

# COMPARISON STUDY OF Al-FLY ASH COMPOSITES IN AUTOMOBILE CLUTCH PLATES

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## ABSTRACT

Now a day the Light weight composite materials are widely used in engineering field. The composite materials has good characteristic of resisting wear resistance, hardness and tensile strength. Due to less weight and good strength the composite materials plays a vital role in engineering field. Aluminium LM6 has been used as matrix material and various weight percentage of fly ash (5%,10%,15%). The mechanical behaviour and microstructure of Al-Flyash composites are investigated. Mg is added to reduces the surface tension and avoids the rejection of the particles from the melts. In this paper we have suggesting fly ash composite material in automobile clutch plate and reducing the wear resistance.

Keywords: fly ash composite, metal matrix composites, wear

## INTRODUCTION

Aluminium- fly ash composite is metal matrix dispersion strengthen composite in which soft and ductile aluminium matrix is strengthen by hard and brittle fly ash particles. Discontinuously reinforced aluminium (DRA) based metal matrix composites are of increasing interest because of their high specific stiffness and strength, high isotropic and excellent wear resistance as well as cost effective manufacturing. DRA composites have been developed in the past two decades for various automobile, aerospace, electronic packaging and other structural applications [1]. Fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants has been successfully dispersed into cast and wrought aluminium alloys to make aluminium-alloy-flyash(ALFA) composites[2]. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for wide spread applications. The substitution of aluminium with fly ash can decrease the need of energy intensive-aluminium, resulting in energy savings [3]. Al-Fly ash composites are being widely used in various applications such as highway and runway signs, sliding tracks for windows and doors, automotive parts, industrial furniture, machine cover, frames & ducts, etc [4]. Studied characterization of A356 Al - fly ash particle composites with fly ash particles of narrow range (53-106 $\mu$ m) and wide size range(0.5-400  $\mu$ m) and reported that addition of fly ash lead to increase in hardness, elastic modulus and 0.2% proof stress [5]. Progress in this area depends upon the development of metallurgy, casting and solidification, heat and surface treatments.

Since fuel consumption relates directly to vehicle weight, reducing weight can improve the fuel usage and price-to performance ratio. Aluminium matrix ceramic reinforcement composites have attracted more attention due to their combined properties such as high specific strength, high stiffness, low thermal expansion coefficient and superior

sdimensional stability at elevated temperatures as compared to the monolithic materials. Aluminium matrix composites reinforced by SiC/Flyash particles are prepared by using modified stir casting method. The stirring arrangement improves the distribution and wettability. The mechanical behaviour and microstructure of Al-Flyash composites are investigated. After the investigation of the flyash composites we have found out that this material is suitable for automobile clutch plate.

## EXPERIMENTAL STUDY

In this study, aluminium LM6 alloy has been used as matrix material and fly ash particle with average size of (1-100 $\mu$ m) were used as the reinforcement materials and its chemical composition was as shown in the table 1. In this research, Al - fly ash composites were produced with a different amount of fly ash (ie 5, 10, 15 wt %) and different amounts of magnesium (ie 2, 4, 6 wt %) by two step stir casting method. The fly ash particles were preheated to 600°C for 2 hours in a separate muffle furnace to remove the moisture content. Aluminum was charged in to the graphite crucible, and the furnace temperature was raised up to liquidus temperature 750°C in order to melt the Al scraps completely and further the melt temperature was dropped to just below the liquidus temperature to attain the semi solid state. Magnesium and then preheated fly-ash particles were added in the crucible. Mg was incorporated into the melt to promote the wetting action between Al matrix and fly ash reinforcement particles. The molten Al composite slurry was stirred at the stirrer speed of 300 rpm for 20 minutes. Since high torque was needed in mixing of the composite slurry in semi solid state, a variable torque - speed controlled mechanical stirrer was employed. The dispersion of fly ash and magnesium with aluminium were achieved by the two step stir casting method. Finally the composite melt was reheated to 750°C and poured into the steel mould to solidify.

Component	Mg	Cu	Fe	Si	Mn	Zn	Al
%	0.1	0.1	0.6	10 -13	0.5	0.1	Bal

Table .1 Chemical Composition sof LM6-Aluminium alloy

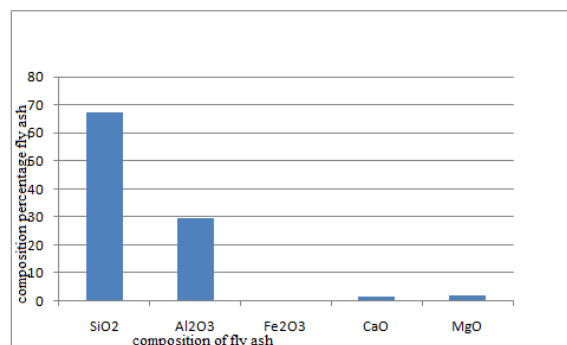


Chart shows the composition of fly ash composite

## **MICROSTRUCTURES ANALYSIS**

Microstructures were examined on the few samples with an optical microscope and a Scanning Electron Microscope (SEM) equipped with X-ray spectrometer. Samples were mechanically polished using sand metallographic practices and etched with Keller's reagent prior to microstructure examination.

## **MECHANICAL PROPERTIES**

### **Tensile strength**

Tensile strength test were carried out on composites using universal testing machine. Specimens were machined with standard dimensions. Three samples were tested for each composition and mean value was considered.

### **Hardness**

Hardness tests were performed composite specimens. The hardness values of the specimen were measured using Brinell hardness testing system with 10mm diameter at a load of 500 kg. The detention time was 30 seconds. Three tests were taken on each specimen to eliminate possibility of segregation and mean value was considered.

### **Wear**

Al and composite specimens were prepared in the size of 12mm diameter and 15mm length and loaded in a computer interfaced pin on –disc wear testing machine. The test piece were secured to the instrument at the normal loads of 5, 10, 15 N and sliding speeds were 0.5, 1.0, 1.5 m/s. Wear test carried out at room temperature.

## **RESULTS AND DISCUSSION**

Here figure 1, 2 and table 2 summarizes the SEM micrograph and tensile and hardness properties of Al–fly ash composites in order to investigate the contribution of fly ash reinforcement and Mg.

The SEM images of Al-fly ash particles,

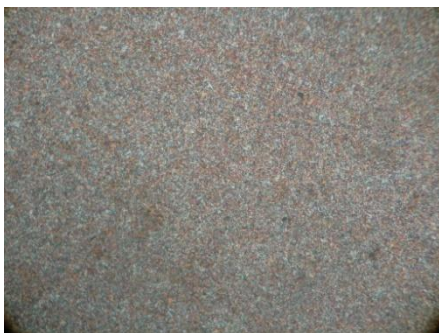


fig .1

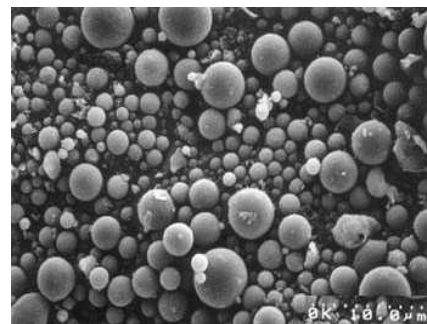


fig .2

Minutes with the stirring speed of 300 rpm at 650°C (above liquidise) and Fig.2 shows at 615°C (in semi solid range). It was observed from the Fig.2 that fly ash particles distribute homogeneously in the composites when the stirring was made in semisolid condition. The homogeneous distribution of fly ash particles in the Al matrix was achieved due to smashing action of solid dendrites in semi solid state. Porosity was not observed from the TEM micrograph. The interface between matrix and reinforcement was almost perfectly bonded.

Table .2 Mechanical properties of existing clutch plate material

	Hardness (BHN)	Tensile strength (Mpa)
Steel(FG150)	130-180	150

Table .3 Mechanical properties of Al-fly ash at various Wt% Composites

	2% Mg		4% Mg		6% Mg	
Fly ash	X	Y	X	Y	X	Y
5%	50	135	65	159	98	174
10%	67	152	74	175	132	189
15%	72	170	88	196	160	207

X –Hardness, BHN

Y – Tensile Strength, Mpa

The existing materials of the clutch plate friction factor are collected and the comparison is made out with fly ash composites. Generally the clutch plate should have good thermal conductivity, thermal resistance and withstand high contact pressures. The material used should be safe to environment.

Material Combination	Coefficient of Friction ( Dry )	Temp. ( max ) °C	Pressure( Max ) MPa
Steel	0.15-0.20	300	0.8-1.3

Table .3 properties of existing clutch plate material

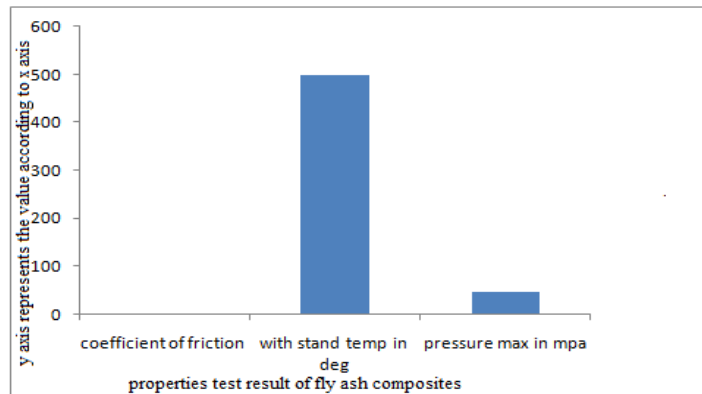


chart shows the coefficient of friction and their properties

The test is done to the fly ash composite specimen and the results were plotted comparatively it has minimum coefficient of friction with comparison existing materials and their temperature withstand capacity and max pressure withstand capacity also discussed.

## CONCLUSION

Development of lightweight materials has provided the automotive industry with numerous possibilities for vehicle weight reduction. Generally the selection of materials in automobiles plays a vital role in it. The material which has been selected should have good mechanical characteristic and less in cost. In this experiment we have suggested that the flyash composites are best suitable for automobile clutch plate compare to the exiting clutch plate materials. Due to its less coefficient of friction the fly ash composites can be used in automobiles in future.

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