Characteristic Studies On Aluminium Based Silicon Carbide And Fly Ash Particulate Metal Matrix Composite

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Abstract

To overcome the problems faced in conventional materials, lots of studies are going on to replace them with alloys/composites. And also to reduce the cost of composites. Aluminium materials found to be the best alternative with its characteristics like high strength to weight ratio and low density. As development of light weight materials has provided numerous possibilities for weight reduction. In this project we are casting aluminium based (Al 6061) composites with silicon carbide and fly ash as reinforcements, fly ash is one of the inexpensive and low density material enormously available as a by product during coal combustion. And then the casted components are machined to specimen dimensions and different material testing had been conducted to obtain the material properties and characteristics. We are varying mass fraction of and fly ash (9%, 12%, & 15%) and keeping 9% SiC as constant. we had got well advancements in mechanical properties like tensile, compression and hardness with the increase in wt % of reinforcement.

Key words: Mechanical properties, Silicon carbide, composite material.

1. Introduction

Composites are just a combination of materials in such a way that the resulting materials have desired/required properties. Nowadays composite materials are widely used for many no of applications like engineering structures, aerospace, marine application, sports and so on. Metal matrix composite, especially aluminium matrix and particulate reinforced composites are getting most applications in present days.

The flyash is extracted from Raichur power plant, and among the various methods of producing MMC we had selected stir casting technique as it appears to be the best technique to introduce particles by forming vortex. Wettability is increased by adding magnesium, magnesium removes the oxygen from the liquid surface thus diminishing the gas layer and enhancing the wetting action.

K. Radhakrishna et al. [1] had used aluminium with copper and fly ash as reinforcements and concluded that up to 15%, the reinforcements are successfully dispersed in the matrix. And hardness, wear resistance increases, up to 15 wt% addition of reinforcements.

Beinias et al. [2] used aluminium with flyash as reinforcements and stated with the addition of fly ash brittleness increases and corrosion increases as it forms porosity.

Hebbar et al. [3] made use of aluminium and flyash composite material for their testing and concluded that a compression tension and hardness property increases with addition of fly ash to the aluminium matrix.

Shanmugsundaram et al [4] stated that beyond 20% of addition of flyash leads to mismatch between the theoretical and measured density values due to increased porosity and particle cluster.

Sudarshan, M.K. Surappa [5, 6] have synthesized A356 Al–fly ash particle composites .They studied mechanical properties and dry sliding wear and come into brief idea that The damping capacity of composite increases with the increase in volume fraction of fly ash. The 6% of fly ash particles into A356 Al alloy shows low wear rates at low loads (10 and 20 N) while 12% of fly ash reinforced composites show lower wear rates compared to the unreinforced alloy in the load range 20–80 N. At

higher load, subsurface delamination is the main mechanism in both the alloy as well in composites.
S. C. Mishra et al. [7] has studied on Aluminum – fly ash composite produced by impeller mixing and came into a brief idea that Up to 17wt% fly ash reinforcement can be reinforced by liquid metallurgy route. The addition of magnesium into the aluminium melt increase the wet ability and thus increase in the mechanical properties such as hardness, tensile strength and the wear resistance is observed.

2. Experimentation

In this work, Al6061 material is used as the matrix element, and silicon carbide and fly ash as reinforcement.

Table 1: Chemical composition of Al6061

Content	Al	Cu	Mg	Si	Fe
%	97.99	0.206	0.729	0.533	0.191
Mn	Ni	Pb	Sn	Ti	Zn
0.076	<0.050	0.024	0.011	0.094	0.064

Table 2: Chemical composition of fly ash

Content	SiO2	Al2O3	Fe2O3	CaO	MgO
%	65.56	19.90	3.79	7.56	1.24
TiO2	LOI				
1.20	0.70				

- **SILICON CARBIDE:**

Silicon carbide is the only chemical compound of carbon and silicon. It is an excellent abrasive. It is having low density, high strength, high elastic modulus, high thermal conductivity, excellent thermal shock resistance. Elevated temperature performance and the fact that they reported only a 35% loss of strength at 1350°C are their best qualities. And its melting point is 2700 °C.

- **FLY ASH:**

Fly ash is one of the most in expensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. They constitute mostly of silicon dioxide (sio_2), aluminium oxide/alumina (al_2o_3) and iron oxide (fe_2o_3). Fly ash particles are mostly spherical in shape and range from less than 1µm to 100 µm. It is having high electrical resistivity, low thermal conductivity.

In this work, Al-Fa-SiC composites were produced by varying % of fly ash (9, 12 and 15 %) by stir casting route. And the set up is shown in figue.1

Figure 1: Stir casting set up

1. Required amount of flyash of by weight should be measured and kept aside.
2. Then the fly-ash were heated to 450-600 degree Celsius and maintained at that temperature for about 20 minutes to remove the moisture content.
3. Then weighed quantity of aluminium was melted in a crucible at 750-800degree Celsius.
4. The molten metal should be degassed at a temperature of 780 degree Celsius using solid dry hexachloroethane tablets. (<.5% weightage)
5. Then the molten metal was stirred to create a vortex and the weighed quantity of pre heated fly ash particle were slowly added to the molten metal maintained at >720 degree Celsius with continuous stirring at a speed of 350-500 rpm to a time of 6-8 minutes
6. During stirring magnesium about >2% should be added to ensure good wettability.
7. Then the melt with the reinforced particles were poured in to moulds the poring temperature should be maintained at 680 degree Celsius.

3. Mechanical properties

3.1 Tensile and Compressive strength:

To conduct tensile and compressive strength the casted specimens are machined to standard ASTM dimensions. And tested on universal testing machine.

3.2 Hardness:

Hardness test was carried out on the composite specimens using Brinell hardness testing apparatus with 10mm diameter and load of 250kg. The loading time was 30 secs. Three readings were taken for each specimen and mean value was considered.

4. Results and Discussion

Al-FA-SiC composite was successfully casted using stir casting method.

Fly ash WT%	Tensile strength (MPa)	Compressive strength (MPa)	Hardness (BHN)
0%	319.901	484.000	50
9%	395.999	498.500	71
12%	398.999	500.260	78
15%	405.984	504.030	88

Table3: Mechanical properties of Al-Fa-SiC composite.

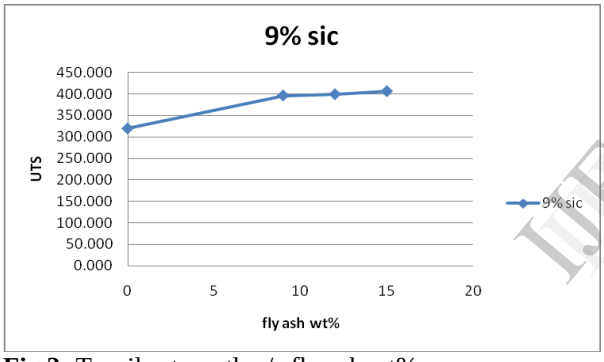

Fig 2: Tensile strength v/s fly ash wt%

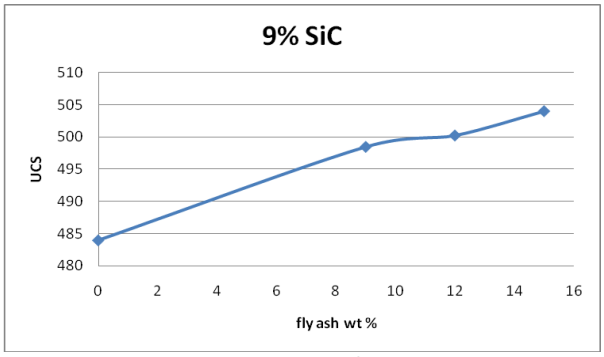

Fig 3: Compressive strength v/s fly ash wt%

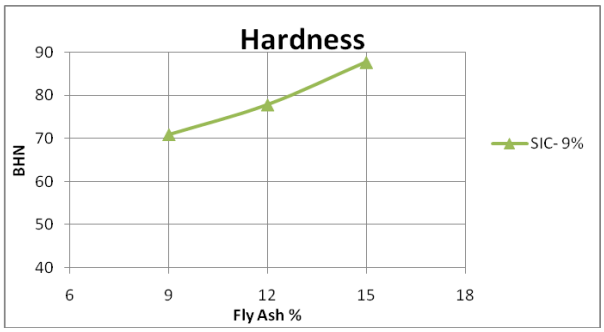

Figure 4: Hardness v/s fly ash wt %

The results of tensile compression and hardness test are as tabulated in table 3.

Tensile strength of the casted composites is comparatively higher than the un-reinforced material. Its variation is show in fig 2.

The compression test results reveals that the addition of flyash particles considerably increases the compressive strength, it is as mentioned in fig 3.

The output of hardness test shows a increasing trend with the increase in fly ash wt%, this is because the flyash particle shows some resistance to dislocation which inturn resists the deformation. And it is also because the fly ash particles have higher hardness than aluminium.

Thus by observing the above figures and tables we can conclude that, with the addition of fly ash and SiC mechanical properties like tensile strength, compressive strength and hardness can be increased up to some extent.

5. conclusions

Based on the observation and results obtained through experiments the following conclusions can be drawn.

- ✓ From the study it is concluded that we can use fly ash for the production of composites and clearing the fly ash storage issues.
- ✓ Fly ash up-to 15% by weight can be successfully added aluminium 6061 alloy by stir casting route to produce composites.
- ✓ Hardness of aluminium (Al6061) is increased from 50BHN to 88BHN with addition of fly ash and magnesium.
- ✓ The Ultimate tensile strength has improved with increase in fly ash content. Whereas ductility has decreased with increase in fly ash content.
- ✓ Compressive strength increases with increase in reinforcement wt%

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