International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

Study on Mechanical Properties of Al6063 Reinforced with Sic & Tur Husk

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***Abstract*---** Metal matrix composites are heterogeneous systems containing grid and reinforcement. Their physical and mechanical properties can be customized according to requirement. They are used in automobile, aerospace and marine industries. Metal composites possess importantly improved properties including high tensile strength, toughness, hardness, low density and good wear resistance compared to other alloys. The present study deals with the investigation of mechanical properties of aluminium alloy (Al6063) based hybrid metal matrix composite reinforced with silicon carbide, and tur husk. The sample specimens were made by different percentage of reinforcement with respect to aluminium alloy through stir casting technique. The reinforcement is different in 3 sets each set comprises of 3 specimens. Sic is kept constant [1% in 1St set, 2% in 2nd set and 3% in 3rd set], tur husk and are different in 1% and 2% in all specimens. The casted composite specimens were machined as per American Society for Testing and Materials standards. The mechanical properties like durability strength, impact strength and wear behavior of the test specimens were tested.

Keywords: Sic, Tur Husk, stir casting, mechanical properties

I. INTRODUCTION

A Composite is a combination of two or more dissimilar materials joined together such that the properties of the resultant material are greater than the individual components. Composite material is composed of two or more constituent phase (i.e.,) matrix phase and reinforced phase. A Metal matrix composite is one of the types of composite in which the matrix phase is predominantly a metal or a metal alloy. The metal is the base material which constitutes the major part and the minor constituents are reinforceds that can be in the form of particles, whiskers, continuous and discontinuous fibers. The MMC consists of superior properties such as high strength, high stiffness, high electrical and thermal conductivity, greater resistance to corrosion, oxidation and wear when compared to the base material. A hybrid composite is one which involves more than two constituting materials. Aluminium is an ideal material to be selected as a matrix as it consists of desirable properties like abundancy, low cost, low density, high strength-to-weight ratio, controlled co-efficient of thermal expansion, increased fatigue resistance and superior dimensional stability at elevated temperatures etc.

Al-6063 is an Al alloy, with magnesium and silicon as the alloying elements. The standard controlling its composition is preserved by The Aluminum Association. It has generally good mechanical properties and is heat treatable and weldable.6063 is the most common alloy used for aluminium extrusion. It allows complex shapes to be formed with very smooth surfaces fit for anodizing and so is popular for visible architectural applications such as window frames, door frames, roofs, and sign frames.

Siliconcarbide was originally produced by high temperature electrochemical reaction of sand and carbon, it is a compound of silicon and carbon with a chemical formula SiC. The material has been developed into a high quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractory, ceramics and numerous high performance applications. The particle size of Sic is 49.1 nm

E-Glassfiber or electrical grade glass was originally developed for standoff insulators for electrical wiring. It was later found to have excellent fiber forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fiber glass. The particle size of taken in the experiment is 6mm.

Tur Husk-India is generating huge amount of low cost byproducts and waste in the form of husk. Presently the use of this husk is only for the cattle feed and possessing very less value. However as this byproduct is biomass and naturally carries carbon content with it so that we can use it in industrial application and hence can be used as reinforced in MMCs. One of the major pulse processed in India is Tur (Cajanuscajan) creating large amount of waste in the form of husk. Cajanuscajan husks in their carbon form is still not deliberated and need extensive study for the better application of these husks as composite material. The particle size of Tur husk is 12mm.

II. LITERATURE SURVEY

Manoj Singla et al.(2009) [1] conducted an experiment on Development of Aluminium Based SiC Particulate Metal Matrix Composite. The area of concern for them was hardness, impact strength and the distribution of SiC particles in the Al sample. They observed that there was an increase in hardness as well as impact strength with the increase in the composition of silicon carbide particles. For weight fraction of 25% and grit size of SiC particles as 320, the maximum hardness is 45.5BHN and maximum impact strength is 36N-m. They also observed a homogeneous dispersion of SiC particles in the Al matrix with a declining trend in the samples prepared by with 2-Step method of stir casting technique, with manual stirring and without applying stirring process respectively.

Mr. Prasanna, Mr. Devraj, Mr. Rakeshkumar, Mr.Mahadevappa [2] reported that an experimental investigation of the mechanical properties of SiC, E-Glass and Red mud reinforced aluminium alloy (LM25) composites samples, processed by stir casting route are reported and analyzed. In this study they varied the reinforcing material in smaller quantity to avoid the mixing problem. And from the results what they got shows the addition of reinforcing materials like Red mud, E-Glass and SiC improves tensile strength, Impact strength and reduces % Elongation. But addition of E-Glass minimizes the hardness.Mr. Vijay kumar S Maga, B. S. Motgi [3] reported that the production of al lm6 mm reinforced with varying weight fraction of sic/fly ash/red mud. The result shown that the increase in addition of fly ash giving better result when compared to redmud. Sandeep Kumar Ravesh,Dr T. K. Garg (2012) [4] reported that "Preparation and Analysis For Some Mechanical Property of Aluminium Based Metal Matrix Composite Reinforced With SiC& Fly Ash.in this study they varied SiC and kept all other parameters constant. The result indicated that the developed method is quite successful and there is increase in the value of tensile strength, hardness and toughness with increase in weight percentage of SiC.[5]Md. HasibulHaque, Ramin Ahmed, Md. Muzahid Khan, ShadmanShahriar (2016) "Fabrication, Reinforced and Characterization of Metal Matrix Composites (MMCs) using Rice Husk Ash and Aluminium Alloy(A-356.2)"reported that MMCs were prepared by addition of 2,4,8 wt% through stir casting technique. The result reveals that the hardness of aluminium alloy decreases with increases in weight fraction of RHA particles and increases the ductility of composites.

III. EXPERIMENTAL PROCEDURE

A. Material preparation

The matrix material used in the present experimental investigation is Al 6063 whose chemical composition (in weight %) is listed below in Table 1. The specimens were casted by stir casting. For stir casting induction furnace is used first the base metal is taken in the furnace and heated to 650^{o}C and then the preheated reinforceds are added to base metal, stirring is done with the help of mechanical stirrer. Then the molten metal is poured in the form of round cylindrical rods of diameter 20mmX160mm length using reinforcing materials as , Tur husk, Sic by varying weight percentages about then the casted rods were rapidly cooled to room temperature. Fig 1.shows casted parts taken out after cooling.

B. Specimen preparation

The test specimen were prepared by machining casted cylindrical rods according to ASTM standards. For tensile test the specimens were machined with dimensions 12mm dia X 100mm length in size. The dimensions for impact test were machined to 10mmX10mmX55mm with 2mm deep V-notch at the Centre and for wear test the specimens with 5.9mmdia X 32mm length were prepared.

IV. RESULTS AND DISCUSSION

A. Tensile Testing

A tensile test, also known as tension test, is probably the most fundamental type of mechanical test you can perform on material. The tensile testing specimen were machined according to ASTM standard. The tensile tests were conducted on these samples at room temperature using a Universal Testing Machine. The specimen dimensions are overall length 100mm, gauge length 50mm, grip section length 25mm, grip dia 12mm. The repeat tests were performed for composites with different percentage of reinforced in specimens. Table 3 shows the result of tensile tests. Among all tested samples the specimenY8 with composition AL6063+3% Sic+2% Tur husk gives better ultimate tensile i.e., 157.99N/mm^2.The Tensile Test samples are shown in Fig 4.The Tensile Test samples are shown in Fig 2.

B. Impact Testing

Impact testing is also known as Charpy impact test/Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. The specimen were machined according to ASTM A370. Impact tests were carried out at room temperature and the readings were taken by breaking specimen due to impact of pendulum. Table 4 shows the results of impact test. Among all tested samples specimen Y1 with composition 1% Sic +1%tur husk+gives high Impact strength i.e., 22 joules. The Impact Test samples are shown in Fig 3.

C. Wear Testing

Wear is a process of material removal phenomena. When two surfaces with a relative motion interact with each other, it results in the progressive loss of material from contacting surfaces in relative motion. The prepared specimens were subjected to wear against a rotating EN-32 pin on disc under dry sliding wear testing machine. The tests were carried out

at room temperature without lubrication for 5mins. In this test, track dia=60mm and time=5mins are kept constant while load and speed are varied. The characteristics are determined by the comparison of the alloys for varying percentages of SiC along with aluminium. The Wear Test samples are shown in Fig 4. The results shows that sample Y1 is having least wear i.e., 31µ m and whereas sample Y9 shows highest wear i.e., 1750µ m. Table 5 shows the results of wear test.

Figure1: Casted parts taken out after cooling

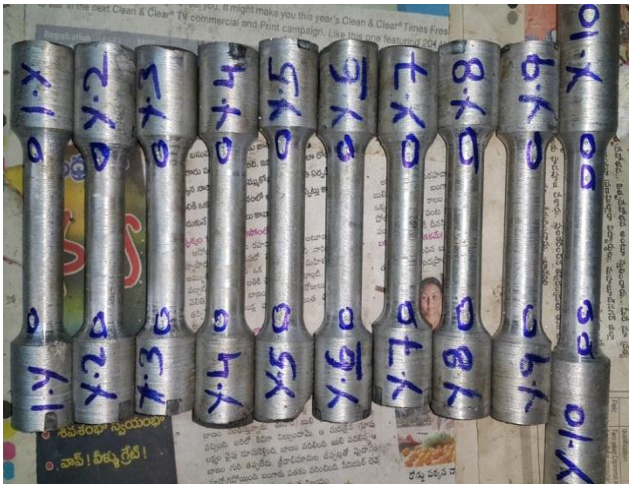


Figure 2: Tensile Test Specimens

Figure3: Impact Test Specimens

Figure4: Wear Test Specimens

Constituents	Weight Percentage
Manganese (Mn)	0.029
Iron (Fe)	0.102
Copper (Cu)	0.0075
Magnesium (Mg)	0.5
Silicon (Si)	0.433
Zinc (Zn)	0.005
Chromium (Cr)	0.0026
Others (Total)	<0.001
Aluminium (Al)	98.8

Table1. Chemical Composition Of Al6063 In (Wt%)

Sample	Composition
Y1	Al6063+1%Sic+1%Tur Husk
Y2	Al6063+1%Sic+2%Tur Husk
Y3	Al6063+1%Sic+1%Tur Husk
Y4	Al6063+2%Sic+1%Tur Husk
Y5	Al6063+2%Sic+2%Tur Husk
Y6	Al6063+2%Sic+1%Tur Husk
Y7	Al6063+3%Sic+1%Tur Husk
Y8	Al6063+3%Sic+2%Tur Husk
Y9	Al6063+3%Sic+1%Tur Husk
Y10(Base)	Al6063 Pure

Table 2: Sample Specifications

Sample	Tensile Strength N/mm^2
Y1	121.75
Y2	132.13
Y3	124.82
Y4	119.18
Y5	94.10
Y6	89.37
Y7	139.72
Y8	157.99
Y9	142.21
Y10(Base)	61.14

Table3: Results of Tensile Test

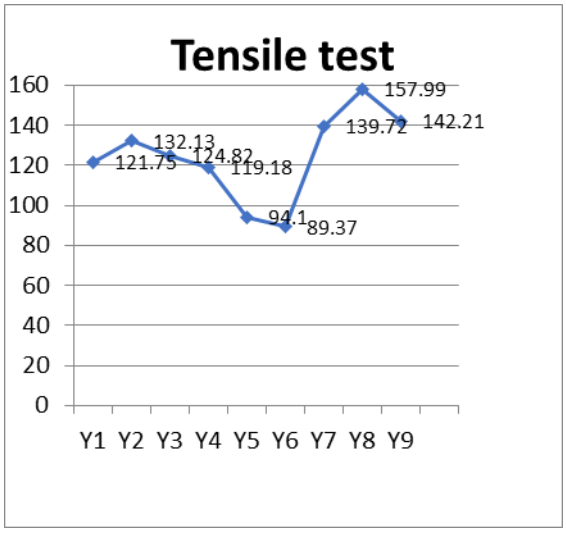
Sample	Energy Absorbed (Joules)
Y1	21

Y2	15
Y3	17
Y4	15
Y5	13
Y6	11
Y7	11
Y8	10
Y9	8
Y10(Base)	13

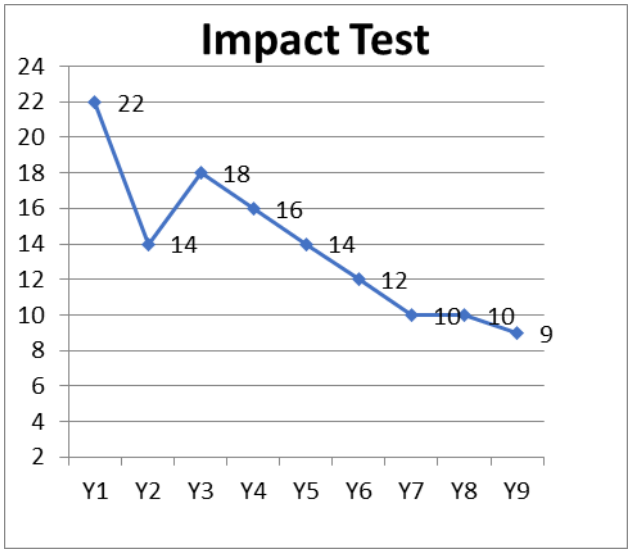
Table4: Results of Impact Test

Sample	Wear in μ m
Y1	31.5
Y2	78
Y3	238
Y4	220
Y5	49
Y6	46
Y7	136
Y8	780
Y9	1756

Table 5: Results of Wear Test

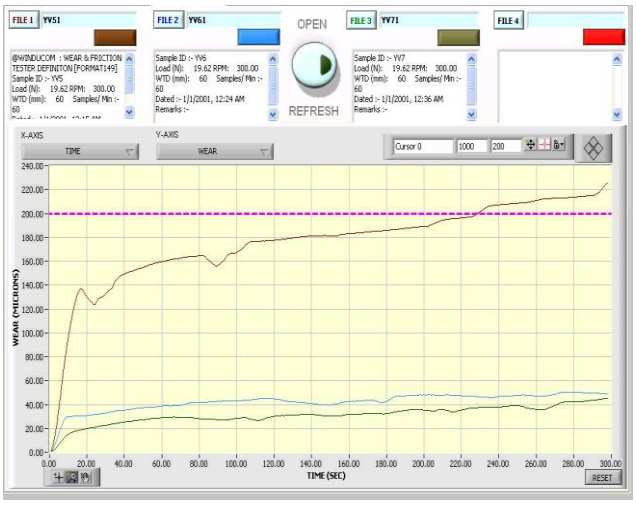


Graph 1: Shows the Tensile test of all samples

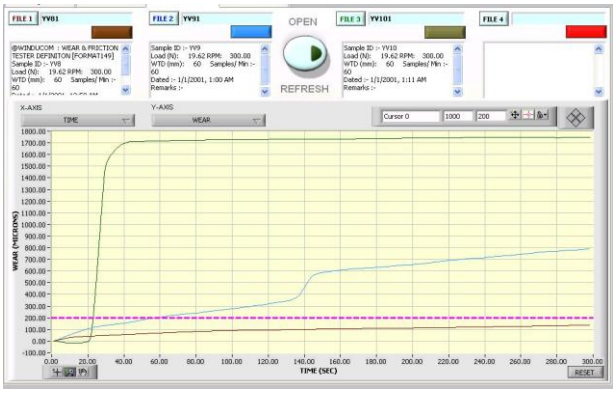


Graph 2: Shows the Impact test of all samples

Graph 3: Shows wear test of sample Y1,Y2,Y3



Graph 4: Shows wear test of sample Y1, Y2, Y3



Graph 5: Shows wear test of sample Y1,Y2,Y3

CONCLUSIONS

The above conducted experiment is to study the effects of adding various weight fractions of SiC, tur husk and glass fiber. We can conclude that

- Composites material Al 6063 alloy reinforced with Sic ,Tur husk and glass fiber were successfully casted by stir casting method.
- When 1% SiC is kept constant and the % of tur husk and glass fiber are varied(1%,2%)the results of 2% tur husk and gives better ultimate tensile strength.
- When 2% SiC is kept constant and % of tur husk and glass fiber are varied (1% & 2%) the results of 1% Tur Husk and gives better ultimate tensile strength.
- When 3% SiC is kept constant and % of tur husk and Glass fiber are varied (1% & 2%) the results of 2% Tur husk and gives better ultimate tensile strength.
- The best result of ultimate tensile strength has been obtained in sample Y8 at the weight percentage of Al6063+3%SiC+2%Tur husk+1%glassfiber.
- When samples Y1,Y2,Y3 are compared in which 1%SiC is kept constant while tur husk and glass fiber weight percentage are varied. The result of 1%tur husk and gives better impact strength.
- When samples Y4,Y5,Y6 are compared in which 2%SiC is kept constant while tur husk and glass fiber weight percentage are varied. The results of 1%tur husk and gives better impact strength.
- When samples Y7,Y8,Y9are compared in which 3%SiC is kept constant while tur husk and glass fiber weight percentage are varied. The results of 2%tur husk and gives better impact strength.
- The best result of Impact strength has been obtained in sample Y1 at weight percentage of Al6063+1%SiC+1%Tur husk.
- The Wear of sample Y1is less and wear resistance is high. The material is hard.Al6063+1%SiC+1%Tur husk.
- The Wear of sample Y9 is high and wear resistance is less. The material is soft.Al6063+3%Sic+1%Tur Husk

SCOPE FOR FUTURE WORK

- This can be further extended by varying geometrical angle of stirrer and by varying stirring speed.
- This MMCs can be manufactured by using other manufacturing techniques like spray casting, powder metallurgy method etc.
- Results can be varied by varying different weight percentages of reinforceds.
- By varying reinforced Grain Size, results can be varied. Heat treatment can be done to improve the properties.

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