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EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF AL6061 & AL7075 NANO METAL MATRIX COMPOSITES

[1]N Harsha, [2]Danamu Sri Surya, [1]M N V S A Sivaram Kotha, [1]B Durga Prasad

[1]Asst Professor, [2]M.Tech pursing, Department of Mechanical Engineering, S.R.K.R. Engineering College, Bhimavaram, west Godavari district, Andhra Pradesh, India.

[1]harsha.n@srkrec.ac.in, [2]srisurya106@gmail.com , [1]sivaramkotha@srkrec.ac.in, [1]baladurgaprasad@srkrec.ac.in

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ABSTRACT- Metal matrix composites(MMcs) Possess significantly improved properties including high specific strength, specific modulus, Damping capacity and good wear resistance compared to un reinforced alloys. Aluminum Metal Matrix Composites (AMMCs) has extraordinary interest so many applications now a days because of the improvement of phenomenal mechanical, thermal, metallurgical and electrical properties like light weight , better Non-corrosion material, thermal obstruction and high damping limit. The current Investigation project using Tribological attributes of Al 6061 and Al7075 compositions reinforced hybrid with built up SiC and fly ash. Composites were fabricated by stir casting process and studied by using a pin-on-disk apparatus. The reinforcement's silicon carbide and fly ash were varied with percentages are 5%, 10%, 15% in Al 6061 and Al 7075, to improve the properties of base metal like strength, stiffness, conductivity etc. AMMCs are widely used in aircraft, aerospace, automobiles and various other fields.

Keywords: *Metal matrix composites(MMcs),stir casting,Al6061, Al7075, Tribological*

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I INTRODUCTION

The main aim of developing these AMMCs with reinforce elements is to achieve desired property by varying matrix phase, reinforcement shape and size synthesis route, volume fraction and processing parameters, including high strength to weight ratio, high wear resistance, low cost, higher thermal conductivity, lower coefficient of thermal expansion and high toughness etc. It has been well established that by using suitable kind of reinforcement with aluminum matrix the properties of aluminum metal matrix composite can be improved. In the field of wear resistance, it is essential to provide a lubrication to reduce the wear. However, sometime it is too difficult to access a lubricant around the wear parts surfaces externally to reduce the wear. Self-lubricated materials consists a lubricant constituent that can be released automatically during the wear process. Now a day, one of the most frequently used solid lubricant materials are Graphite and Molybdenum disulphide. Friction and wear is induced when the two bodies are in contact (sliding or rolling) with each other. The most of the energy of the system is dissipated by the cause of friction, and wear is responsible for the material failure. So it is very important to select an appropriate material for mating bodies. Solid and liquid lubricants are used to control the friction and wear. For the material design it is very important to understand a deeply knowledge of these two factor wear and friction, to select the appropriate material.

OBJECTIVES:

The objective of the present work is to consolidate various published investigational and analytical results of AMMCs using most common reinforcing elements such as Silicon Carbide (Sic), Aluminium Oxide, Boron Carbide, Titanium Carbide, Graphite, Flyash, Zircon, Carbon nano-particles, Carbon nano-tubes etc. It is observed that each type of reinforcing element results in improvement of certain properties.

Although little information is available at present, it is felt that the study on the tribological characterization of AMMCs with each of the element as reinforcement will help in selecting proper application of these composites in right place. Further, the method or process used in fabricating AMMCs with reinforcement will also influence on the improvement and resulting properties.

Composite material:

A composite is a combination of at least two constituents or stages which are chemically distinct on a microscopic scale, separated by a distinct interface, and can easily be specified. composite materials are engineering materials produced using at least two constituent materials.

METAL MATRIC COMPOSITES:

A metal network composite will be composite material made at any rate two distinct stages. One is a metal (aluminum, magnesium, copper and so on) and the other material can be an alternate metal or another material, like a ceramic(SiC, Al2O3 etc) or natural compound. When at any rate three unique materials are available, it is called mixture composite.

STIR CASTING PROCESS:

In the current work, stir casting process is utilized to manufacture the crossover metal framework composite. stir Casting is the straightforward and the most conservative interaction of fluid state creation. The liquid composite material is then cast in the sand casting mold and permit to set it. The proper temperature range is kept up to blending or keep away from some substance response between the support and matrix material.

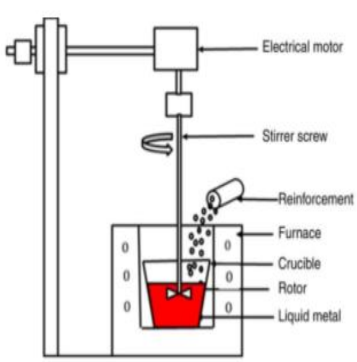

FIG : l STIR CASTING

CONCEPT OF TRIBOLOGY:

The word Tribology is comes from the Greek word 'tribos' which means rubbing or sliding. Tribology which deals the friction, wear and grease of interfacing surfaces in relative movement. Tribology is an interdisciplinary science which includes in different fields like as mechanical point of view, fluid elements, science and chemical engineering, material science and other related branches.

FRICTION:

The friction force consistently act inverse to the overall movement toward a path corresponding to the space of contact. The Friction force (FF) relies upon the typical power (FN) and the idea of the surfaces in question (μ). The rubbing power doesn't rely upon the surface region (contact territory).Friction force is communicated as FF = μ FN.

WEAR:

Wear is a cycle of reformist loss of a material from working surfaces of solids, subject to contact and sliding. The disengaged material structures a free wear trash. At the point when the material is eliminated from either of two strong surfaces in relative movement (sliding, rolling or effect) is named as wear. Wear happens either by precisely scraped spot activity, synthetic response, or by blend of the two cycles and is by and large increment at quick rate by the augmentation of temperature.

II LITERATURE SURVEY:

Atla Sridhar, et al. (2019) [1] In this they revealed that metal matrix composite strengthened with ceramic material of carbide (SiC) has smart mechanical characteristics. Metal-based composites, however, demand progress in their friction and tribological characteristics. In this work-study an effort is made to design a completely new material through the method of metallurgy by adding graphite, which acts as a solid lubricant. This study explored the effect of graphite on the tribological behaviour of hybrid composite Al 7075/5 wt. % SiC / X wt. % graphite (X=10, 5 and 0). The research confirms the performance of wear properties by incorporating graphite into the composite. The sic-graphite reinforced Al 7075 (aluminium alloy 7075) was studied. Metallurgy route was used to prepare the composites. Microstructures, the mixture of materials, wear and wear resistance properties were analyzed by optical micro cope and scanning electron microscope, XRD, and pin-on-disc apparatus. This studies revealed that further addition of 10% Gr within the hybrid composite doesn't facilitate to enhance the wear properties. Then the experimental investigations confirm that a sliding distance of one thousand meters and a sliding velocity of 1.5 m / s with an applied load of 5 N leads to minimum wear loss of 0.01062g and coefficient of friction as 0.1278During this investigation.

Prasad reddy. A, et al (2019) [2] they studied the tribological properties of 2% of SiC and X wt% of Gr (x=0,0.5,1,1.5,2,and 3) nano particles reinforced Al6061 alloy. This project aims at the processing of aluminium metal matrix composites (MMCs), reinforced with alumina (Al_2O_3) and analyzing the mechanical and tribological behavior manufactured by powder metallurgy method. Even if Al has higher hardness, higher strength, excellent wears resistance, and high-temperature corrosion protection. It is the order of the day to further enhance the properties for increasing its usage and applicability. They used sintered compacts have been prepared by incorporating Al_2O_3 particles to aluminium metal matrix in different weight fractions (10%, 15%, 20%, and 25%). Then the mechanical and tribological properties of these compacts have been studied in detail for assessing the effectiveness of the adopted fabrication technique. T

Jims john wessley. G, et al. (2019) [3] prepared and characterized of an aluminium 6061 with reinforcements such as alumina oxide and fly ash were varied as 5%, 10%, 15%, 9% and 11% by volume fraction. These composites are prepared by the stir casting process and for micro structural analysis they used SEM and EDAX. Six samples were fabricated and their mechanical properties and micro structural properties were analyzed and results are obtained. Then the composite with Al 6061 and reinforcements Fly Ash-3%, Al_2O_3-6%, Magensium-1%by volume fraction has shown improved mechanical properties like tensile strength, wear resistance and hardness compared as compared to the parent material. A Metal matrix composite with Al6061 as matrix and reinforcement's alumina and Fly Ash along with small quantities of magnesium as a wetting agent is stir casted and analyzed. Then the mechanical properties and micro level analysis of the samples is performed and the following results are obtained. They studied the presence of fly ash and alumina with composition of (90% Al 6061, 3% FA, 6% Al_2O_3& 1% Mg) used in sample 3 has shown increased tensile strength by 3%. The micro structural analysis using SEM and EDAX shows good bonding of the reinforcement with the matrix material. By reinforcing these alumina oxide and fly ash reinforcement mechanical properties such as tensile strength and hardness could be improved.

Rinki yadav, et al. (2018) [4] Aluminium metal matrix composites (MMC's) play a crucial role in various fields like automobile, aerospace, military, aircrafts, sheet metal, construction etc. due to unique combination of their properties. The properties such as high strength to weight ratio, high wear resistance and low cost lead to increase in the demand of aluminium composites. Various fabrication techniques are available to produce such composites. In liquid phase processes, Stir casting is a widely used process to fabricate aluminium composites. This paper reviews the effects of various reinforcements on tribological and mechanical properties of aluminium alloy. Various reinforcements like SiC, Al_2O_3, TiC, MoS_2 etc. are used to produce composites. We can fabricate a composite material with the single reinforcement or the combination of two or more reinforcements depending upon the application.

Darshan, et al.(2018) [5] in this paper, the work report deals with the Investigations made on microstructure and Mechanical behavior and Tribological properties of 4 different weight percentage of Aluminium alloy (7000 series) with Graphene nano powder composites. Aluminium matrix composite having Nano graphene is fabricated by liquid stir casting method. The microstructure of the composites was examined by Scanning Electron Microscopy and EDS. Further, mechanical behavior of composites was studied. Tensile properties like hardness, ultimate tensile strength; yield strength and wear were evaluated as per ASTM standards. The analysis gives the result that the ultimate tensile strength, yield strength and the hardness of composites increases with increases the percentage of graphene and the wear test results reveals that as the percentage of graphene increases wear rate decreases. The liquid metallurgy technique was successfully adopted in the preparation of aluminium alloy reinforced with graphene. The microstructure studies revealed that the uniform distribution of reinforcement (graphene) is observed and in some specimen voids and porosity is present because of improper casting. The ultimate tensile strength and yield strength and wear resistance of the composites is increases as the wt.% of graphene increases. Improvement in the hardness of the aluminium metal matrix composites due to increases in graphene percentage in the composites.

L. Natrayan et al. (2018) [6] in this paper they presented as Al6061 used as matrix material, SiC and various leaf ashes (bamboo leaf, neem leaf and tamarind ashes) used as reinforcement. Mechanical and wear properties of Al6061 matrix metal containing separate leaf ashes and silicon carbide as reinforcement was studied. That they results display that in generally presence of ash particles micro or nano level allows to increases the mechanical property hardness of the materials. According to our observation BLA has tends to induce more hardness of the material compared with TLA and NLA. Density has decreased with increasing in the leaf ash content; BLA has less density compared to pure Al6061. Its shows maximum porosity 2.7943%. Al6061/SiC/BLA shows better ultimate tensile strength and yield strength compared to the other fabricated samples. Microstructure shows mixing of the leaf ashes and SiC with matrix. it's clearly reveals of that the composites materials produced by stir casting method shows without voids and discontinuities of SiC/ leaf ashes particulates in the Al6061 metal matrix. Finally, the mechanical and tribological properties of the composites were evaluated, and their relation to the corresponding microstructure and wear worn surface of the composites was discussed.

Praveen kumar B, et al. (2018) [7] this paper revealed that the detailed review of various manufacturing processes and discussed the influenced of reinforcements material on the tribological and mechanical properties of Aluminium Hybrid Metal Matrix Composites. That the AMMCs exhibits the better mechanical and tribological properties and relatively low production cost make them a very attractive for a variety of applications, both from scientific and technological point of view. This paper discussing the different merger of reinforcements used in the synthesis of aluminium hybrid metal matrix composite and how it control its performance.

Nallusamy. S, et al (2017) [8] studied the effect on aluminium matrix composites reinforced with nano sized silica particles with different wt%. The Alumina particulate reinforced aluminium MMCs at 4 wt%, 6 wt% and 8 wt% were successfully prepared through stir casting process. They noted that an increase above 6 wt% of SiO2 there has been decrease in the UTS of the composite material. And also mechanical properties of the composites with particle volume fraction less than 6wt% was found to have the best comprehensive mechanical properties with good tensile strength, yield stress and percentage elongation.

P. Amuthakkannan et al. (2017) [9] they attempted made in current study is that basalt fiber reinforced with aluminium metal matrix composites have been prepared by using stir casting. They studied the effect of basalt of basalt fiber reinforcement on the dry sliding wear of al6061 alloy composites the pin on wear tester is used initially hardness of the composites was tested, it was founded that increasing reinforcement in the composite hardness value of the composites also increased. Located on the grey relation analysis (GRA) the effects of wear resistance of the composites were studied. Dissimilar weight percentage of basalt fiber reinforced with Al 6061. Then basalt fiber reinforced Aluminium metal matrix composite was prepared by stir casting ability with different reinforcing % of basalt fiber successfully. Then the wear rate of the composites was measured with parameters such as % of reinforcement, Sliding velocity and Normal load using Grey relation analysis. Based on the optimization technique, all the parameters taken for the wear study are significant and the most significant parameter was on Normal load. The optimized parameters are Sliding velocity (m/sec) of 2, Normal load (N) of 20, Reinforcement of basalt fiber (%) of 10.

Vipin k Sharma, et al. (2017) [10] they presented the work deals with the fabrication and tribological testing of an aluminium fly ash composite. The aluminium and fly ash contents in different percentages were reinforced within it to fabricate the necessary metal matrix composite (MMC). Stir casting process was used to fabricate the MMC with 2–4–6% weight of flyash contents in aluminium. Tribological analysis of the tribopairs formed in the middle of the smooth surfaces of cast iron disc and smooth MMC pin have been considered and friction force and wear of the MMC were investigated by using a Pin-on-disc equipment. It has been observed that the MMC with 6% weight of fly ash content in aluminium matrix results in less wear (0.32 g) and 4% weight of fly ash content gives the low coefficient of friction (0.12) in the middle of the tribopairs of cast iron surface and MMC surface. Aluminium fly ash composites were prepared by using stir casting process with different weight % (2, 4 and 6%) of reinforcement particles.

Mohammed Imran, et al. (2017) [11] focused on the fabrication of aluminium alloy (7075) with reinforcements may be particulate SiC, Al_2O_3, Gr, TiO_2, bagasse ash, etc. The objective is to review the literature on fabrication of the aluminum metal matrix composite materials by combining alloys and reinforcements. These particulate reinforcements are incorporated in the stir casting method. The results revealed that, there is significant improvement in mechanical properties. Aluminum metal matrix composites are fabricated by using powder and liquid metallurgy routes. In this review covers the liquid metallurgy route by vortex method that is stir casting method. In this casting method was used success-fully to manufacture AMMCs with desired effect of different ceramic reinforcement particles on mechanical and tribological properties of aluminum alloys. They improved the mechanical properties were observed by addition of various wt% . Addition of these silicon carbide, alumina, barium chloride of aluminium based matrixes and revealed that the composites showed increased value of tensile strength, hardness, yield strength, compressive strength, flexural strength, where as ductility decreased. And also the addition of graphite improves the tensile strength, ductility, elastic modulus whereas hardness is decreased. Corrosion resistance and superior wear, low coefficient of thermal expansion as compared to base alloys.

Rohit Sharma, et al (2017) [12] presented a review on the fabrication process of stir casting process by adition of reinforcements such as graphite, flyash, silicon carbide, red mud etc. to the aluminium matrix in various proportions. An effort has been made to review the different combinations of the composites and how they affect the properties of the different alloys of aluminium. A comprehensive knowledge of the properties is provided in order to have an overall study of the composites and the best results can be employed for the further development of the Aluminium reinforced composed. This paper shows that Al metal matrix composites can be replaced with other conventional metals for excellent performance and extensive life. They concluded that hardness increases with the increase in silicon carbide at 25 wt% but decreases with increases graphite. They investigated that aluminium-silicon carbide is better than aluminium-graphite for the thermal expansion.

Sandeep. G.M, et al. (2017) [13] Composites are playing a vital role in development of mankind, for they have drastically improved all walks of life be it transportation, entertainment, health care and many more areas. Use of Aluminium metal as a MMC has brought in revolutionary changes in manufacturing and usage of metals. The presented paper deals with wear characterization of Aluminium 6061 MMC reinforced with Beryl forming the Al-Beryl Metal Matrix Composite. The composite is prepared by stir casting process followed by wear test using pin-on-disc wear testing machine. The results have been found and interpreted. The conclusions derived from the results and discussions of experiments are as follows The co-efficient of friction was found to depend on state of stress which was in turn dependent on normal load. The state of stress influences the co-efficient of friction and found to be at maximum when the state of stress is not severed. This is because of the increased surface roughing and a large quantity of wear debris. The co-efficient of friction was found to reduce when the state of stress found to become very sever.

P. Amuthakkannan, et al. (2017) [14] they examined the Aluminum alloy based metal matrix composite participate have a wider applications in wear resistance applications. The basalt fiber reinforced aluminum metal matrix composite have been prepared by using stir casting method. various weight percentage of basalt fiber reinforced with Al (6061) metal matrix composites are make to study the wear resistance of the composites. Considering wear study, percentage of reinforcement, normal load and sliding velocity are the considered as important parameters. To study the effect of basalt fiber reinforcement on the dry sliding wear of Al6061 alloy composites the Pin On wear set-up is used. Initially hardness of the composites was tested, it was found that increasing reinforcement in the composite hardness value of the composites also increased. Depending on the Grey relation analysis (GRA) the effects of wear resistance of the composites were studied. The basalt fiber reinforced Al metal matrix composite was compose by using stir casting technologiques with various reinforcing % of basalt fiber successfully

Vijayakumar. S, et al. (2016) [15] in this present work, composite materials are given first priority due to less weight ratio and high strength. The project work focuses on the metal matrix composites, which are mainly used in marine, aeronautical and automobile applications. Mostly now a day's metal matrix composites plays energetic role in engineering applications. Silicon carbide is combining as reinforcement in to Aluminium alloy (6061) for making metal matrix composite. The metal matrix composite is prepared by using Stir Casting process.

III METHODOLOGY OF THE WORK

This chapter brings forth the details of design of the proposed study. The chapter describes the methodology of the work and design of the study based on the selection of an input parameters (concentration) , selection of material used to fabricate the aluminium metal matrix composite, the method of fabrication, experimental equipment and facilities used for evaluating the properties aluminium metal matrix composites, and the process parameters which helped to achieve the objective.

MATERIAL SELECTION:

This section describes the constituents (of the composites to be fabricated) with regards to their characteristics, properties, concentration range etc. to be used in the proposed work.

MATERIALS AND PROCESS:

The table 3.1 given shows the chemical composition of the parent material chosen in this study.

TABLE 3.1 composition of aluminum 6061 by weight percentage

Elements of Al6061	Percentage %
Copper	0.4
Manganese	0.15
Magnesium	1.2
Silicon	0.8
Zinc	0.25
Titanium	0.15
Iron	0.7
Aluminum	96.35

Tab 3.2 composition of aluminum 7075 by weight percentage

Elements of Al7075	Percentage %
Copper	0.20
Manganese	0.30
Magnesium	2.4
Silicon	0.40
Zinc	6
Titanium	0.20
Iron	0.50
Aluminum	90

For the present study, Silicon Carbide and Fly Ash is chosen as the reinforcement materials. Silicon Carbide particles have become one of the popular reinforcing phases for many aluminum alloy-based metal matrix composites. They are hard brittle ceramic particles with high strength high modulus of elasticity, and high thermal and electrical resistance. Fly Ash is left–out residue from the boilers in thermal power plants. Since it is a by-product, it is available in plenty and also at very low cost. The chemical compositions of Fly Ash are used in the study is shown in Table3.3

Tab 3.3 Composition of Fly Ash of weight percentage

Elements of Fly Ash	Wt%
CuO	0.01
Na_2O	0.34
MgO	0.38
CaO	0.63
K_2O	1.09
TiO_2	1.14
Fe_2O_3	2.78
Al_2O_3	19.09
SiO_2	59.98

The composite samples in the present study are obtained by stir casting method. The stir casting apparatus used in the study. Sic and Fly Ash reinforced matrix composites were prepared by stir casting process. The aluminum matrix alloy was melted in resistance furnace. The crucible with molten metal was taken out from the furnace and treated with sodium modifier. The liquid melt was then allowed to cool down just below the liquidus temperature to get semi solid state melt at the state free heated (500^{o}C per one hour) reinforcement particle were added to the semi state liquid melt. Silicon Carbide particles were preheated at 750℃ for about two hours. An electrical resistance furnace assembled with graphite impeller used as stirrer was used for stirring purpose.As same procedure has been used for the Fly Ash reinforcement was weighed and preheated to 750℃ before incorporation into the melt. This was done to facilitate removal of any residual moisture as well as to improve wetability. The preheated Fly Ash particles in 5, 10 , 15 wt% were added into the molten metal at constant rate.The molten alloy on the reinforcement particles are thoroughly stirred manually for 15 minutes. After manual stirring the semi solid liquid make was heated in the resistance furnace followed by automatic mechanical stirring using a mixer to make the melt homogeneous for about 200rpm. The temperature of melted metal was measured using a dip type thermocouple. By repeating the same procedure the other compositions were prepared with mixing separated silicon carbide and fly ash 5%, 10%, 15% by weight respectively. When the mold was cool, it was broken and the composites were taken out.

IV EXPERIMENT EQUIPMENT AND FACILITIES:

This section provides an overview of the various machines and equipment used in the present study for fabrication, characterization and testing of the composites.

WEIGHING BALANCE:

The digital weighting balance was used for weighing a specimen before and after an experiment. It is highly accurate and precise measuring device with least count 0.0001 g

CASTING FURNACE:

A Casting furnace is a furnace with a heated chamber; the walls of the furnace are radiated heat due to the electrical resistance heating element. So that the material being heated has no contact with the flame. Casting furnace is used to heat and melts the material to desired temperature by the principle of conduction, radiation and convection. Figure is shown a Casting furnace have a maximum temperature range of 11000 C.

GRAPHITE STIRRER:

The function of a stirrer is to agitate the liquid metal and mix up the reinforcement particulates into the molten metal. Stirrer design plays an important role to maintain a vortex formation for the homogenous dispersion of the particulates. Figure 3.4 is shown a graphite stirrer have a wings bent at 45 degree. In stir casting process stirrer speed is a very critical parameter for consideration to maintain a vortex. During the fabrication of stir casting, stirring speed was 240 rpm used which was effectively producing vortex without any spreading the molten metal.

FABRICATION OF COMPOSITES BY STIR CASTING PROCESS:

The various steps involved in the processing and fabrication of composites in the present work are described as follows. The steps are:

1. The relative weight percent of constituents of the composite system (i.e. Aluminium 6061 and 7075, Sic, Fly Ash wt. % of base Alloy) was calculated as follows:

Calculate the weight of constituents by deciding the final weight of the composite. Let the final weight of the composite be 700 g. For example: For a composite containing 1% Graphite and 5% Silicon carbide by weight. Total weight of the composite = 700 g Weight of Graphite = 0.01×700 = 7.0 g Weight of Silicon carbide = 0.05 ×700 = 35 g

Weight of the Aluminium alloy and Magnesium = 700- (7.0+35) = 658 g Weight of Magnesium = 0.01 × 658 = 6.58 g .

Weight of Aluminium alloy = 658- 6.58 = 651.42 g

2. Aluminium alloy was melted in a graphite coating crucible shown in Figure 3.5 by heating it in a casting furnace at above its liquidus temperature i.e. 7500 C. The graphite crucible is used to keep the molten metal in the casting furnace.

3. Calculated amount of reinforcement is being fed into the melt three to four times rather than introducing all at once, and mixed for 10 min in the vortex with the help of stirrer. Then the slurry is again heated to a fully liquid state. The furnace temperature was controlled at 760±1000C.

4. After stirring process the melt was poured into the sand casting mold.

CHARACTERIATION OF COMPOSITE MATERIAL:

In the present study, the main purpose of characterization is to determine the effectiveness of the metal matrix composites in the wear resistance and friction behavior. The characterization methods used here are: Universal testing machine, Charpel impact testing Brinell hardness testing, pin - on- disk wear testing and coefficient of friction measurement. They are discussed below in details.

TENSILE TEST:

The fundamental concept of the universal testing machine is to supply the force through the sample on a specimen surface and measuring the force per unit area. The tensile strength of Aluminum metal matrix composites with silicon carbide and fly ash, in different proportions are obtained by stir casting method and subsequently heat treated are evaluated by conducting tensile test on a standard tensile specimen. The specimen dimensions are selected as per ASTM E 646-98 standards. Tensile test was carried out on UTM of 20tones loading capacity duly calibrated by strain gauges.

HARDNESS MEASUREMENT:

Surface properties of a composite play a main role in wear and friction behavior. Hardness represents the mechanical property of the material. Hardness is a quick and very simple method to obtain the mechanical property of the material.

In the present study, the hardness of a stir cast MMCs was performed on a B scale with ball diameter 1.588mm and a load of 100kgf. Hardness was measured at three different locations on both sides of a sample and sample is cut between the centers of the composite material. The average reading of the three different locations was reported.

IMPACT TEST:

Many machines or machine components are expose to a suddenly applied load which is called impact blow. For determining the suitability of a material to resists the impact. The Charpy impact test necessitates striking a notched impact specimen with a swinging weight or a tup attached to a swinging pendulum. The impact specimens are tested at a series of specified temperatures (e.g -20°C, -10°C, 0°C, 10°C, 20°C) in the range of -452°F to 500°F. once a specimen reaches the precise temperature; it is quickly placed into a special holder in the test machine.

SAMPLE PREPARATIONS FOR WEAR TESTS:

The wear pin samples were cut from the stir cast hybrid metal matrix composite material with a height 40mm and 6mm diameter hemispherical tip are shown in Figure 3.10. The Pin samples were polished with a fine emery paper of grades 600, 800, 1000 and 2000 on a polishing machine, Before conducting the dry sliding wear tests. Dry sliding wear test were performed according to the ASTM G99-95a standards. The material of counter disc was EN32. The disc had a diameter of up to 80 mm and thickness of 8 mm. The pin and disc are cleaned by acetone before and after performing the wear test.

Figure 2 Wear test

EXPERIMENTAL SETUP:

The pin-on-disk apparatus (DUCOM make), shown in Figure 3.11 was used to examine the dry sliding wear characteristics and the coefficient of friction of the metal matrix composites. A pin which is made up of composite material is rest on a rotating disc under the effect of a dead weight. Influencing parameters such as normal load, sliding velocity, wear track diameter and sliding distance is to be set according to the design of experiment.

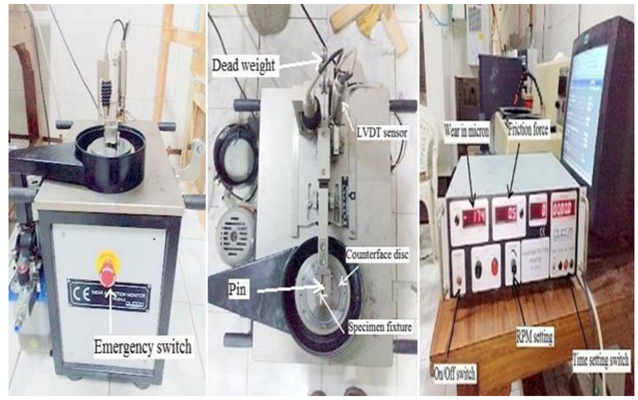

Figure 3 Components of pin-on-disk test apparatus

V RESULTS AND DISSCUSIONS

HARDNESS OF THE COMPOSITES:

Hardness is a measure of the resistance to localized plastic deformation induced by either mechanical indentation or abrasion. Some materials (e.g. metals) are harder than others (e.g. plastics, wood). Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness. Hardness is dependent on ductility, elastic stiffness, plasticity, strain, strength, toughness, viscoelasticity, and viscosity. Common examples of hard matter are ceramics, concrete, certain metals, and super hard materials, which can be contrasted with soft matter. There are three main types of hardness measurements: scratch, indentation, and rebound. Within each of these classes of measurement there are individual measurement scales. For practical reasons conversion tables are used to convert between one scale and another.

AL6061 METAL MATRIX COMPOSITES RESULTS TESTING IN HARDNESS TEST

- Al6061 hardness result 62.8 HRC for SiC & 62.8 HRC for flyash (HARDNESS ROCKWELL C)
- On addition of 5% reinforcement the Al-MMC obtained 66 HRC for flyash and for SiC 66.02 HRC.
- Increasing the 10% of reinforcement material got 69 HRC for SiC & 69.02 HRC for flyash
- For 15% reinforcement material hardness got 74 HRC for SiC & 72.12 HRC for flyash.

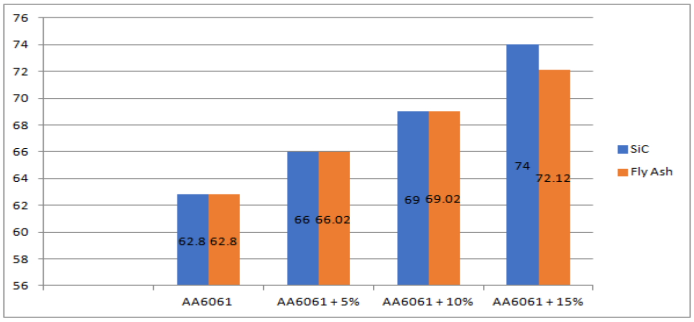

Fig 4 shows the variation in hardness values for both reinforcements of Al6061 Metal Matrix Composites.

RESULTS TESTING IN HARDNESS TEST

- First plot shows Al6061 hardness result 62.8 HRC
- Second plot shows in addition of 5% fly ash material got 66.02 HRC
- Third plot shows Increasing the 10% fly ash material got 69.02 HRC

Fourth plot shows in 15% added material hardness got 72.12 HRC

AL7075 RESULTS TESTING IN HARDNESS TEST

- Al7075 hardness result 96.83 HRC For Sic & 96.83 HRC for flyash
- In addition of 5% fly ash material got 98.20 HRC for Sic & 97.12 HRC for flyash
- Increasing the 10% fly ash material got 100.60 HRC for Sic & 98.62 HRC for flyash
- In 15% added material hardness got 110.25 HRC for Sic & 100 HRC for flyash

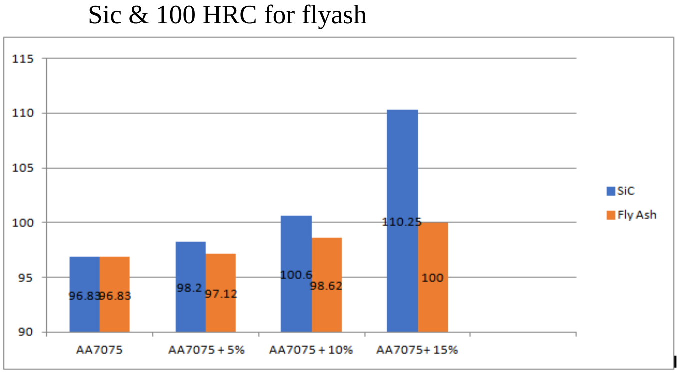

FIG 5 HARDNESS VALUES VS % REINFORCEMENT OF AL7075

The figure 4.2 shows the variation in hardness values for both reinforcements of Al7075 Metal Matrix Composites. The plot will show Al7075 results testing in hardness test

- First plot shows AA6061 hardness result 96.83 HRC for Sic & 96.83 HRC for flyash
- Second plot shows In addition of 5% fly ash material got 98.20 HRC for SiC & 97.12 HRC for flyash
- Third plot shows Increasing the 10% fly ash material got 100.60 HRC for SiC & 98.62 HRC for flyash
- Fourth plot shows In 15% added material hardness got 110.25 HRC for SiC & 100 for flyash

TENSILE STRENGTH

The fracture result as shown in Fig. obtained is very much influenced by the parameter. From the result shows fractured on retreating side. This could lead due to incompatibility of combination on transverse and rotational speed for these samples thus fractured on retreating side. Tensile strength is a measurement of the force required to pull something to the point before it breaks .Tensile test was done using Universal Testing Machine (UTM) fig 4.1 The Specimen used as per ASTM E8 standard. The specimen made of AL metal matrix composites having 20% is used for tensile test.

G-Gage length: 25±0.1mm W-Width: 6±0.1mm

T-Thickness 6±0.1mm R-Radius of fillet, min: 6mm

L-Overall length, min: 100 mm: A-Length of reduced section: 32mm

B-Length of grip section, min: 30 mm C-Width of grip section: 10mm

In Tensile strength tests shown facture values below tables

AL6061 results testing in tensile test

- AL6061 Tensile strength result 115 N for Sic & 115 N for flyash
- In addition of 5% fly ash material got Tensile strength result 126 N for Sic & 126 N for flyash
- Increasing the 10% fly ash material got Tensile strength 126 N for Sic & 132 N for flyash
- In 15% added material hardness got Tensile strength 130 N for Sic & 135 N for flyash

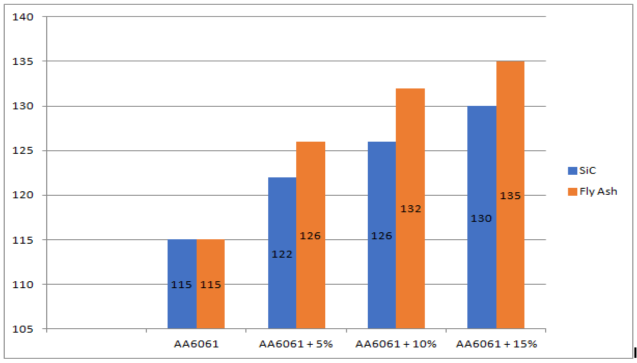

FIG 6 TENSILE STRENGTH VS % REINFORCEMENT IN AL6061

In Tensile strength tests shown facture values below tables

Graph shows results variation which is better gives withstanding values

AL6061 results testing in tensile test

- Al6061 Tensile strength result 115 N for Sic & 115 N for flyash
- In addition of 5% fly ash material got Tensile strength result 122 N for Sic & 126 N for flyash
- Increasing the 10% fly ash material got Tensile strength 132 N for Sic & 135 for flyash
- In addition of 15% material hardness got Tensile strength 135 N

AL7075 RESULTS TESTING IN TENSILE TEST

- First graph Al7075 Tensile strength result 80.88 N for Sic & 50.88 N For flyash
- Second graph In addition of 5% fly ash material got Tensile strength result 90.02 N for sic & 50.88 for flyash
- Third graph Increasing the 10% fly ash material got Tensile strength 126.42 N for Sic & 80 N for flyash
- In Addition of 15%material hardness got Tensile strength 150.09 N for sic.

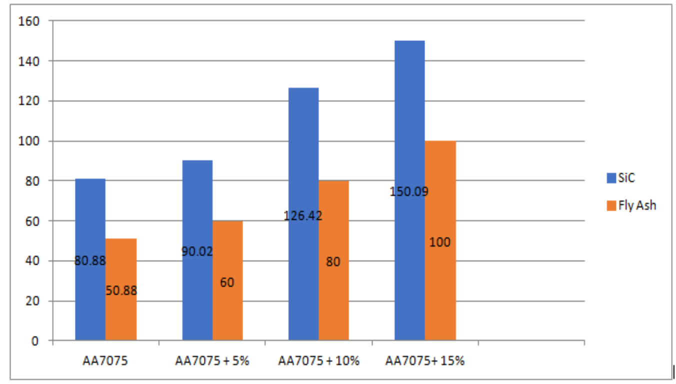

FIG 7 TENSILE STRENGTH VS % REINFORCEMENT IN Al7075 COMPOSITIONS

IN TENSILE STRENGTH TESTS SHOWS VALUES OF FACTURE:

Graph will shown results variation which is better gives withstanding values

AL7075 RESULTS TESTING IN TENSILE TEST

- First plot shows Al7075 Tensile strength as80.88 N for SiC & 50.88 N For flyash
- Second plot In addition of 5% reinforcement, material got Tensile strength result 90.02 N for SiC & 50.88 for flyash
- Third plot Increasing the 10% reinforcement, material got Tensile strength 126.42 N for SiC & 80 N for flyash
- In 15% added reinforcement material got Tensile strength 150.09 N for SiC & 100 N for flyash

IMPACT STRENGTH:

Impact strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a impact test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The impact strength represents the highest stress experienced within the material at its moment of yield. It is measured in terms of stress, here given the symbol

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AL6061 RESULTS TESTING IN IMPACT STRENGTH TEST

- Al6061 impact strength result 2
- In addition of 5% fly ash material got impact strength result 2.5
- Increasing the 10% fly ash material got impact strength 3
- In 15% added material hardness got impact strength

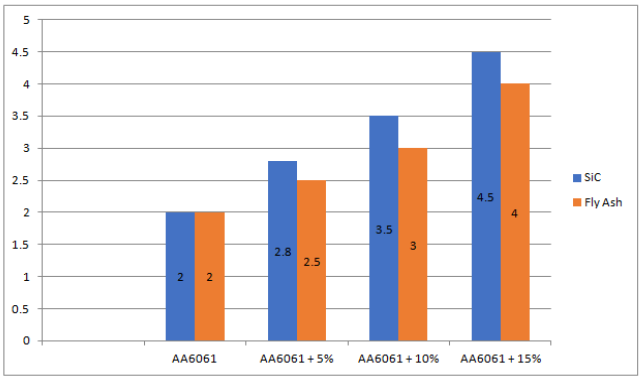

FIG 8 IMPACT STRENGTH VALUES VS % REINFORCEMENT IN AL6061 COMPOSITIONS

Graph will shown results variation which is better gives withstanding values

Al6061 results testing in impact test

- Al6061 Tensile strength result 2 for Sic & 2 For flyash
- In addition of 5% fly ash material got Tensile strength result 2.8 for sic & 2.5 for flyash
- Increasing the 10% fly ash material got Tensile strength 3.6 for Sic & 3 for flyash
- In 15% added material hardness got Tensile strength 4.5 for sic & 4 for flyash

AL7075 RESULTS TESTING IN IMPACT TEST

- Al7075 impact strength result 2
- In addition of 5% fly ash material got impact strength result 2.5
- Increasing the 10% fly ash material got impact strength 3
- In 15% fly ash added material hardness got impact strength 3.5
- In addition of 5% SiC material got impact strength result 2.8
- Increasing the 10% SiC material got impact strength 3.6
- In 15% SiC added material hardness got impact strength 4.2

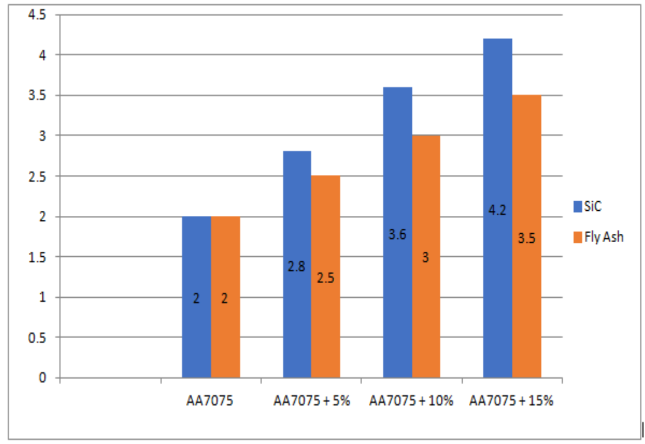

Fig 9 IMPACT STRENGTH VALUES VS % OF REINFORCEMENT OF Al7075 COMPOSITIONS

Graph will shown results variation which is better gives withstanding values

AL7075 RESULTS TESTING IN IMPACT TEST

- Al7075 impact strength result 2 for Sic & 2 For flyash
- In addition of 5% fly ash material got Tensile strength result 2.8 for sic & 2.5 for flyash
- Increasing the 10% fly ash material got Tensile strength 3.6 for Sic & 3 for flyash

In 15% added material hardness got Tensile strength 4.5 for sic & 4 for flyash

WEAR TEST:

Wear test is carried out to predict the wear performance and to investigate the wear mechanism. Two specific reasons are as follows: – From a material point of view, the test is performed to evaluate the wear property of a material so as to determine whether the material is adequate for a specific wear application.

Usually wear rate is expressed and calculated as W=mm3/N.m where mm3refers to wear volume and N.m is normal load per sliding distance. The value of this equation is that is independent of hardness. The sliding distance can be calculated as the linear speed times the duration of the test

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TABLE 4.7 WEAR RATE OF AL6061+SIC COMPOSITIONS

AL6061 + SiC				
S.No	SLIDING DISTANCE	WEAR RATE mm^3/N-m		
		5%	10%	15%
1	20	0.5	0.75	0.8
2	40	0.25	0.5	0.7
3	60	0.125	0.25	0.5
4	80	0.15	0.125	0.25
5	100	0.1	0.125	0.15

Al6061 results test in Wear rate for 20,40,60,80,100

- Al6061+Sic 5% wear rate result 0.5,0.25,0.125,0.15,0.1 for Sic
- In addition of 10% Sic material got wear rate result 0.75,1.5,0.25,0.125,0.125
- In addition of 15% Sic 0.8,0.7,0.5,0.25,0.15

TABLE 4.8 WEAR RATE OF AL6061+FLYASH COMPOSITIONS

AL6061 + flyash				
S.No	SLIDING DISTANCE	WEAR RATE mm^3/N-m		
		5%	10%	15%
1	20	0.6	0.85	0.9
2	40	0.35	0.6	0.8
3	60	0.225	0.35	0.6
4	80	0.25	0.225	0.325
5	100	0.2	0.125	0.25

Al6061 results test in Wear rate for 20,40,60,80,100

- Al6061with 5% flyash of addition got the wear rate as 0.6,0.35,0.225,0.25,0.2.
- In addition of 10% flyash material got wear rate result 0.85,06,0.35,0.225,0.125.
- In addition of 15% flyash material got wear rate results 0.9,0.8,0.6,0.325,0.25.

TABLE 4.9 WEAR RATE of AL7075+SIC COMPOSITIONS

AL7075 + SiC				
S.No	LOAD	WEAR RATE mm^3/N-m		
		5%	10%	15%
1	20	0	0	0
2	40	1	2	3
3	60	0.5	1	1.5
4	80	1	2	3
5	100	3	4	5

Al7075 results of Wear rate for load 20,40,60,80,100

- Al7075+Sic 5% wear rate result 0,1,0.5,1,3
- In addition of 10% Sic material got wear rate result 0,2,1,4
- In addition of 15% Sic 0,3,1.5,3,5

The above the values are obtained for Al7075 + Sic by giving a load 20,40,60,80,100 and the wear rate is calculated according to adding 5%,10%,15%

TABLE 4.10 WEAR RATE OFAl7075+FLYASH compositions

Al7075 + flyash				
S.No	LOAD	WEAR RATE mm^3/N-m		
		5%	10%	15%
1	20	0.5	0.65	0.7
2	40	0.3	0.7	0.8
3	60	0.2	0.3	0.5
4	80	0.1	0.215	0.315
5	100	0.05	0.105	0.2

Al7075 results test in Wear rate for given load of 20,40,60,80,100

- Al7075+ flyash in addition of 5% 0.5,0.3,0.2,0.1,0.05
- In addition of 10% flyash material got wear rate result 0.65,0.7,0.3,0.215,0.105
- In addition of 15% flyash material got wear rate results 0.7,0.8,0.5,0.315,0.2

The values are obtained by calculating the loads and percentage added to Al7075 according to that.

PICTORIAL REPRESENTATION:

FIGURE 10 DIFFERENT COMPOSITIONS

VI CONCLUSION

1. Hardness of the composites was improved with the increase in weight percent of SiC but due to the soft nature of flyash, hardness is slightly decreased comparing with flyash.
2. Tensile strength the composite was improved with the increase of Sic, Tensile strength is increased more in flyash.
3. Impact strength the composite was improved with the increase of Sic, Impact strength is slightly decreased in flyash.
4. Wear rate in the Sic+Al6061composites is less when compared to flyash+Al6061 composites.
5. Wear rate in the Sic+al7075 composites is more when compared to flyash+Al7075 composites.
6. During the process of Harding, hardness is depent upon the ductility, elastic stiffness, plasticity, strain, strength, toughness, and viscosity.
7. Wear rate of Al6061 & Al7075 composites is depent upon the siliding distance and compositions of the Sic & flyash weight percentage

REFERENCES:

[1] S.Sarkar, S.Sen and S.C.Mishra, Studies on Aluminum-Fly ash composite produced by impeller mixing, Journal of Reinforced plastics and composites, Vol 00, 2008, pp1-6
[2] Y.Sahin, M.Kok, H.Celik, Tool wear and surface roughness of Al2O3 particle reinforced aluminum alloy composites, Journal of material processing technology,128 (2002), pp280-291
[3] S.Kannan, H.A.Kishawy, 2008, Tribological aspects of machining aluminum metal matrix composites, Journal of material processing technology, 198, pp399-406
[4] E.Kilickap, O.Cakir,M.Aksoy,A.Inan, Study of tool wear and surface roughness in machining of homogenized SiCp reinforced aluminum metal matrix composite, Journal of material processing technology, 164-165 (2005) pp862-867
[5] M.E.l-Gallab, M.Sklad, Machining of Al/SiC particulate metal matrix composites,Part II: Work piece integrity, Journal of material processing technology, 83 (1998) pp277-285.
[6] G.E.D.Errico, R.Calzavarini, Turning of metal matrix composites, Journal of material processing technology, 119 (2001) pp257-260
[7] A.Torpov,S.L.Ko,B.K.Kim, Analysis of burr formation mechanism in turning aluminum alloy Al6061-T6, Key Engineering materials, Vols 291-292 (2005), pp253-258
[8] Metin Kok, A study on the machinability of Al2O3 particle reinforced aluminum alloy composite, Inorganic Bonded Fiber Composites Conference, November 5-7, 2008, pp272-281
[9]. C. R. Alavala, Influence of Debris on Wear Rate of Metal Matrix Composites, Journal of Materials Science & Surface Engineering, vol.4, no.6, pp.458-462, 2016.
[10]. C. R. Alavala, Nano-mechanical modeling of thermoelastic behavior of Al6061/silicon oxide nanoparticulate metal matrix composites, International Journal of Science and Research, vol.5, no.1, pp.550-553, 2016.
[11]. A. C. Reddy, Thermal Expansion Behavior of Aluminum Matrix Composites Reinforced with Fused Quartz Nanoparticles, National Conference on Advanced Materials and Manufacturing Techniques, Hyderabad, 8-09th March 2004, pp.350-355.
[12] . A. C. Reddy, Evaluation of mechanical behavior of Al-alloy/Al2O3 metal matrix composites with respect to their constituents using Taguchi, International Journal of Emerging Technologies and Applications in Engineering Technology and Sciences, vol.4, no.2, pp.26-30, 2011.
[13] . A. C. Reddy, Essa Zitoun, Tensile properties and fracture behavior of 6061/Al2O3 metal matrix composites fabricated by low pressure die casting process, International Journal of Materials Sciences, vol.6, no.2, pp.147-157, 2011.
[14] . A. C. Reddy, Cause and Catastrophe of Strengthening Mechanisms in 6061/Al2O3 Composites Prepared by Stir Casting Process and Validation Using FEA, International Journal of Science and Research, vol.4, no.2, pp.1272-1281, 2015.
[15] . A. C. Reddy, Cause and Catastrophe of Strengthening Mechanisms in 6063/Al2O3 Composites Prepared by Stir Casting Process: Validation through FEA, International Journal of Scientific & Engineering Research, vol.6, no.3, pp.75-83, 2015.