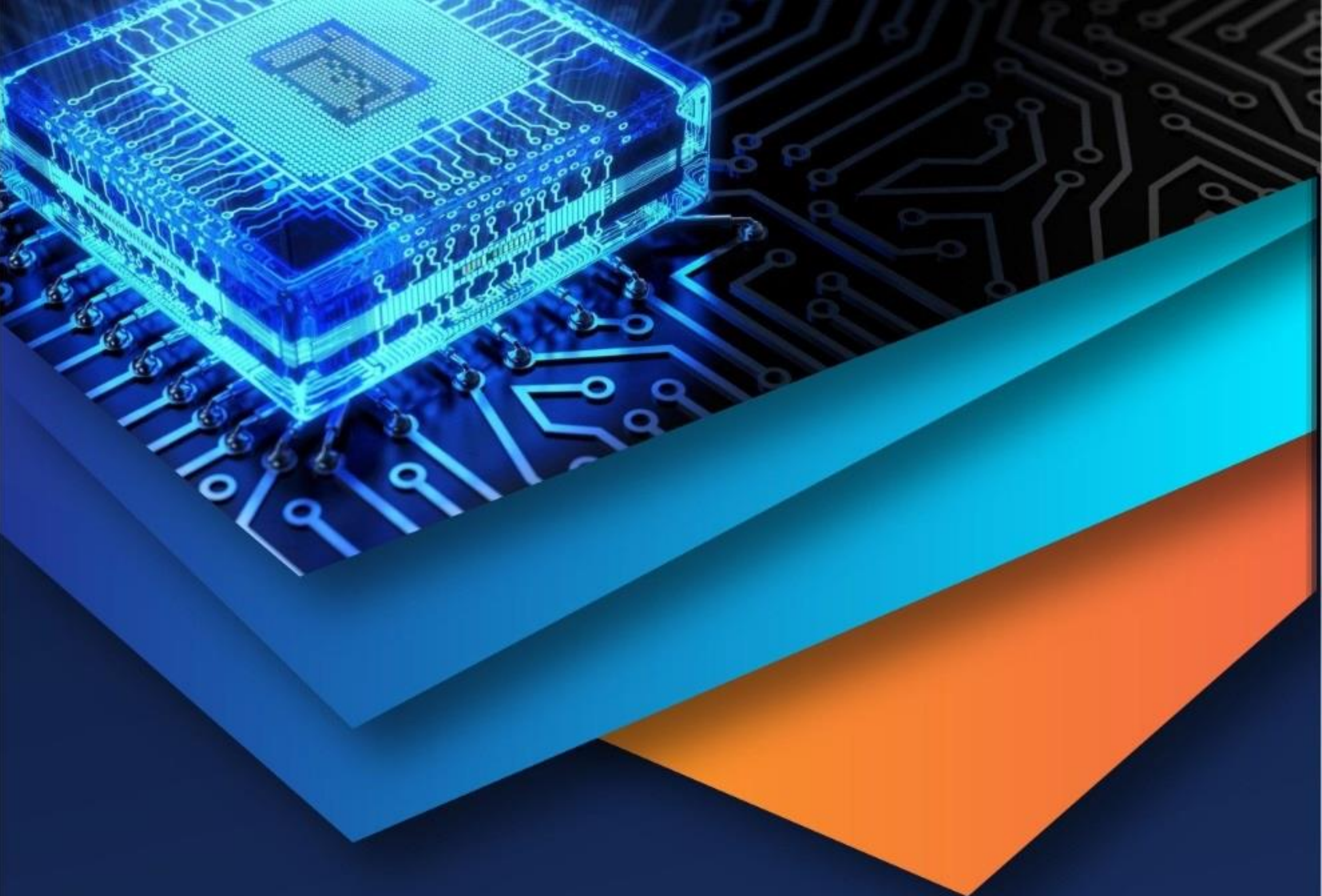
IV. CONCLUSIONS

The Research work entitled, "Production of Aluminium Magnesium Alloy Flyash Graphite Metal Matrix Composites and its Rolling Application in Industry" has led to the following Conclusions:

A. The composite castings with Al356 as base material and Flyash-Graphite reinforcements with varying particles of 44µm mesh size (2 % to 8%) were successfully prepared by using stir casting technique.
B. The UTS of rolled specimens were analyzed and Al-6Mg with 6 wt% showed highest strength of 204.74 MPa
C. Hardness values of the rolled specimens for Al-6Mg with 6 wt% showed highest BHN of 72.2
D. The base alloy wear rate is higher than the developed composite Extreme wear is portrayed by a excessive plastic disfigurement as a consequence of thermal softening of the material. Flyash and Graphite particles not only bring down the wear rate but also retards the change over to excessive wear.

REFERENCES

[1] Introduction to Composites and History of Composites, 2001. Composites, Volume 21 of ASM Handbook,
[2] Jatitz, Whittenberger,J.D. 1990, in Solid State Powder Processing, ed. A.H.Clauer & J.J. deBarbadillo. The Minerals, Metals and Materials Society, Warrendale, PA,,p. 137.
[3] Berghezan, Stoloff, N.S. & Alman, D.E. , 1990, In Intermetallic Matrix Composites vol.194, ed. D.L. Anton et al. Materials Research Society, Pittsburgh, PA, p. 31.
[4] J.A.E. Bell, A.E.F Warner, and T.F. Stephenson, 1996,Processing, Properties, andApplications of Cast Metal Matrix Composites, P. Rohatgi, Ed., TMS, , p 247.
[5] F.T. Wallenberger, 1996, Advanced Inorganic Fibers—Processes, Structures,Properties, pplications, Kluwer Academic Publishers, Dordrecht, the Netherlands.
[6] T.F. Starr, 1997,Glass-Fibre Dictionary and Databook,2nd ed., Chapman & Hall,London,
[7] T.F. Starr, 1995, Carbon and High Performance Fibres, Directory and Data book, 6thed., Chapman & Hall, London,
[8] D.W. Johnson ,1998,National Materials Advisory Board Committee, , Chair, "Ceramic Fibers and Coatings," National Research Council, Publication NMAB-494, National Academic Press, Washington, D. C.,
[9] V.I. Kostikov,1995, Fibre Science and Technology, Chapman & Hall, London,
[10] Kelly, 1994, Concise Encyclopedia of Composite Materials, Revised ed., R.W. Cahn and M.B. Beaver, Ed., Pergamon, Elsevier Science Ltd., Oxford.
[11] V. Milewski and H.S. Katz,1987, Handbook of Reinforcements for Plastics, VanNostrand Reinhold Company, New York.
[12] M. Sreenivasa Reddy, Dr. Soma V. Chetty, Dr. Sudheer Premkumar , 2012,"Evaluation of Hardness And Tensile Propertiesof Al7075BasedComposite "International Journal of Advances in Engineering Research http://www.ijaer.com/(IJAER) Vol. No. 3, Issue No. I,
[13] W Q.Song ,P kraulis ,A.P.Mourrtz 1995,The effect of thermal ageing on the abrasivewear behaviour of age-hardening 2014 Al/SiC and 6061 Al/SiC composites wearVol.85, pp.125-130.
[14] Narinder Singh, Shweta Goyal and Kishore Khanna, July 2010. "Effect of ThermalAgeing on Al Alloy Metal Matrix Composite", Department of Mechanical Engineering, M.E. Thesis, ThaparUniversity, Patiala, India,
[15] Yu Zingwen et.al Fuhe Calliao Xuebao/Acta,May 2000, Materiae Compositae Sinica Vol. 17, N 2,pp 30-33.
[16] Shakesheff A.J. et al1 1995,,May Journal of Material Science Vol.30, N9, pp. 2269-2276
[17] Zhou W.,Jan 1997, Journal of Material processing technology Vol.63, N1-3, pp.358-363
[18] Sergej, J. Trowsdale, B. Noble, S.J.Harris, I.S.R.Gibbons, G.E.Thomson and G.C.Wood,1996, "The influence of silicon carbide reinforcement on the pittingbehavior of aluminium", Corrosion Science, vol.38, No.2, pp.177-191.
[19] Yukun and Dolholf R.Kochendorfer,1993, Composite Science and Technology, Vol.46, pp 1-6.



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