PREPARATION OF AMCs BY STIR CASTING METHOD: A REVIEW

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ABSTRACT

Present time is the era of cut throat competition in every field. This causes many new inventions and modifications in the present techniques. In these techniques there is an involvement of composite materials also. If we see the recent applications at a glance, then we will see that there is major place of aluminium alloy based composites. Pure aluminium alloy has the properties likely light in weight, easily extricable good, tensile strength, corrosion resistance, etc. ; but if we want to make a such type of material which will be light in weight but good at strength, resistance to wear, and somewhere tough, then aluminium based composites will be the better option for it. There is an identifiable number of composite materials in the total materials available at present in the world. In this experiment based study there is shown that how the properties of aluminium alloy are changed with mixing of some reinforcement material. Aluminium 6061 alloy and silicon carbide are used for study.

Keywords: Al6061, SiC, AMCs, stir casting.

INTRODUCTION

Composites have good mechanical properties such as strength, hardness, anti-abrasion, light weighted, anti-corrosion and other properties which are used to make various parts such as automobiles parts (i.e. piston, floor ,axle, casing, brake shoes and wheels.), aeroplane parts, parts used in marines, electricity polls and several components of the desired properties. The metal material matrix made by aluminium alloy base is widely used. In this study when we will discuss about matrix phase this should be referred to aluminium alloy 6061, whereas the reinforcement should be referred to 400 mesh silicon carbide powder. In present study there will be concentration on the proper mixing of silicon carbide in aluminium alloy. Different casting are made for different weight percentage of SiC powder.

Some widespread exemplars included are, these supplies are sturdy, radiance and fewer luxurious when counterpart to conformist supplies.

Very topical, researchers also started vigorously including actuation, sagacity, anthology and communiqué into the fused I.E Robotic stuffs.

Archetypal engineered amalgamated stuff embraced beneath:

1. Mortars and concrete

2. Reinforced plastics, like fibre-reinforced polymer
3. Metal composites
4. Ceramic composites i.e(composite ceramic and metal matrices)
5. complex stuffs universally worn for edifices , edifice of overpass ,formations like yacht hulls, pool, simulation of stonework & countertops.
6. Nearly all exemplars performed habitually these days is on rocket ship & jet submissions.

1. MATRIX SEGMENT

Here complex segment alloy tiny makeup, moreover nonstop or wholly delimited by supplementary i.e detached segment.

It has following traits:

- The principal segment has unbroken distinctiveness (characterstics).
- normally supplementary elastic and moderately minor hard segment
- Grips reinforcing segment and splits t he stuck with it.

2. REINFORCING SEGMENT

- The subsequent segment disseminated in the template is in a dis-continuous form.
- Generally sturdier than the milieu, a bits called as reinforcing segment.

3. PROPERTIES OF COMPOSITES

Complex exploit as engineering stuffs on average refer to stuff with the

Following given distinguishing:

1. These are artificially produced.
2. They subsist of less than two distinct materials with well defined interfaces.
3. Their assets are altered by the volume % of ingredients.
4. They have at slightest assets not smitten by supplementary ingredient.

Some other important properties of composites are as below:

a. HIGH STRENGTH TO THE WEIGHT RATIO

Fibre composites are very strong for their weight. By refining the laminates many characteristics can be improved. A common laminate let 3mm Chopped strand mat, is quite flexible when compared to say a same size ply. However, it will bend a long way when

compared to the ply before yielding. Stiffness is not same as Strength. A carbon fibre laminate on the other size, will have a stiffness many times that of the mild steel of the same comparable thickness, increased ultimate strength (uts), yet with only 1/4 of it's weight.

b. LIGHTWEIGHT

Typically specified Fibreglass laminate have explicit severity in range like 1.5 as compared Alloy of 2.7 & steel of 7.8. While you look at Carbon laminates, potencies can be numerous instants that of steel, other than solitary with portion of burden.

c. FIRE RESISTANCE

Aptitude of merged to endure blaze have been gradually widen over the years. There are two brands of these structures to be considered:

- Blaze Retardant –these are self quenching shields, frequently made of chlorinated resins & additives V I A Antimony trioxide. They ejection C O 2 while burned thus while blaze foundation is eliminated, they are extinguished.
- Fire Resistant - More difficultly made with the use of Phenolic Resins. These are difficult to use, are cured by formaldehyde, and require a high degree of post curing to achieve complete fire resistance.

d. ELECTRICAL PROPERTIES

Fibreglass Developments Ltd produced an Insulator Support straps for the Trains Rail main trunk electrification systems. These straps, although only 4mm thick, meet the required loads of 22kN, as well as the insulation requirements.

e. CHEMICAL & WEATHERING RESISTANCE

Composite products generally have good weathering properties and also resist a wide range of chemicals. This depends mostly on the resin used in manufacture, but by careful selection resistance the most extreme conditions can be achieved. Because of this, composites are used in the manufacture of chemical storage tanks and pipes, chimneys and ducts.

The method used for making casting of aluminium alloy are many one of these is stir casting. It is described below:

4. Stir casting

Stir casting is from one of the mostly used techniques for making AMMCs. The function of the stirrer in this process is to mix the reinforcing phase (SiC) into the matrix phase (AA 6061). In this process, reinforcing phases (ceramic particles, short fibers) introduce by mean of mechanical stirring into molten metal. In this method of casting, first we heat the AA 6061 upto it become semi solid and preheat the SiC, then the preheated reinforcing material is mixed in the aluminium alloy by stirrer. Stirrer is rotated in the mixture for 5 minutes. Then this mixture is poured out in a casting mould. In this tech, first matrix material is melted, then it is stirred up very swiftly to make a vortex at the face of melt, and the reinforcing materials are then added at the sides of vortex. The stirring is carried on for few more time till slurry is casted. In this tech, when matrix material has been melted down, it is stirred very swiftly to make a vortex on the surface of the melt formed, then reinforcing material is added at side of the vortex. The stirrer is then moved for few more minutes till slurry is casted. There are no. of designs of stirrers used for this process. Out of them, the turbine type is a most popular. During this process of manufacturing of composites, stirring add up in two following ways:

(1) Moving of particles into the liquid material.

(2) Sustaining the particles in suspended state.

Microstructure inhomogeneties may cause noticeable particle aggregation and strengthening of melt during the solidification process. Non-homogeneity in reinforcement scattering in cast composites may be a difficulty due to intercommunication of suspended ceramic particles and movement of solid-liquid collaboration during the solidification process. It is sometime achievable to have up to 30 percent of ceramic particles in size b/w 5 - 100 μm in various types of aluminum alloys. It is sometimes not good for having sub-micron size ceramic particulates or whiskers.

LITERATURE REVIEW

Sanjeev Kumar et al. investigated the effects of Thermal Cycling on Cast Aluminium Composites Reinforced with Silicon Carbide and Fly Ash particles. During this investigation, dry fly ash was used with Aluminium reinforced with SiC and a composite was prepared using Liquid metal stir casting route with the reducing quantity of SiC. During the research, Thermal cycling was carried out on the samples prepared and effects on samples before and after thermal cycling were observed.

Narinder Singh et al. studied the effect of age hardening behaviour of Aluminium LM-4/ Zircon sand composite produced by the stir casting technique. During this research, Water and Brine solution has been used as the quenching media and the thermal ageing has been done at different temperature, time and quenching media. Thermal ageing has been done at different temperature, time and quenching media. Microhardness and wear tests were performed on the samples obtained from the stir casting process. The results obtained from this investigation that the ageing demonstrate that the microhardness of the composite depend on the quenching medium in which they are heat treated.

Vishal Sharma et al. investigated the effect of Al-4.5wt%Cu/ zircon sand/ SiC hybrid composite by stir casting route by controlling various casting parameters. The as-cast samples were observed under optical and scanning electron microscope. Micro structural observations of the as-cast hybrid composite, shows uniform distribution of reinforcement particles and also good interfacial bonding between the particles and the matrix. Micro hardness tester is employed to evaluate the interfacial bonding between the particles and the matrix by indenting the micro hardness indenter on the particle with the varying load (100 gm, 200 gm, and 300 gm) and time (10 sec, 15 sec, 20 sec and 25 sec). It has been concluded that by the variation in hardness at constant load varying time or at constant time varying load, the bond strength can be compared.

Shailove Kumar et al. studied the age hardening behaviour of Aluminium alloy (6351) - 9%wt SiC composite produced by the stir casting technique. Water and Brine solution has been used as the quenching media. Thermal ageing has been done at different temperature,

time and quenching media. Micro hardness and wear tests were performed on the samples obtained from the stir casting process. The results of ageing demonstrate that the micro hardness of the composite depend on the quenching medium in which they are heat treated and peak hardness depends on quenching media and ageing time durations. X-ray Diffraction was performed to know the presence of the phases of reinforced material. Optical micrography was done to know the distribution of SiC particles in aluminium alloy.

M.Ramachandra and K. Radhakrishna had presented that aluminium based metal matrix composite containing up to 15% weight percentage of Silicon carbide particles are synthesized using stir-cast method. Macrostructural studies have shown near uniform distribution of SiC particulates in the longitudinal direction. Microstructure also showed uniform distribution along the cross section of the specimen. Friction and wear behavior is studied by using computerized pin on disc wear testing machine. Resistance to wear has increased with increase in silicon carbide particles. But wear has increased with increase in normal load and sliding velocity. Hardness has increased with increase in SiC particles.

S. Sawla and S. Das examined the abrasive wear behaviour of LM13 alloy and LM13–15 wt. % SiC composite, in cast and heat-treated conditions, as a function of applied load. The wear constant (K) was calculated based on the wear rate data. It was observed that the wear constant decreases with load. In the case of cast alloy the value of wear constant was higher than that of the heat-treated alloy and composite. The wear surface and the subsurface were studied using scanning electron microscope (SEM).

G. B. Veeresh Kumar et al. this paper deals with the mechanical properties such as hardness, tensile strength and wear resistance etc. of Al6061-SiC and Al7075-Al_2O_3 composites. The composites are prepared using the liquid metallurgy technique, in which 2-6 wt % of particulates was dispersed in the base matrix in steps of 2. The SiC and Al_2O_3 resulted in improving the hardness and density of their respective composites. Further, the increased %age of these reinforcements contributed in increased hardness and density of the composites. The microphotographs of the composites studied revealed the uniform distribution of the particles in the matrix system. The dispersed SiC in Al6061 alloy and Al_2O_3 in Al7075 alloy contributed in enhancing the tensile strength of the composites. The

wear factor K obtained using computerized pin on disc wear tester with counter surface as EN31 steel disc (HRC60) and the composite pin as specimens, demonstrated the superior wear resistance property of the composites.

N. R. Prabhu Swamy et al. the aim of this paper is to investigate the Al6061–SiCp composites was fabricated by liquid metallurgy route with percentages of SiCp varying from 4 wt% to 10 wt% in steps of 2 wt%. The cast matrix alloy and its composites have been subjected to solutionizing treatment at a temperature of 530°C for 1 h followed by quenching in different media such as air, water and ice. The quenched samples are then subjected to both natural and artificial ageing. In this paper microstructural studies have been carried out to understand the nature of structure. Mechanical properties such as microhardness, tensile strength, and abrasive wear tests have been conducted both on matrix Al6061 and Al6061–SiCp composites before and after heat treatment. However, under identical heat treatment conditions, adopted Al6061–SiCp composites exhibited better microhardness and tensile strength reduced wear loss when compared with Al matrix alloy.

M.K. Surappa et al. studied the tribological behaviour of stir-cast Al–Si/ SiCp composites against automobile brake pad material was studied using Pin-on-Disc tribotester. The Al-metal matrix composite (Al-MMC) material was used as disc, whereas the brake pad material forms the pin. It has been found that both wear rate and friction coefficient vary with both applied normal load and sliding speed. With increase in the applied normal load, the wear rate was observed to increase whereas the friction coefficient decreases. However, both the wear rate and friction coefficients were observed to vary proportionally with the sliding speed. I this during the wear tests, formation of a tribolayer was observed, presence of which can affect the wear behavior, apart from acting as a source of wear debris.

Tribolayer formed over the worn disc surfaces was found to be heterogeneous in nature. It has also investigated the morphology and topography of worn surfaces and debris were studied using scanning electron microscope (SEM).

Jaykant Gupta et al. investigated the mechanical properties and wear behaviour of mild

steels carburized at different temperature range of 850, 900 and 950^{0}C and found that the simple heat treatment greatly improves the hardness, tensile strength and wear resistance of the mild steels. It also examined the effects of these different carburization temperatures and conditions on the mechanical and wear properties of the carburized mild steels. For this purpose the mild steels are carburized under the different temperature range as stated above and then it is tempered at 2000 C for half an hour after this the carburized and tempered mild steels are subjected for different kind of test such as abrasive wear test, hardness test, tensile test and the toughness test. The results of these experiment shows that the process of carburization greatly improves the mechanical and wear properties like hardness, tensile strength and wear resistance and these properties increases with increase in the carburization temperature but apart from this the toughness property decreases and it is further decreases with increase in carburization temperature.

S.M Seyed Reihani et al 6061 aluminum matrix composites containing 30vol% SiC with mean mass particle size of 16 and 22 μm as the reinforcing phase were synthesized by squeeze casting route. The process consisted of fabricating of SiC preform followed by squeeze casting of 6061 aluminum alloy. The SiC preform was made by blending SiC particles with silica as a coal and sintering. The microstructural features, aging behavior, mechanical properties and wear

characteristics of the composites were investigated. The results indicated that a homogenous distribution of SiC particles in the aluminum matrix, which is almost free of pores, can be obtained by squeeze casting method. Higher strength and lower wear rates were observed in the composite materials than the unreinforced aluminum alloy part.

Sallahauddin Attar et al in this review studies on the past advancements with current scenario is done on the Aluminum matrix composites. By suitable choice of the metal matrix and the reinforcement phase, a wide range of property combinations can be obtained. Particle reinforced metal matrix composites (PRMMCs) have become very promising

materials due to their significant advantages over conventional materials such as high specific modulus, improved resistance to wear, improved resistance to high cycle fatigue and fatigue crack threshold, higher stiffness-to-weight ratio, low coefficient of thermal expansion and high thermal conductivity.

Sijo M T et al in the current study effects of stir casting Al-Sic alloy composite are studied by experiments. It is found that To improve fracture toughness it is necessary that reinforcement should be uniformly distributed. The experimental work to find out the optimum values is difficult and costly. Since stir casting process involves very high temperature, experimentation is difficult and dangerous. So, proper simulations of stir casting process considering all relevant factors are necessary to yield good results.

Recep Ekici et al This study investigates the effects of particle size, volume fraction, random dispersion and local concen-tration underneath a spherical indenter on the indentation response of particle reinforced metal matrixAl 1080/SiC composites. The ceramic particles in certain sizes and volume fractions were randomly dis-tributed through the composite structure in order to achieve a similar structure to an actual microstructure as possible. The particle size and volume fraction affected considerably indentation depths anddeformed indentation surface profiles. The indentation depth increases with increasing particle size, but decreases with increasing particle volume fraction.

Munmun Bhaumik et al In the present study, Al-MMC has been fabricated by mixing the 5wt% ZrO2 and Al2O3 reinforcement into the Al6063aluminium alloy matrix. Stir casting method has been adopted for the fabrication of MMC. The prepared casted MMC has been characterized by scanning electron microscope (SEM), X-ray diffraction (XRD) analysis. The physical property (density) and mechanical property (hardness, tensile test, bend test, compression test) have been measured for the fabricated MMC. The fracture surface has been studied. The fracture of Al-MMC is found brittle in nature.

CONCLUSION

From the previous researches and experiments done in history, we have got following conclusions have been drawn:

1. The tensile strength of the alloys formed by reinforcements by stir castings generally increased with increase volume of reinforced material.

2. The rate of wearing also decrease with increase in volume percentage of mg induced in the composite alloy but after certain limits these also show a various trends.

3. Methods used for cast preparation are different like Metallurgy, squeeze casting and stir casting.

4. The modulus of elasticity of Al alloys formed also increases with incresed reinforcement.

f. The fractural toughness is generally decreased with increased percentage of reinforced material in alloy formed of Al.

g. The distribution of reinforcement is generally made uniform with the help of the stir casting method.

8. The stir casting method used for reinforcement mixing is most economical of all other methods used for casting of alloys.

9. The percentage elongation of composite Alloys of Aluminium is generally decreased with increased value of reinforcement in the alloy.

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