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Strength Analysis of Aluminium Composite Reinforced with Coconut Ash Powder: A Review

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ABSTRACT

The strength of Al 6063 and against its reinforced samples using coconut husk has been analysed. The wide range of applications of these metals lies in the field of aeronautical engineering, automobile engineering, marine Industry, military and also in the architectural field. The different tests which have been carried out on this metal and its composites are UTM, Brinell test and Impact test.

KEYWORDS: *Al 6063, AMC, UTM, Brinell, Izod, Charpy, Compression, Coconut Ash, Stir Casting, Metal Matrix. Indenter*

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1. INTRODUCTION

The word composite can be defined as the combination of two or more different materials which when mixed together changes the properties of the base metal. Conventional materials made up of solid have confined with great mixing accomplishment of firmness and Stability. To overcome these deficiencies and to fulfill the consistently expanding need in the present world, the metal composites are the materials that were provided by the late intrigue. Grid composites have altogether provides explicit quality.

Purushotham G.et al. [5] [2013]displayed that aluminium silica combinations had wide-spread application in tri natural segments, for example, grips, chamber liners and cylinders in the car business attributable to its relative daintiness and great warm conductivity. The nearness of silicon brings about decrease of the co-proficient of warm development of aluminium and produces a compound with great throwing machining and erosion qualities.

The different reinforcing materials used in the development of AM's can be classified into three broad groups, which are synthetic ceramic particulates, industrial wastes and agro waste derivatives**. [11]**

However, high cost and limited supply of conventional ceramic reinforcing materials especially in developing countries has remain a major problem associated with the development of discontinuously reinforced aluminium matrix composites (DRAMCs). Other challenges facing DRAMCs that are reported to be of interest to researchers are inferior ductility, low fracture toughness and inability to predict the corrosion behaviour of AMCs. Research efforts put in place to resolve these problems are mostly channelled towards selecting the right choice of reinforcing materials. This is an indication that the reinforcing materials play significant role in determining the overall performance of the composites. **[10]**

Arun M. et. al. [6][2013] introduced that aluminium poles are utilized for nonstop expulsion on business expulsion at various wheel speeds and expulsion proportions utilizing diverse kick the bucket size. A definitive rigidity, hardness and rate extension of the expelled feedstock at various wheel speed and expulsion proportion are evaluated by playing out the elastic and hardness test.

Now a days agro squanders are being utilised as an optional fortification in the manufacture of different types of composites which in turn has a vast application in the industrial sector. With everything considered, these agro squander improved the properties of AMC's over the unreinforced composites. Coconut husk ash is the best and easily available reinforcement agent. Due to its easy availability and being cheaper, it is often used as a

reinforcement agent. In this research, coconut husk ash is being used with the base metal Al 6063 to improve its strength properties. An excellent composite is being prepared with this kind of reinforcement agent, thereby enhancing the mechanical properties of the base metal being used. Various metals can be used in the manufacturing field but the best metal which is considered as the superior one because of its light weight is Aluminium.

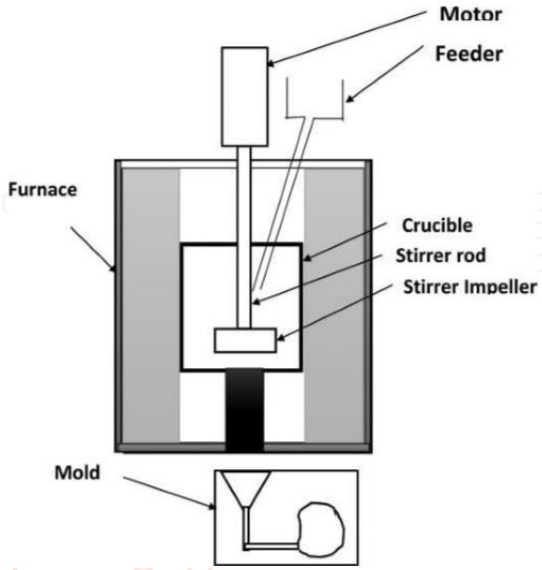
A typical composite material is a system of materials composing of two or more materials (mixed and bonded) on a macroscopic scale. Generally, a composite material is composed of reinforcement (fibres, particles, flakes, and/or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. Composite materials are mixture or a combination of two or more constituents differing in form and material composition and that are essentially insoluble in each other. Since these constituents retain their identity as they do not dissolve or melt in each other, and act in such a way that a new material will be formed whose properties are better than the sum of their constituents. The integration of several different types of ceramic particulates into a single matrix leads to the development of hybrid composites. By using a hybrid composite which contains two or more types of particulates, the advantages of one type of particulate could calculate to what is lacking in the other **[4].**

Nowadays, agro-wastes are used as secondary reinforcements in the fabrication of the composites and they are gaining more importance in today's world. The most important reason why we need composite materials is the versatility in their properties which enables them to be applied in large number of fields. Other reasons are their light weight, corrosion resistance and durability. Many researchers have reported the potentials and limitations of the use of wastes as reinforcements. Composite material includes any products made from a blend of two or more base materials, according to the University of Delaware's Centre for Composite Materials.

Aluminium matrix composites (AMCs) are noted for their unique combination of mechanical, physical and chemical properties which are hardly attainable with the use of monolithic materials. This benefit has made AMCs a strong competitor to steel in terms of versatility for use in a wide range of engineering applications **[14].**

Nowadays AMCs have wide application in the design of components for automobiles, aircrafts, marine structures, defence assemblies, sports and recreation among many others. Agricultural waste ashes obtained by the controlled burning of agro waste products such as bamboo leaf, coconut shell, ground nutshell have the advantages of low densities and processing cost compared with common synthetic reinforcing ceramics such as silicon carbide and alumina. The composites in my research work has been prepared by Stir Casting Method. Separate Stir Castings were done for different percentages of reinforcement added in the Al 6063 and the corresponding percentages by weight are 7,11 and 18.

The present research is focused to fabricate aluminium alloy (6063) and reinforced with coconut shell ash (CSA) to produce matrix composites through stir casting method. The various weight fractions of coconut ash shell particles are considered in this study. Experiments have been conducted so as to note down the mechanical behaviour of the Aluminium Metal Matrix composites. Stir casting is the economical, effortless and most commercially adopted technique, and is known as 'vortex technique'. In this process, reinforcing phases (ceramic particles, short fibres) introduce by the mean of mechanical stirring into molten metal. PAMMC was stirred by S.Ray first in 1968, where alumina (Al_2O_3) particles are introduced into molten aluminium by mechanical stirring. Major disadvantage of this process is agglomeration of particles during fabrication process**. [9].**



Schematic diagram of stir casting setup **[13]**

2. STEPS INVOLVING FOR PROCESSING OF METAL MATRIX COMPOSITES (MMC'S)

S. NO			
1	**Liquid State Processes**	A	Casting or Liquid State Process
		B	Squeeze Casting or Pressure Infiltration
2	**Solid State Processes**	A	Diffusion Bonding
		B	Deformation Processing
		C	Powder Processing
		D	Deposition Techniques

3. TESTS CONDUCTED

Different types of tests were conducted in order to analyse the strength characteristics of the composite Al 6063.The composite has been formed by incorporated the coconut husk ash to the base metal and three samples were prepared. The different tests which were performed are underlined below;

A. Tensile strength:

The tensile test is mostly widely used of all mechanical tests. In this test, ends of the specimen are fixed between grips of the UTM, which strains the particular specimen. The tensile strength of the specimen as compared to the base metal shows an increase for 7% and 11% but was reduced at 18%. On increasing the percentage from 7 to 11, tensile strength was enhanced approximately up to 6 MPa. The improvement in the tensile strength of the reinforced specimen may be due to the fact that the filler CSA possesses higher strength by offering more resistance.

B. Impact test:

In this type of strength analysis, two tests namely Izod and Charpy were conducted. An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of un-notched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test **[7]**. The required dimensions of the specimen are as:

For Izod test, sample size is **75mmx10mmx10mm**
For Charpy test, sample size is **55mmx10mmx10mm [3]**

The total energy in case of Izod is taken as 170J but in case of Charpy test the total energy is taken as 300J. The tests were performed on the base metals and on three composites incorporated with different percentages of coconut husk ash. For Izod test, the specimen was placed vertically with the notch facing towards the hammer whereas in case of Charpy test, the specimen was placed in the horizontal way (simply supported specimen) with the notch facing opposite to that of hammer. On experimentation it was seen that the impact strength was decreased with increase in the percentage of reinforcement. The impact energy was calculated by using the below formula

Impact Energy = Total energy – Residual Energy

C. Brinell test:

The hardness of a material is its resistance to penetration under a localised pressure or resistance to abrasion **[2].** Hardness provides an accurate and economical way of determining the resistance. The hardness of the material depends upon the resistance which it exerts during a small amount of yielding or plastic straining. Standard procedure requires that the test be made of a ball of 10mm±0.0045mm diameter.

For soft metal load =**5000N**
For hard metal load=**30000N** [**12]**

The diameter of the impression produced is measured by means of travelling microscope usually graded into tenth of a millimetre, permitting estimates to the nearest 0.005mm. The hardness measurement has been carried out on composites of varying percentages of 7,1 1 & 18. Then the hardness was measured using Brinell hardness Tester for a period of about 30 seconds in accordance with the ASTM. Brinell hardness number can be calculated by using the below formula

Brinell hardness number,

$$BHN = \frac{2P}{\pi D\left(D-\sqrt{D^2-d^2}\right)} \quad [2]$$

Here 'D' is the diameter of a steel ball (indenter) and 'd' is the mean diameter of the indentation, left on the surface of the specimen and 'P' is the load applied on it. The Brinell hardness number goes on increasing with increase in the coconut husk ash up to the percentage of 11 but with a further increase in the reinforcement for the percentage of 18, the hardness shows the decline in value. The reduced grain size with increase surface in area of composite offers resistance to plastic deformation which leads to increase in hardness.

D. COMPRESSIBILITY TEST

The compressibility test was being conducted on the Universal Testing Machine. The testing was being done as per ASTM-1000KN. On performing test, it was analysed that the compressive strength of the specimen got increased on addition of the coconut husk ash for 7,11 &18 percentages. The increase in compressive strength may be due to the hardening of the base alloy by coconut ash particles.

E. DUCTILITY TEST

Ductility is the physical property of a material associated with the ability to be hammered thin or stretched into wire without breaking. A ductile substance can be drawn into a wire. **[8]** As the tensile strength of the composites goes on increasing up to a certain percentage with an increase in the coconut husk ask, the percentage elongation of those specimen goes on decreasing. The ductility of the specimen on increasing the reinforcement shows the decrement in its value. It may be due to the fact that on increasing the percentage of coconut husk ash, the brittleness gets increased, thereby reducing its ductility. The specimens made were put between the universal tensile machine jaws where on applying a load on it, their length got increased from their original dimension and the required percentage elongation was calculated. The percentage elongation of the specimen is calculated by the below formula:

$$\text{Percentage Elongation} = 100 \frac{L_B - L_O}{L_O}$$

Where L_O and L_B are the initial length of the tensile test specimen and its final length in rupture, respectively. **[1]**

CONCLUSION

Coconut Shell Ash, the agricultural waste generated from milling of solid coconut has been successfully used as a reinforcing material to produce Aluminium Metal-Matrix Composite. The use of CSA for the production of composites can turn agricultural waste into industrial wealth. This can also solve the problem of storage and disposal of CSA. The tensile strength got increased up to 11% by weight but got reduced with further increase in the reinforcement. Similarly, the Brinell hardness number got increased up to 11% by weight of the sample but got reduced with further increase in the coconut husk ash. On the other side compressive strength got increased with an increase in the reinforcement agent and was tested up to an addition of 18% ash by weight of the sample. The work on this research can be extended by increasing the percentage of the reinforcement and the mechanical properties of the Al composites can be analysed. The time for cooling of the composite formation during casting phenomenon is an important parameter which can affect the particle size.

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BIOGRAPHY

Muhib ul Hussian has completed his Bachelor's in Engineering from university of Kashmir in Mechanical branch and is currently pursuing his Masters from Ramgarhia institute of Engineering & Technology. His field of specialisation is production Engineering. His research interests are the strength analysis of Aluminium composites.

Dr. Gautam Kocher is presently working as Head of Mechanical Engineering Department at Ramgarhia Institute of Engineering and Technology, Phagwara. He did his B.Tech from Punjab Engineering College, Chandigarh and M.Tech. in Industrial Engineering from Dr. B R Ambedkar NIT Jalandhar. He has also completed his P.hd degree in Mechanical Engineering from Bangalore University. He has total 30 years of experience (17 years in teaching and 13 years in industry). He has published/attended a number of research papers in National and International Journals/Conferences. During his experience, he has also guided 15 M.Tech. Thesis.

Er Pradeep Singh has done his Master's in technology from Ramgarhia institute of Engineering & Technology (phagwara) in the Mechanical stream. He has also done his Bachelor's in Engineering & Technology from the same college. He is currently working as Assistant Professor in Ramgarhia institute of Engineering & Technology.