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Analysis on the Experimental Behavior on the Mechanical Estates of Aluminum Metal Matrix Composites

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***ABSTRACT**: Today we are broadly utilizing aluminum-based metal framework composite for basic, aviation, marine and vehicle applications for its light weight, high quality and low creation cost. The motivation behind structuring metal network composite is to include the attractive characteristics of metals and pottery to the base metal. Right now, created aluminum metal grid mixture composite by fortified Aluminium7075 amalgam with silicon carbide and aluminum oxide (alumina) by technique for mix throwing. This procedure is more affordable and exceptionally compelling. The Hardness test and Wear test were performed on the examples which are set up by mix throwing strategies. The outcome uncovers that the expansion of silicon carbide and alumina particles in aluminum network improves the mechanical properties.*
***KEYWORDS**: AERODYNAMIC DRAG, DRAG COEFFICIENT, CLADDING,CFD, BICYCLE*

I. INTRODUCTION

The wear conduct and hardness assume a significant job in choosing the metal network composites for utilizing in different enterprises, vehicles and so forth. Aluminum (Al) based metal network composites i.e., AMCs is generally utilizing in aviation, car and farming businesses and so on. For the examination and directing investigation, first we should think about the Metal Matrix composites. A composite material is a material made out of at least two constituents. The constituents are joined at a minuscule level and are not solvent in one another. By and large, a composite material is made out of fortification (strands, particles/particulates, chips, as well as fillers) inserted in a lattice (metals, polymers). The framework holds the support to shape the ideal shape while the fortification improves the general mechanical properties of the lattice. At the point when planned appropriately, the new consolidated material shows preferable quality over would every individual material. The most crude man-made composite materials are straw and mud consolidated to frame blocks for building development [1].

Metal matrix composites (MMCs), like all composites; consist of at least two chemically and physically distinct phases, suitably distributed to provide properties not obtainable with either of the individual phases. Generally, there are two phases either a fibrous or particulate phase in a metallic matrix. For e.g. Al2O3 fiber reinforced in a copper matrix for superconducting magnets andSiC particle reinforced with in the Al matrix composites used in aero space, automotive and thermal management applications [2].

For many researchers the term metal matrix composites is often equated with the term light metal matrix composites (MMCs). 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 aluminum crank cases with strengthened cylinder surfaces as well as particle strengthened brake disks. These innovative materials open up unlimited possibilities for modern material science and development; the characteristics of MMCs can be designed into the material, custom-made, dependent on the application [2].

The matrix is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the reinforcement. In high temperature applications, cobalt and cobalt-nickel alloy are common.

The role of the reinforcement in a composite material is fundamentally one of increasing the mechanical properties of the neat resin system. All of the different particulates/ fibers used in composites have different properties and so affect the properties of the composite in different ways.

Aluminum is the most abundant metal in the Earth's crust, and the third most abundant element, after oxygen and silicon. It makes up about 8% by weight of the Earth's solid surface. The chief source of aluminum is bauxite ore. Its Atomic number is 13. Aluminum is a soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. Aluminum is nonmagnetic and non-sparking. Aluminum has about one-third the density and stiffness of steel. It is easily machined, cast, drawn and extruded. Corrosion resistance can be excellent due to a thin surface layer of aluminum oxide that forms when the metal is exposed to air, effectively preventing further oxidation.

The aluminum alloy Al-7075 has been selected as the matrix material is more compatible with the reinforcement and has good mechanical property and cast ability at the alloy level itself. The application of the alloy in automobile and aircraft application itself indicated that it is the proper selection. The material is also having good response to age hardening, heat treatment process and precipitation hardening. The reinforcement selected as alumina (Al_2O_3) in the form of particle size 50 micron to 150 microns. It is more stable with aluminum and withstands high temperature. It is an oxide ceramic having low affinity for the oxygen to form oxides. The particulate form of the reinforcement has better distribution in the matrix to provide isotropic property for the composite. The Silicon carbide has been selected as the next ceramic which is a carbide type of ceramic. The Sic has good lubricating effect along with it reduces the noise and vibration during the relative motion. Aluminium7075 is an aluminum alloy in which zinc is a primary alloying element. The composition and properties of aluminium7075 is shownbelow;

Table 1: Composition of AL7075 [3]

ELEMENT	Cu	Cr	Mn	Mg	Si	Ti	Zn	Fe	Al
PERCENT (%)	1.6	0.15	0.3	2.5	0.4	0.2	5.5	0.5	88.85

Table 2 : Properties of Aluminum 7075 [3]

Mechanical properties	value
Hardness –Brinell	150
Ultimate tensile strength	582MPa
Tensile yield strength	512Mpa
Elongation at beak	11%
Modulus of Elasticity	72Gpa
Poisson’s ratio	0.35
Fatigue strength	155Mpa

Silicon carbide (SiC), also known as carbonado, is a compound of silicon and carbon with chemical formula SiC. It was originally produced by a high temperature electro-chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has been developed into a high-quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractories, ceramics, and numerous high-performance applications. The material can also be made an electrical conductor and has applications in resistance heating, flame igniters and electronic components, floor tiles etc. Structural and wear applications are constantly developing. Silicon carbide is composed of tetrahedra of carbon and silicon atoms with strong bonds in the crystal lattice. This produces a very hard and strong material. Silicon carbide having 16-100grit size[2].

Table 3: Properties of Silicon Carbide [3]

Property	**values**
Melting Point °C	2200-2700
Hardness(k g/mm2)	2785
Density(g/ cm3)	2.96
Coefficient of thermal expansion(micron/m °C)	4.0
Fracture Toughness	4.58
Poisson’s ratio	0.14
Colour	Chunky Black

The chemical formula of aluminum oxide is Al_2O_3. It is commonly referred to as alumina, or corundum in its crystalline form, as well as many other names, reflecting its widespread occurrence in nature and industry. Alumina (Al_2O_3) is the most cost effective and widely used material in the family of engineering ceramics. The raw materials from which this high-performance technical grade ceramic is made are readily available and reasonably priced, resulting in good value for the cost in fabricated alumina shapes. With an excellent combination of properties and an attractive price, it is no surprise that fine grain technical grade alumina has a very wide range of applications. Its most significant use is in the production of aluminum metal, although it is also used as an abrasive due to its hardness and as a refractory material due to its high melting point [2].

Table 4 : Properties of Aluminum Oxide [3]

Property	values
Melting Point °C	2069
Hardness(kg/m m2)	1182
Density(g/cm3)	3.87
Coefficient of thermal expansion(micron/m °C)	8.06
Fracture Toughness	3.95
Poisson’s ratio	0.19
Colour	Cloudy White

II. EXPERIMENT

The matrix material Al-7075 obtained in the form of ingots. The ingots are cleaned to remove the impurity, dust and oil and heated in graphite crucible in induction furnace. The quantity of alumina and the reinforcement are shown in table 3.The melting temperature was held a t 720°C and the reinforcement heated separately at 8500°C being added to the melt. The constant stirring of the melt carried out with alumina stirrer to get uniform distribution of the ceramic particles. The stirring was carried out for 10 minutes and the melt was poured in to graphite mould [3]. The stir casting process is shown in belowfigure1.

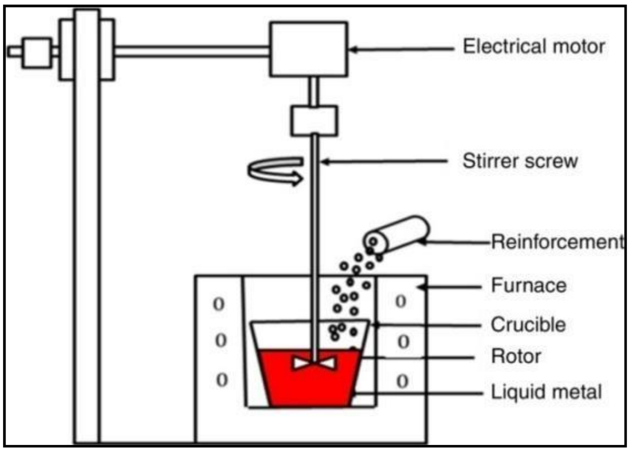


Figure 1 : Stir casting technique

The composition percentage is chosen from the literature and the most common percentage is used in the most of the literature was selected and is given below. According to volume fraction the percentage of reinforcement of silicon carbide and aluminum oxide is varied in steps of 5% to 15%. The weight of reinforcement is based on the weight of matrix material.

Table 5: specimen composition for varying volume fraction [3

Specimen Code	AL -7075	Al_2O_3	SiC
1	100%	0	0
2	90.01%	4.9%	5.02%
3	80.01%	9.9%	10.03%

4	70.01%	14.9%	15.02%

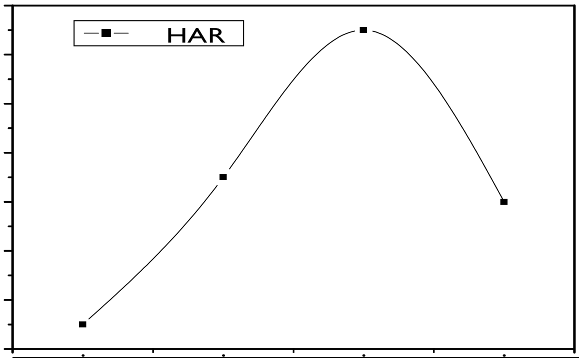
Specimenpreparation:

Castings that are taken out from the mould having a diameter of 12mm and length 100mm and another casting having a diameter of 25mm and length 100mm. These castings are machined in a conventional lathe to a diameter of 10mm and length 35mm and polished in 1000grit emery paper for making wear test. Another casting is reduced to 24mm diameter and 1inch length and polished in a dry and wet polishing machine to get a high surface finish and making a hardness test on the specimen. These specimens are prepared according to ASTM standard for testing. The wear test and hardness tests are performed on the specimens and the readings arerecorded.

III. RESULTS AND DISCUSSIONS

The castings of circular cross section of 25mm diameter and 100mm length have been casted. The specimens were machined to reduce the diameter to 24 mm and length to 1inch for microstructure characterization and hardness test. All the tests are carried out as per ASTM standards. The Specimens were grinded and polished with 300, 600, 900 and 1000 grit emery paper followed by dry and wet polishing in polishing machine. The hardness test is conducted through vicker's hardness tester having a microscope of magnification 10X and 40X

Table 6 : vicker's hardness number for various composition

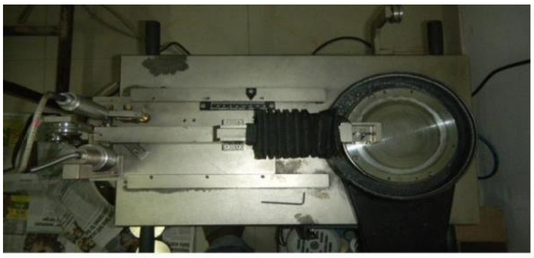


COMPOSITION	MEAN HARDNESS NO
Pure AL7075	108
Al7075+5%(SiC and Al_2O_3)	111.5
Al7075+10%(SiC+Al_2O_3)	121
Al7075+15%(SiC+Al_2O_3)	109

The Graph and Hardness table shows that pure aluminum having low hardness number and then the hardness number increases as the percentage of reinforcement increases upto 10% of reinforcement and the hardness number decrease at 15% reinforcement. Hence from the above data we can say that the strength of the AMC is more at 10% of reinforcement of silicon carbide and aluminium oxide. Wear test carried out on 'wear and friction monitor TR-20 supplied by DUCOM, Bangalore. Rotating disc against the loaded pin was used to determine the wear loss of the material at various conditions. The wear simulations confirms to ASTM standards. Tests are conducted in dry conditions and with rotating motion. The test parameter includes load, speed, temperature, roughness, shape and wear track etc.

Figure 3: Wear and Friction monitor

It is very much essential and close approximate the actual conditions encountered the wear tests, however the most sliding wear tests were carried out using pin-on-disc (Ducom TR-20-PHM-400) type wear testing machine, with a large number of variables, which affect the wear mechanism and wear rate Dry sliding wear tests for different number of specimens was conducted by using a pin-on- disc machine .The pin samples which are obtained after machined and polished were 35 mm in length and 10 mm in diameter. The surfaces of the pin samples were slides using emery paper prior to test in ordered 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 0.0001 gm using microbalance) prior to and after each test. The wear rate was calculated according to Wear measurement by mass change. In this experiment was conducted with various parameters such as load, speed, distance, timeetc.



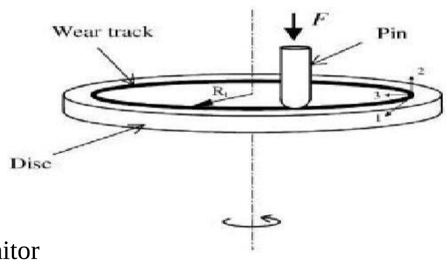


Figure 4. Wear and friction monitor

Table 7 : Numbers Indicating Samples

Identification Number	**Sample**
1	Pure Al7075
2	Al7075+5%
3	Al7075+10%
4	Al7075+15%

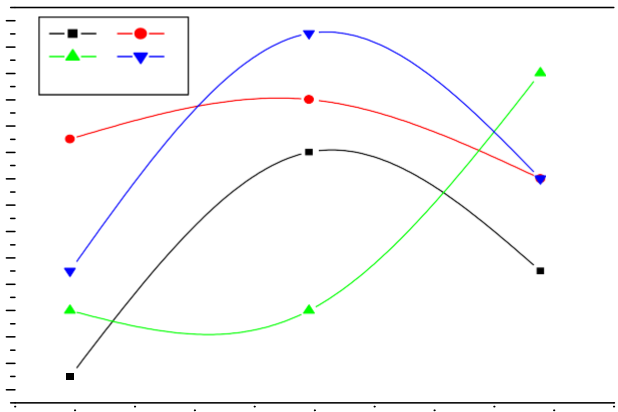


Figure 5 : Graph of Load v/s weight loss

Figure 5 Shows the Graph Plotted for 200 RPM having sliding distance=282.74m, time= 5minutes, sliding velocity=0.9424m/s, track diameter=90mm shows that weight loss is less at 2kg of load, at 4kg weight loss increases and at 6kg again the weight loss decreases.
Figure shows the graph plotted for 200 RPM having sliding distance=282.74m, time= 5minutes, sliding velocity=0.9424m/s, track diameter=90mm shows gradual decrease of specific wear rate as the load is applied.

IV. CONCLUSION

From the above research work, it is concluded that –

- By mix throwing system the crossover metal framework composite can be grown successfully.
- Wear rate found to increment with increment in load and sliding separation. Measure of don diminishes at higher speed than at lower speed of circle.
- The expansion of Sic as auxiliary clay decrease in the commotion and vibration during the movement.

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