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Investigations on Aluminium and Fly-Ash Reinforced Composites in Automotive Applications

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ABSTRACT

In Recent days the less weight composite materials are majorly used in engineering applications. The composite materials have enough characteristics of resisting tribological properties, hardness and tensile strength. Due to lesser weight and strength, a composite material plays a major role in emerging engineering applications. Aluminium LM5 has been used as matrix material and different weight percentage of fly ash (10%, 20%, and 25%). The mechanical behaviour and microstructure of Al-Flyash composites are evaluated. Magnesium is added to reduce the surface tension and avoids the neglecting of the particles from the melt. In this article we are suggest fly ash composite material gives better efficiency in automotive applications and reducing the tribological properties.
Keywords : Fly Ash Composite, Tribological Properties, Microstructure.

I. INTRODUCTION

Al-fly ash composite is a metal matrix dispersion strengthen composite in which soft and ductile aluminium matrix is strengthen by heavy and loose fly ash particles.

Discontinuity reinforced aluminium based metal matrix composites are of increasing interest because of their higher specific stiffness and strength, high isotropic and good wear resistance as well as economical manufacturing. DRA composites have been developed in the past two decades for various automotive applications, aerospace, electronic devices packing and other structural areas. Fly ash is one of the less expensive and low density reinforcement material 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.

Here, composite material with fly ash as reinforcement are widely to overcome the cost behaviour for wide spread applications. The substitute of Al with fly ash can decrease the demand of energy intensive-aluminium, resulting in energy savings. Aluminium-Fly ash composites are majorly 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 Studied characterization of A353 Al - fly ash particle composites with fly ash contents of narrow limit (50-110µm) and wide size range (0.5-500 µm) and reported that addition of fly ash lead to increase in hardness, elastic modulus and 0.3% proof stress. Progress in this area depends upon the development of metallurgy, casting and solidification, heat and surface treatments.

The fuel consumption relates directly to vehicle mass, reducing weight can improve the fuel consumption and cost-to efficiency 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 dimensional stability at specific temperatures as compared to the monolithic materials.

Al matrix composites reinforced by SiC/Flyash particles are prepared by using modified stir casting equipment. The stirring set up improving the distribution and wettability charateristics. The mechanical characteristics and microstructure of Aluminium -Flyash composites were investigated.

After the experimentation of the flyash composites, have find out this component is suitable for automotive applications.

II. EXPERIMENTAL INVESTIGATION

In this article, aluminium LM5 alloy has been used as matrix material and fly ash particle with average size of (1-200 µm) have used as the reinforcement materials and its chemical composition as shown in the table No 1. In this paper, Al - fly ash composites are produced with a different amount of fly ash (ie 10, 20, 25 wt %) and different amount of mg (ie 4, 8, 12 wt %) by stir casting method.

The fly ash particles have preheated to 800ºC for 2 hours in a individual muffle furnace to release the moisture elements. Aluminium is charged in to the graphite crucible, and the furnace temperature was raised up to liquidus temperature 950ºC in order to melting the Aluminium scraps completely and further the melting temperature is dropped to just below the liquidus temperature to attaining the semi-solid stage. Mg and preheated fly-ash components has added in the furnace. Magnesium has incorporated into the melt to provide the wetting action among Aluminium matrix and fly ash reinforcement component. The molten Aluminium composite slag was stirred at the stirrer speed of 450 rpm for 30 minutes. Since higher torque is needed for mixing the composite slag in semi-solid stage, a variable torque - speed controlled mechanical stirring function has completed. The dispersion of fly ash and magnesium with Al is achieved by the two step stir casting equipment.

Lastly the composite melt is reheated to 850ºC and pour into the steel moulding for solidification

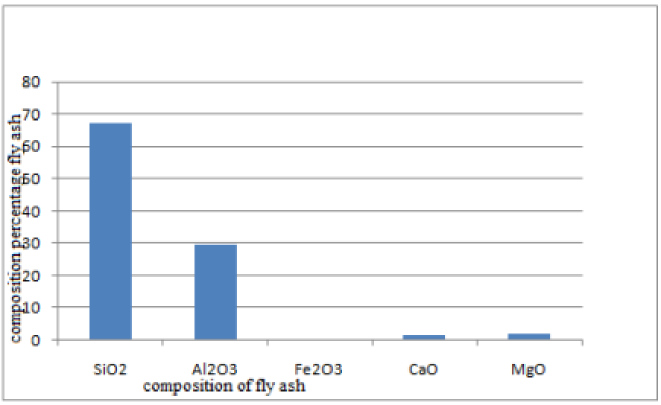


Fig.1.

Table .1 Chemical Compositions of LM5-Aliminium alloy Composition of the fly ash composite

Component	Mg	Cu	Fe	Si	Mn	Zn	Al
%	0.2	0.2	0.8	15 -20	0.7	0.5	Bal

III. MICROSTRUCTURES ANALYSIS

Microstructures of the specimen were examined on the few samples with an optical microscope and a Scanning Electron Microscope (SEM) connected with X-ray spectrometer. Specimens were mechanically polished using sand metallographic particles and etching with Keller's regent prior to microstructure analysis.

IV. VARIOUS MECHANICAL PROPERTIES

Hardness

A hardness test has performed on composite samples. The hardness values of the specimen being measured using Brinell hardness testing (BHN) system with 10mm diameter at a load of 500 kg. The confinement time was 45 seconds. Three tests has taken on each specimen to eliminate possibility of segregation and mean value have taken into account.

Tensile strength

Tensile strength test has done on specimens using universal testing machine (UTM).

Specimens were machined with standard dimensions and records. Three samples were tested for each composition and mean value have taken for calculation.

Wear

Aluminium and Fly ash composite specimens are prepared in the size of 10mm diameter and 20 mm length and loaded in a computer interfaced pin on – disc wear testing machine. The test specimen is 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 has performed in room temperature.

V. RESULTS AND DISCUSSION

Figure 1, 2 and table 2 shows the SEM micro image and tensile and hardness properties of Al–fly ash composites in order to examine the contribution of fly ash reinforcement and Magnesium.

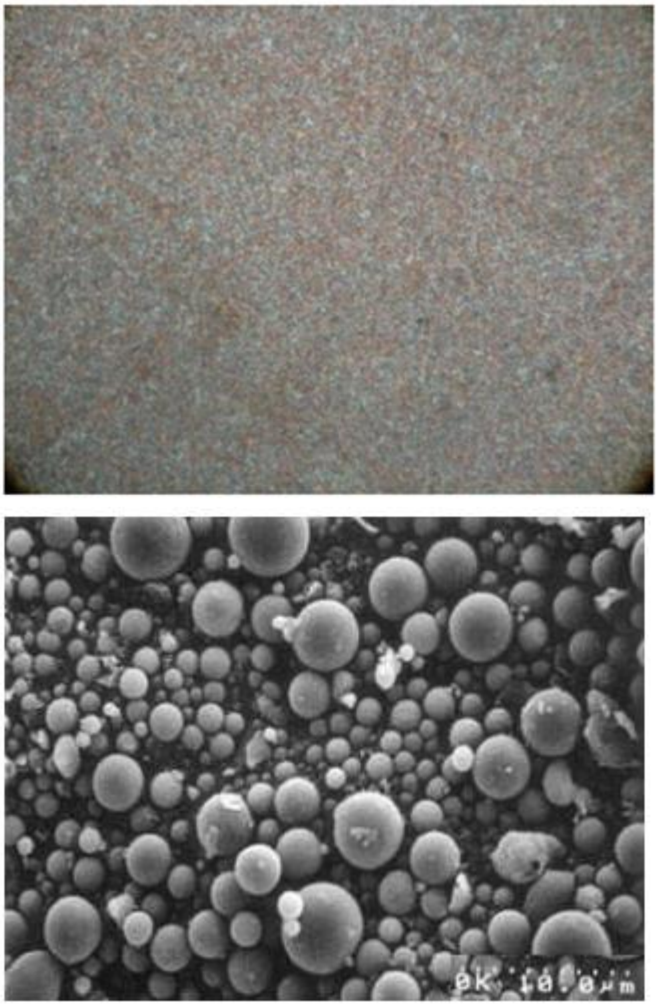


Fig.2 The SEM Images of Aluminium-Fly Ash Particles

Figure 1 and table 2 shows the SEM micro image and tensile and hardness properties of Al–fly ash composites in order to examine the contribution of fly ash reinforcement and Magnesium.

Minutes with the stir speed of 400 rpm at 750ºC (above liquidise) and Fig.2 shows at 630ºC (in semi solid range). It was observed from the Fig.2 that fly ash particles distribute homogeneously in the composites when the stirring has made in semisolid condition. The homogeneous distribution of fly ash particles in the Aluminium matrix has achieved. Due to crashing action of solid dendrites in semi solid state. Penetrability was not observed from the SEM micrograph. The line between matrix and strengthening has almost flawlessly merged.

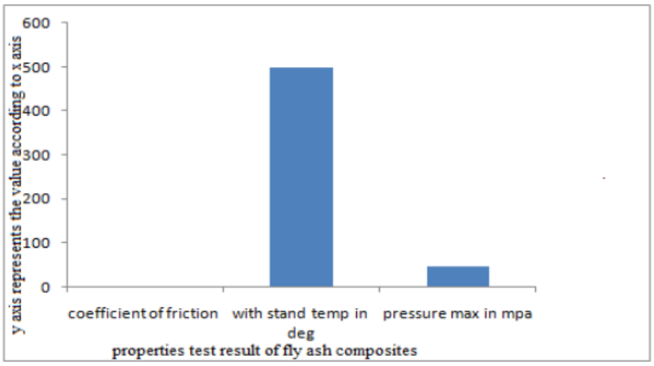
Table. 2 Mechanical properties of existing automotive component material

	Hardness (BHN)	Tensile Strength (MPa)
Steel FG(150)	**140-190**	**165**

Table. 3 Mechanical properties of Aluminium-fly ash for various Wt % Composites

	4 % Mg		8 % Mg		12 % Mg	
Fly Ash	**Hardness (BHN)**	**Tensile Strength (MPa)**	**Hardness (BHN)**	**Tensile Strength (MPa)**	**Hardness (BHN)**	**Tensile Strength (MPa)**
10 %	70	165	105	180	122	193
20 %	80	190	140	212	148	223
25 %	95	210	163	212	175	227

The existing materials of the automotive element friction factor have composed and the evaluation is made out with fly ash composites. Usually the automotive element should have good thermal conductivity, thermal resistance and withstand high interaction pressure. The material used should be non-toxic to the environment.



Co-Efficient of friction and their properties

Table 4. Properties of present automotive element material

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

The experimental investigation is completed to the fly ash composite specimen and the results were intended comparatively it has minimum coefficient of friction with assessment of existing materials and their characteristics and maximum pressure withstand capacity also conversed.

INFERENCE

Progress of lightweight materials has provided the automotive industry with plentiful possibilities for vehicle weight reduction. Commonly the selection of materials in automobiles acting a vital role in it. The material which has been selected should have good mechanical characteristic and economically less.

In this research we have recommended that the flyash composites are finest suitable for automotive elements compare to the present automotive element materials.

Due to its less coefficient of friction the fly ash composites are used in automotive components in upcoming years.

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