

## Processing and Characterization of Al-Flyash Composite by Stir Casting

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**Abstract:** In this paper the study on wear behavior, tensile and microstructure characterization of composite material made up of base metal Aluminium 6061 and reinforcement material fly ash processed by stir casting technique. Three combination of composite were produced by adding 3,6,9 percentage weight fraction of fly ash with base metal Aluminium 6061. The microstructure of all the specimen were observed in optical microscope and distribution of reinforcement material is observed. From the results wear tests the variation of wear rate is directly proportional to the load, as the load increases wear rate increases and tensile test has given the result that UTS of the as cast is less than the composite material.

**Keywords:** Aluminium 6061, Flyash, stir casting

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### I. Introduction

Composite material is a material composed of two or more different phases like matrix phase and reinforcing phase leading to a new material bearing properties like high stiffness, high strength, low density, high temperature sustainability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, improved wear resistance etc. MMC performs a very good properties including high specific strength, specific modulus, damping capacity, good wear resistance etc. Due to low cost and low density MMCs are widely used in manufacturing of automobile spares. Fly ash is the most cheap and low density reinforcement available in abundant quantities as waste by product during combustion of coal in thermal power plants. Composite with fly ash as a reinforcement material are less costly and can be used to manufacture automobile spares. Composite with fly ash as a reinforcement material are less costly and can be used to manufacture automobile spares [1]. Size of fly ash particles is usually size of 0-100  $\mu\text{m}$  which are extracted from combustion of coal. India produces about 110 million tons of fly ash per year from burning about 250 million tons of coal for electric power generation. Stir casting is the most promising route for production of Aluminium matrix because of easy methodology and ability to produce products in industrial scale economically [2]. According to the chemical nature of the matrix phase, composite are classified as Metal matrix (MMC), polymer matrix (PMC) and ceramic matrix composites (CMC). Fatigue properties and wear resistance compared to many of the metals and alloys. Over the past two decades metal matrix composites have been transformed from a topic of scientific and intellectual interest to a material of broad technological and commercial significance. MMCs offer a unique balance of physical and mechanical properties. Aluminium based MMCs have received increasing attention in recent decades as engineering materials with most of them possessing the advantage of high strength, hardness and wear resistance [3]. In general fly ash contains  $\text{Fe}_2\text{O}_3$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ , as major proportions and oxides of Ca, Na, Mg etc. as minor proportion. Fly ash particles are mostly spherical in shape and range from less than  $1\mu\text{m}$  to  $100\mu\text{m}$  with upper area, between 250 and  $600\text{m}^2/\text{kg}$ . The specific gravity varies between 0.6-2.8g/cc [4]. Fly ash is the most cheap and low density reinforcement available in abundant quantities as waste by product during combustion of coal in thermal power plants. Composite with fly ash as a reinforcement material are less costly and can be used to manufacture automobile spares [5].

### II. Experimental Details

#### 2.1. Material Composition

Aluminium 6061 is precipitation hardening Aluminium alloy containing magnesium and silicon as its major alloying elements. It has good mechanical properties and exhibits good weldability. It is one of the most common alloys of Aluminium for general purpose use.

#### 2.2. Stir Casting

By using stir casting process the base metal Al6061 and reinforcing material Fly ash is mixed with the help of stirrer and a composite material is produced. 2 kg of Aluminium and 20gms of Fly ash, 4kg Aluminium

80gms of Fly ash and 6kg Aluminium 160gms of fly ash is mixed. Aluminium 6061 is taken in crucible and kept it melting in electric furnace. Set the temperature to 770°C. Close the furnace and wait for 3 hours. After that remove the crucible from furnace and add the reinforcement material which is already preheated in the heat treatment furnace by using stirrer setup while mixing add degasifying agent nitrogen to remove the gases and to avoid oxidation. The stirrer is rotated at 100-300rpm for 1-2 min and pour the molten metal in to the pre heated die at constant rate of pouring at room temperature. Allow the mould to cool until it reaches the room temperature. Remove the mould box and detach the specimen from the mould. The entire procedure is repeated for the different percentage of reinforcement material and base metal.

### 2.3. Microstructural studies

A specimen of 10mm dia and 10 mm high is taken for optical study. Specimens were polished with emery papers of grit size 200,400,600,800,1000 until the scratches disappear, Then the samples are taken to polishing machine for polishing on polishing cloth to achieve the mirror surface. The etching is done to get the clear grain boundaries by using 95% of water and 5% of HNO<sub>3</sub>. While polishing add a mixed solution of water and Al<sub>2</sub>O<sub>3</sub> on the polishing cloth to reduce friction and heat generation. Next the specimen is taken to the optical microscope and the photographs will be taken. Same procedure will be repeated for different compositions.

### 2.4. Wear studies

The material is turned to required dimensions on lathe machine which is 8mm dia and 30 mm length. The surface should be smooth for the test and it is obtained by using emery paper. The specimen is thoroughly cleaned and burrs should be removed, check the electrical connections to the set up, weigh the specimen before put into the machine, set the time, speed on the digital indicator and put the load as required for the test. Carry out the test for particular variable like load speed and rpm after that weigh the specimen, take the average of two weights and take the friction force acted on the specimen for each 30 sec, the average of that will be the total friction force. Repeat it for the other composition.

### 2.5. Tensile Test

A casted product is machined on the lathe to get required dimensions that is 106mm length, 9mm dia, 22mm gauge length, 2mm radii. According to ASTM STD-E8. Adjust the UTM for required load and mount the specimen in to the jaws. Switch on the machine set the load and start the test, at one point of time the material will break take that point as breaking load and take down the ultimate load when it breaks note all the readings, repeat it for other specimens.

## III. Figures and Tables

**Table No. 1:** Chemical composition of Al6061

Element	Al	Cr	Cu	Fe	Mg	Mn	Si	Tn	Zn	Other
Wt%	Balance	0.04	0.15	0.2	0.8	0.15	0.4	0.15	0.25	0.15

**Table No. 2:** Chemical composition of Fly ash

Element	LOI	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	Mgo
Wt%	19.0	56.0	13.21	4.79	5.60	1.20



**Fig.1.** Resistance furnace



**Fig.2.** Portable electrical motor stirrer

IV. Results And Discussion

4.1. Microstructural studies

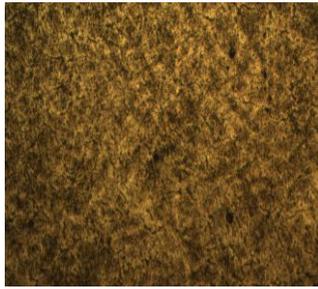


Fig. a 3% Al-flyash

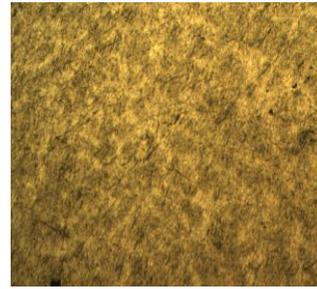


Fig. b 6% Al-flyash

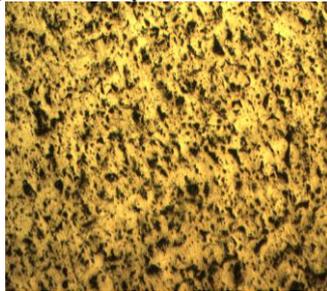


Fig. c 9% Al-fa



Fig. d As cast

As the above fig. a shows that there is presence of voids and blow holes and uneven mixing of the reinforcement material and grain size and grain boundaries are unable to see clearly. Fig.b shows the clear indication of mixing base metal and reinforcing material. Fig.c shows more porosity, uneven surface.

4.2. Wear studies

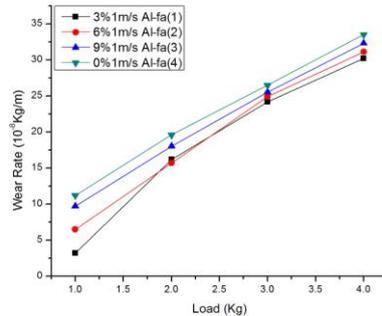


Fig.1. Variation of wear rate against load V=1m/s.

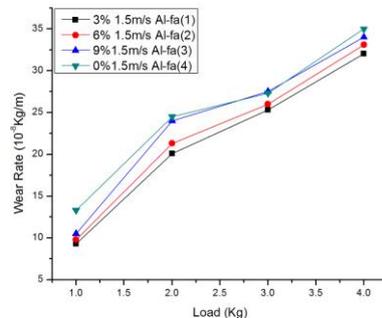


Fig.2. Variation of wear rate against load V=1.5m/s.

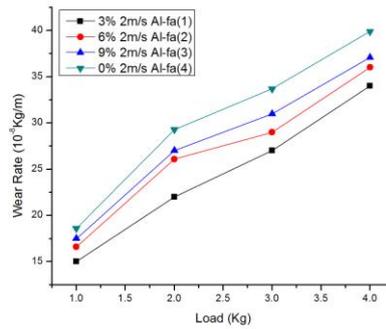


Fig.3.Variation of wear against load V=2 m/s.

From the study of wear, we can say that at constant velocity and rpm of the rotating disc the wear rate increases with increase in the load and it is directly proportional.

#### 4.3. Tensile studies

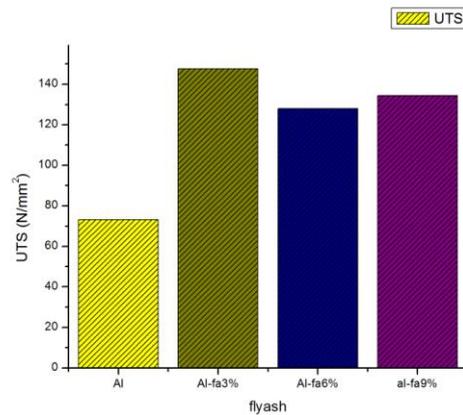


Fig.4. Variation of UTS against Wt% of flyash

From the tensile test it is observed that the ultimate strength of the as cast specimen is more less compared to the composite specimen. 3% flyash reinforced with Aluminium 6061 shows the highest UTS compared to other (6,9%).

#### V. Conclusion

A study is carried out on a Aluminium-fly ash composite material, a series of tests were carried out like microstructural characterization, wear behavior and tensile test. From the photographs taken from optical microscope it is observed that distribution of reinforcement material is uniform in Fig. a. In the Fig .b, the moderate distribution is seen and in Fig. c, the porosity and voids were seen. From the results of wear it is seen that as the percentage of reinforcement increases the wear rate increases, comparing with the as cast specimen the wear rate is improved and it is less than the as cast specimen. As the load increases the wear rare increases and it is directly proportional. The results of tensile test say that the increase in the percentage of reinforcement material the UTS will decrease , as compared to the as cast the UTS value is more.

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#### References

- [1]. D Mohan Rao, Bapi Raju Bandam M.E et. al "Preparation and Characterization of AL- Fly ash Metal Matrix Composite by Stir Casting Method" International Journal of Innovative Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-3 Issue-1, December 2014.

- [2]. P. Shanmugasundaram, R. Subramanian and G. PrabhuDevelopment.et al “Some Studies on Aluminium – Fly ash Composite Fabricated by Two Step Stir Casting Method” European Journal of Scientific Research ISSN 1450-216X Vol.63 No.2 (2011), pp.204-218 © EuroJournals Publishing, Inc. 2011.
- [3]. Anilkumar H. , H. Suresh Hebbar. et al Effect of Particle Size of Fly ash on Mechanica and Tribological Properties of Aluminium alloy (Al6061) Composites and Their correlations
- [4]. Review Muruganandhan.P, Dr.Eswaramoorthi.M. et al Aluminum Composite with Fly ash – A Review IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 6 Ver. III (Nov- Dec. 2014), PP 38-41.
- [5]. gerg fisher “composite: engineeringthe ultimate material”,Am.ceram.soc,bull.vol.63(2), pp.360-364