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Wear testing on heat treated al6061 with reinforcements

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***Abstract*— Aluminium Metal matrix composites are gaining wide spread popularity in several technological fields and are finding extensive commercial applications in several sectors such as aerospace, space, automotive and structural applications. The development of aluminium metal matrix composites with discontinuous reinforcement represents a well-established method for improving the strength and stiffness of a material. Al 6061 alloy based composite is age-harden able and can be strengthened through heat treatment. The present work is aimed at investigating the wear behavior of heat treated Al 6061 hybrid metal matrix composites. Tungsten carbide (WC) and graphite particles have been used as the reinforcements. Composites have been fabricated by stir casting method. The quenched samples are then subjected to artificial ageing for durations of 2 hr at a temperature of 440K. Wear studies were performed using a pin-on-disc apparatus. Investigations show that heat treatment had a profound influence on the wear behavior of both the matrix alloy and its composites.**

Keywords - Metal matrix composites, Heat treatment, Wear, Hybrid aluminium matrix composites.

I. INTRODUCTION

A Composite material is a material system composed of two or more macro constituents that differ in shape and chemical composition and which are insoluble in each other. The discontinuously reinforced Al alloy matrix composites offer wide range of properties suitable for a large number of engineering applications. Substantial progress in the development of light metal matrix composites has been achieved in recent decades, so that they could be introduced into the most important applications. In traffic engineering, especially in the automotive industry, MMCs have been used commercially in fiber reinforced pistons and aluminium crank cases with strengthened cylinder surfaces as well as particle-strengthened brake disks. The technology of MMCs is in competition with other modern material technologies, for example powder metallurgy.

The advantages of the composite materials are only realized when there is a reasonable cost performance relationship in the component production. The use of a composite material is obligatory if a special property profile can only be achieved by application of these materials. The reinforcement of metals can have many different objectives. The reinforcement of light metals opens up the possibility of application of these materials in areas where weight reduction has first priority. Here we use the Al6061 metal matrix and it is reinforced with tungsten carbide and graphite and addition to it age hardening process is done at temperature of 440K.

Metal composite materials have found application in many areas of daily life for quite some time. Often it is not realized that the application makes use of composite materials. These materials are produced in the conventional production and processing of metals. Materials like cast iron with graphite or steel with a high carbide content, as well as tungsten carbides, consisting of carbides and metallic binders, also belong to this group of composite materials.

Al6061 is selected as Metal Matrix composites(MMC) and Tungsten carbide(WC) and Graphite(Gr) is selected as reinforcement material.

Percentage of reinforcement is varied is to mmc according to the requirement.

Initially the tungsten carbide is taken as reinforcement and mixed in percentage of 5%, 10%, 15%, 20% with Al6061.Three parameters are taken, in this one parameters is varied accordingly and other two parameters are fixed. In this parameters taken are load, sliding distance, sliding speed. Our aim is to study the wear behaviour of heat treated aluminium metal matrix composites reinforced with tungsten carbide and graphite.

II. EXPERIMENTAL PROCEDURE

The stir casting technique was used to fabricate the composite specimen as it ensures a more uniform distribution of the reinforcing particles This method is most economical to fabricate composites with discontinuous fibers or particulates. In this process, matrix alloy was first superheated above its melting temperature and then temperature is lowered gradually below the liquids temperature to keep the matrix alloy in the semisolid state. At this temperature, the preheated tungsten carbide and graphite particles were introduced into the slurry and mixed. The composite slurry temperature was increased to fully liquid state and automatic stirring was continued to about five minutes at an average stirring speed of 300-350 rpm.

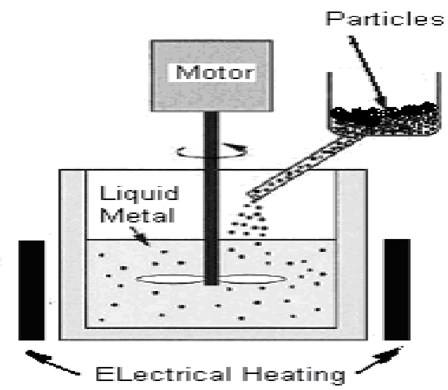


Figure-1

Graphite is added 2% as additional reinforcement with already taken combination 5%, 10%, 15%, 20% of tungsten carbide with Al6061. The inclusion of graphite as additional reinforcement in Al/Sic reinforced composite reduces the thrust force and burr formation. The specimen is fabricated using the stir casting process. In stir casting process initially Al6061 is heated up to 750^0c and by this heat treatment Al6061 is converted to molten state. The reinforcement material tungsten carbide is mixed with required percentage to the molten Al6061.Figure-1 shows the stir casting setup. And then stirring is done by the blade that is placed inside the bowl where the molten Al6061. This blade is connected to the motor by using connecting rod. After mixing the reinforced material, the molten material is poured into the pattern that already prepared for our required shape and size. The specimen length is 150mm and diameter is 15mm. After that the specimen length is reduced to our required length and diameter as 10mm diameter and 25mm length.

III. AGE HARDENING PROCESS

Hardening is a metallurgical and metal working process used to increase the hardness of a metal. The hardness of a metal is directly proportional to the uniaxial yield stress at the location of the imposed strain. A harder metal will have a higher resistance to plastic deformation than a less hard metal .Precipitation hardening also called age hardening is a heat treatment technique used to increase the yield strength of malleable materials, including most structural alloys of aluminium, magnesium, nickel, titanium, and some stainless steels. In this each proportion of specimen is heated at temperature of 440K in the muffle furnace. The temperature is maintained for 2 hours of duration then water quenching has been done immediately. After age hardening process wear testing has been done to study the wear behavior of the each proportion.

III. WEAR TEST

Wear tests were carried out using pin-on-disc apparatus with data acquisition system. The tests were carried out by rubbing a hybrid composite specimen against a rotating disc . The tests were conducted at a room temperature of 300K and a relative humidity of 30 per cent. The wear loss of the pin in microns was recorded during each wear test using an LVDT transducer with accuracy 1.0mm. On wearing of the pin surface during rubbing with counter disc, the pin continuously moves down to re-establish the contact with the disc surface. The linear downward motion of the pin is thus a measure of the wear loss of the pin material that is being recorded by the LVDT provided in the wear testing apparatus. A pin of a uniform square cross-sectional area is held in position by a 4-jaw chuck which is mounted onto a rail system.

A pin- on- disc test apparatus is like the figure-2 was used to investigate the dry sliding wear characteristics of the aluminum alloy and its composites as per standard. The experiments were conducted to study the effect of sliding speed, applied load, amount of reinforcement, sliding distance on wear behavior of composites and the matrix alloy. The tests were conducted with the load ranging .To study the effect of sliding distance, different sliding distances were considered at constant sliding speed and applied load. All these tests were conducted at room temperature. Before wear testing the specimen is weight is noted to compare the weight loss.

During the test, the specimen was pressed against the counterpart rotating against steel disc having hardness of 65 HRc by applying load. After running through a fixed sliding distance, the specimen were removed and weighed to determine the weight loss due to wear. The difference in the weight measured before and after test gives the wear of the composite specimen. The wear of the composite was studied as a function of the volume percentage of the reinforcement, sliding distance, applied load and the sliding velocity.

Figure-2

The wear testing is done by varying one parameter and fixing other two parameter as constant. If velocity is varied other two parameter load and sliding speed is kept constant. In next testing load is varied other two parameters sliding distance and speed is kept constant. In final testing sliding distance is varied other two parameters load and velocity is kept constant. After testing weight loss is calculated by taking the final weight.The below mentioned formula is used to calculate the weight loss

Weight Loss, $W_L = W_I - W_F$

Where, W_I= Initial Weight of the Specimen

W_F= Final Weight of the Specimen

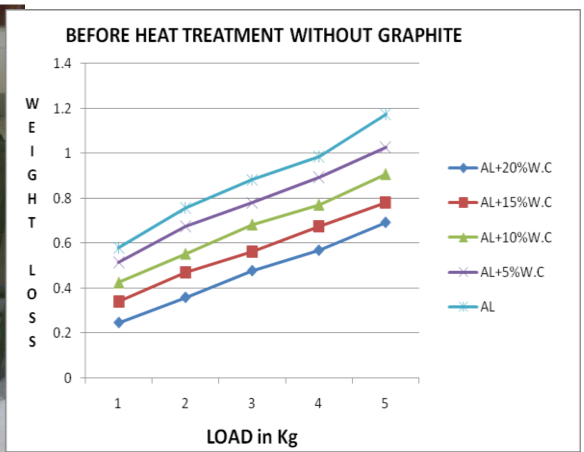
PARAMETERS		
Load, kg	Sliding Distance, m	Velocity, m/s
1	100	1
2	200	2
3	300	3
4	400	4
5	500	5

IV. RESULT AND DISCUSSION

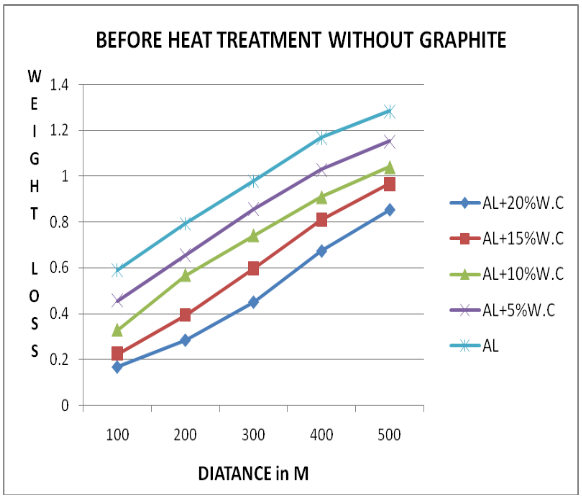
1.BEFORE HEAT TREATMENT WITHOUT GRAPHITE

Weight loss is plotted for the before heat treated without graphite. Graph shows that increase in percentage of tungsten carbide is directly proportional to increase in wear resistance. In this graph shows about before heat treated without graphite for three different parameters like load, distance and velocity.

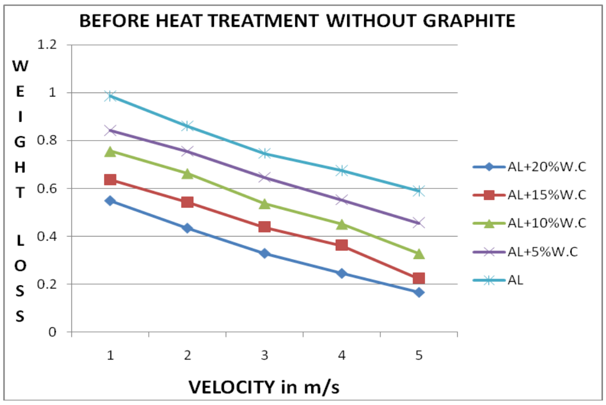
GRAPH-1



GRAPH-2



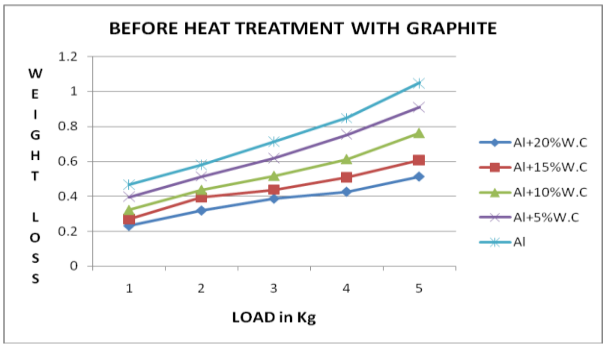
GRAPH-3



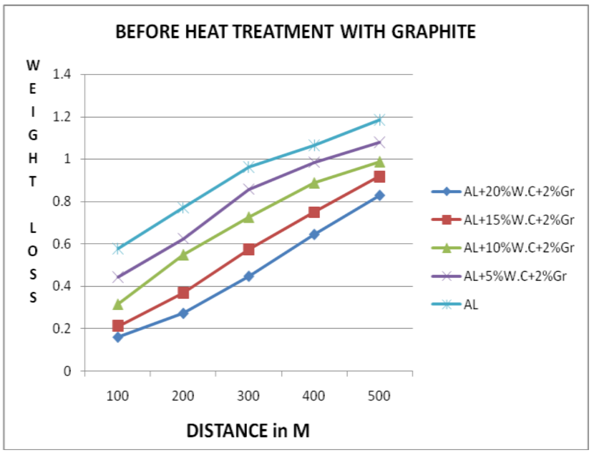
2.BEFORE HEAT TREATMENT WITH GRAPHITE

Weight loss is ploted for the before heat treated with graphite. Graph shows that increase in percentage of tungsten carbide is directly proportional to increase in wear resistance and addition of graphite increase wear resistance compare to without graphite. In this graph shows before heat treated with graphite for three different parameters like load, distance and velocity.

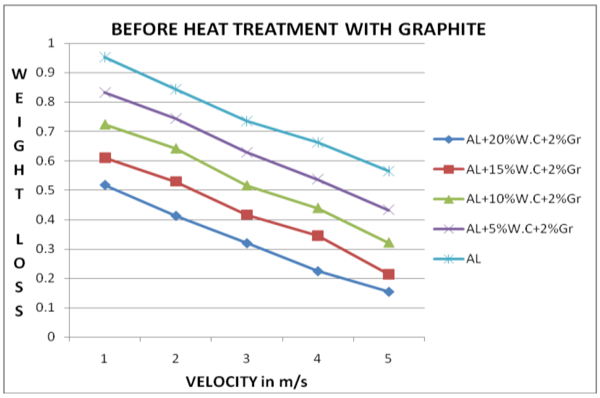
GRAPH-4



GRAPH-5



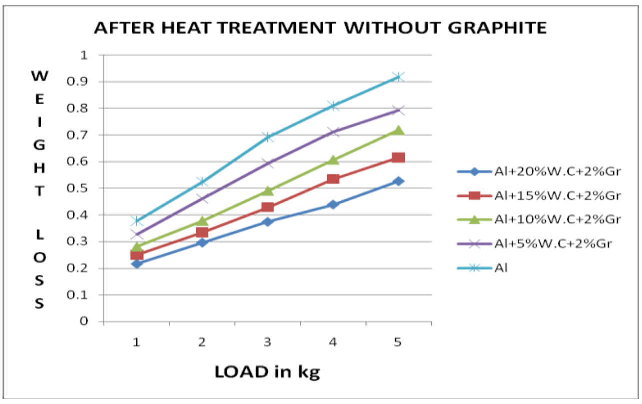
GRAPH-6



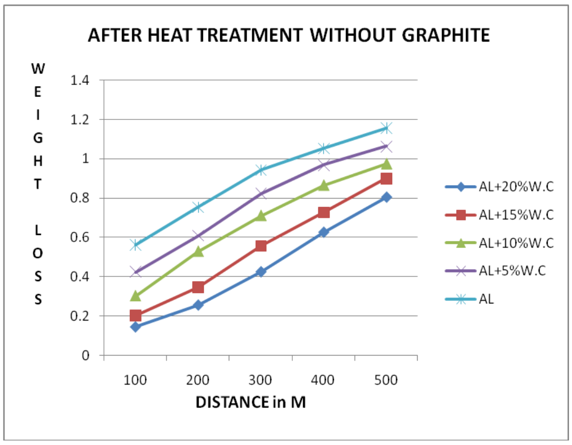
3.AFTER HEAT TREATMENT WITHOUT GRAPHITE

Weight loss is ploted for the after heat treated without graphite. Graph shows that increase in percentage of tungsten carbide is directly proportional to increase in wear resistance. In this graph shows after heat treated with graphite for three different parameters like load, distance and velocity.

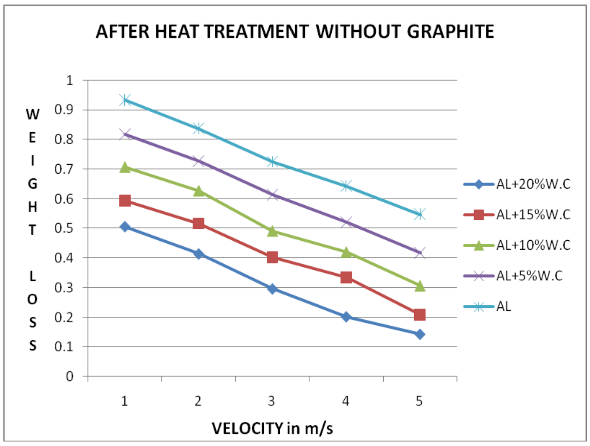
GRAPH-7



GRAPH-8



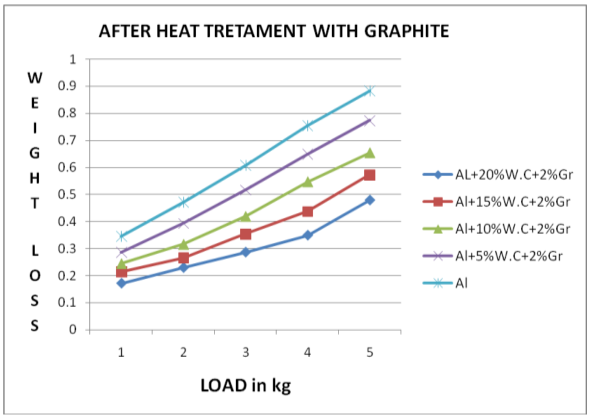
GRAPH-9



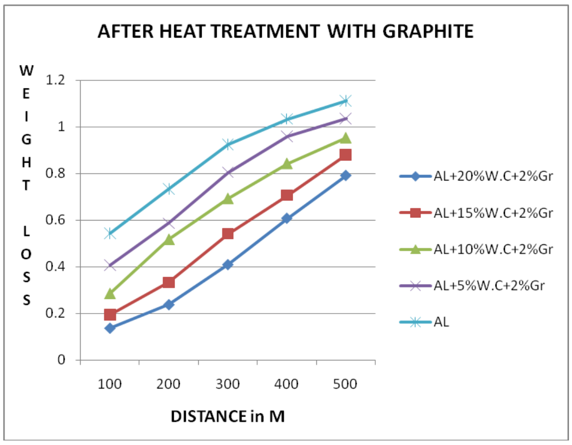
4.AFTER HEAT TREATMENT WITH GRAPHITE

Weight loss is ploted for the after heat treated with graphite. Graph shows that increase in percentage of tungsten carbide is directly proportional to increase in wear resistance and addition of graphite increase wear resistance compare to without graphite. In this graph shows after heat treated with graphite for three different parameters like load, distance and velocity.

GRAPH-10



GRAPH-11



GRAPH-12

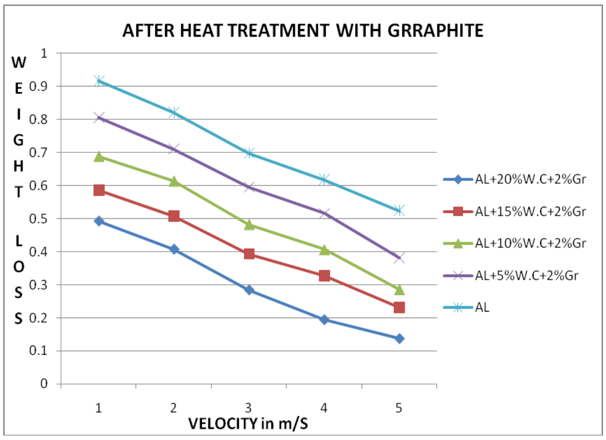


Figure-3 shows that tungsten carbide is equally reinforced with the metal matrix Al6061. This optical image is taken from optical microscope in 750X.

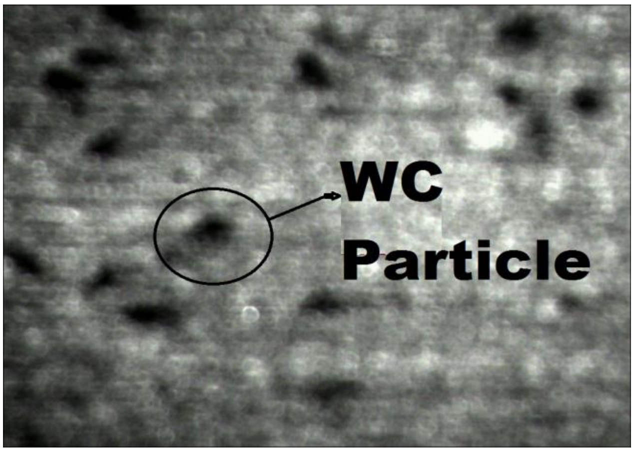


Figure-3

V. CONCLUSION

Important conclusions of this investigation are:

1. Increasing reinforcement of tungsten carbide(WC) leads to increases the wear resistance and reduces the coefficient of friction of the composites.
2. Adding 2% of graphite leads to lubrication while wear,so it increase wear resistance of hybrid composites.
3. Age hardening process increases the wear reisitances of both reinforced and unreinforced hybrid composites.
4. Increase in load increase the wear loss, increase in sliding distance increase the wear loss and increase velocity decrease the wear loss.

VI . REFRENCES

[1].C.Velmurugan, R.Subramanian, S.Thirugnanam, S.S.Ramakrishnan(2010) “Experimental studies on the wear behavior of heat treated Al 6061 hybrid metal

matrix composites", ", International Journal of Engineering, Science and Technology vol.3 P87-101.

[2].A. R. K. Swamy, A. Ramesha, G.B. Veeresh Kumar, J. N. Prakash (2011) "Effect of Particulate Reinforcements on the Mechanical Properties of Al6061-WC and Al6061-Gr MMCs A. R." , Minerals & Materials Characterization & Engineering vol.10 1141-1152.

[3].Sanna Ala-Kleme, Paivi Kivikyto-Reponen, Jari Liimatainen, Jussi Hellman and Simo-Pekka Hannula(2006), "Abrasive wear properties of metal matrix composites produced by hot isostatic pressing" , Proc. Estonian Acad. Sci. Engineering vol.4 445-454.

[4].Prakash C.H., Pruthviraj R.D (2011) "Microstructural Studies of Cast Zinc - Aluminum-Sic-Graphite Hybrid Composites", *Research Journal of Chemical Sciences vol.6 88-90.*

[5].M.Sreenivasa Reddy, Soma V. Chetty, Sudheer Premkumar(2012) "Effect of reinforcements and heat treatment on tensile strength of Al-Si-Mg based hybrid composites", Applied Sciences and Engineering Research vol.1 No. 2

[6].A. Dolata-Grosz, J. Wieczorek(2007) "Tribological properties of hybrid composites containing two carbide phases", Archives of Materials Science and Engineering vol.28 149-155

[7].*Vahid Majazi Dalfard* (2012) "Effect of Particle Size of Tungsten Carbide on Weight Percent of Carbide in Ni-WC Nano-composite", ELECTROCHEMICAL SCIENCE vol. 3537 – 3542

[8].A. Chennakesava Reddy and Essa Zitoun (2010) "Matrix Al-alloys for silicon carbide particle reinforced metal matrix composites", Indian Journal of Science and Technology vol.3 No.12

[9]. E. Bayraktar, J. Masounave, R. Caplain, C. Bathias(2008) "Manufacturing and damage mechanisms in metal matrix composites", Achievements in Materials and Manufacturing Engineering vol.31 No.2

[10]. Rajesh Kumar Bhushan (2010)" Effect of machining parameters on surface roughness and tool wear for 7075 Al alloy SiC composite", Int J Adv Manuf Technol vol.50 459–469.

[11]. Patrick W.Leech , XingS.Li , NazmulAlam (2012)" Comparison of abrasive wear of a complex high alloy hardfacing deposit and WC–Ni based metal matrix composite", CSIRO Earth Science and Resource Engineering vol. 25 P380-386.

[12]. S.C. Sharma (2001)" The sliding wear behavior of Al6061–garnet particulate composites", *Department of Mechanical Engineering, R.V. College of Engineering vol. 249 P*1036–1045.

[13]. T. Miyajima, Y. Iwai (2010)" Effects of reinforcements on sliding wear behavior of aluminum matrix composites", *Department of Mechanical Engineering, Fukui University vol. 255 P606-616.*

[14]. A. Mandal , M. Chakraborty, B.S. Murty (2007)" Effect of TiB2 particles on sliding wear behaviour of Al–4Cu alloy", *Department of Metallurgical and Materials Engineering vol.262 P160-166.*

[15]. S. Basavarajappa, G. Chandramohan, Arjun Mahadevan, Mukundan Thangavelu (2007)" Influence of sliding speed on the dry sliding wear behaviour and the subsurface deformation on hybrid metal matrix composite", *Department of Mechanical Engineering, PSG College of Technology vol.262 P1007-1012.*