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FABRICATION AND STUDY OF SLIDING WEAR BEHAVIOUR OF ALUMINUM (AA5083) WITH FLY ASH COMPOSITE MATERIAL

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ABSTRACT

The advancement of metal matrix composites (MMCs) is of impressive interest in industrial applications for lighter materials with more specific strength, heat resistance and stiffness. Aluminum-matrix composites (AMCs) reinforced with discontinuous or particle reinforcements are very attractive because they give the best combination of strength, ductility and toughness and they can be processed by traditional process such as rolling, extrusion ,forging, and as a final process, machining. These theses provide sliding wear behavior of composites. Here composite material is fabricated by AA 5083 with fly ash (0 %, 4 %, 8%). Aim of these theses is produce low cost composite. Fly ash is one of the solid wastes, its produce by thermal power station in large quantity. . At the end, optimize the wear parameter by using Taguchi method with the use of L_9 orthogonal array.

Key word; fly-ash, metal matrix composite, aluminum, stir casting

I. INTRODUCTION

Conventional monolithic materials have limitation good combination of strength, stiffness, toughness; ductility etc so composite material is good choice to short out these problem. Composites materials have high strength to weight ratio and high stiffness. Now days demand of composite material increase compare to conventional monolithic materials. Composite material uses in aircraft, aerospace, automotive industry and home-made application etc. It is possible to developed new composite material with improve mechanical and physical property by study fundamental nature of material and understanding their structure property relationship.

Metal matrix composites have good mechanical property such as tensile strength, impact strength, bending strength, hardness etc, MMCs also improve specific modulus, wear resistance damping capacity, corrosion resistance, stiffness etc. Today, research interest produce MMCs at low cost, low density with improve mechanical and physical property. So use of waste particle use as reinforced increases. Fly ash is one of solid waste which produce by combustion of coal in power plant.fly ash also have low density and inexpensive reinforced particle. Fly ash in aluminum alloy reduced the cost of aluminum product. Today; 1600 engineering material available in market, more than 200 are composites, show importance of composite material as engineering materials [1].

II. MATRIX MATERIAL

In the present work, Aluminum alloy (AA 5083) is chosen as a matrix material. It finds many applications such as shipbuilding, rail cars, vehicle bodies, pressure vessel, welded structure, drilling rigs. AA 5083 is excellent ductile and thermal conductivity material. Chemical compositions are AA 5083 given below table.

Table 1 Chemical composition of AA 5083 alloy [1]

S/N	CHEMICAL ELEMENT	% (WEIGHT %)
1.	Aluminum	Balance
2.	Magnesium	4 to 4.9
3.	Iron	0.40 max
4.	Silicon	0.0 to 0.4
5.	Zinc	0.0 to 0.10
6.	Titanium	0.05 to 0.25
7.	Other	0.05 to 0.50

AA5083 alloy know as also Mg-Al alloy. Density of aluminum alloy is 2.66 g/cm^3. This alloy withstand at low temperature without loss of property. Above 65^{0}C its lose their property.

1. REINFORCEMENT MATERIAL

Fly ash produces by combustion of coal in thermal power station **(NTPC BADARPUR, DELHI)** use as reinforce material. Chemical composition of fly ash is finding out by **EDAX**. Low cost and low density fly ash produce light weight and low cost composites. Fly ash contains physical property such as low density, high electrical resistivity and low thermal conductivity. In power thermal station, fly ash come out with flue gas and collected through electro-static precipitator.**fly ash also known as ESP ash or dry ash**. Size of fly ash is 0 to 100 micron. Thermal power station is also produce **bottom ash** and pond **ash/mound ash**. Pond ash is mixture of fly ash and bottom ash. Density of fly ash is 2.17 g/cm^3.

2. FABRICATION METHOD

The aluminum alloy (AA 5083) based metal matrix composites were designed as per given table (Table 2), amounting to 100% by weights and prepared using Stir casting technique. Stir casting is a liquid state fabrication technique; in which dispersed phase (Fly ash) is mixed with AA5083 alloy (melting temperature of 750°C achieved using muffle furnace and graphite crucibles) by manual stirring for 2-3 minute. The mixture is then poured into a permanent mold and allows cooling to room temperature. Thereafter, specimens were cut as per standard size for characterizing physical, mechanical and sliding wear.

Table 2 Design of fabricated composite
(fly ash particle with AA 5083)

SET NO	AA 5083 (wt %)	FLY ASH (wt %)
SET 1	100	0
SET 2	96	4
SET 3	92	8

Figure 1 fabricate metal matrix composite plate

Parameters affect the properties of material by erosion wear, like weight loss, decreased efficiency of component, decreased life of component etc, so the different parameters which effect on sliding wear like sliding velocity and load on composites are discussed.

3. SLIDING WEAR CHARACTERISTIC OF COMPOSITE

Sliding wear is defined as a progressive loss of material occurs from a solid surface owing to a mechanical interaction between the surfaces. Materials that exhibit high wear resistance can increase machinery efficiency by maintaining design tolerance longer than unreinforced materials. For example alumina –reinforced aluminum used as automotive engine pistons results in increased power output together with longer component life.

4. INFLUENCE OF VELOCITY ON SLIDING WEAR RATE

In the material the sliding wear should be occurred as minimum as possible because if it will high then the life and efficiency of the material will decreases, so from the research it found that sliding wear reduced when velocity decrease.

Table 3 sliding wear rate at different velocity and different filler content (load 15 N and time 16 min)

Sliding velocity (m/sec)	**1.047**	**2.094**	**3.140**
Sliding wear rate at 0%	100×10^{-11}	474.96×10^{-11}	816.72×10^{-11}
Sliding wear rate at 4%	75.658×10^{-11}	226.95×10^{-11}	269.96×10^{-11}
Sliding wear rate at 8%	51.04×10^{-11}	140.34×10^{-11}	272.99×10^{-11}

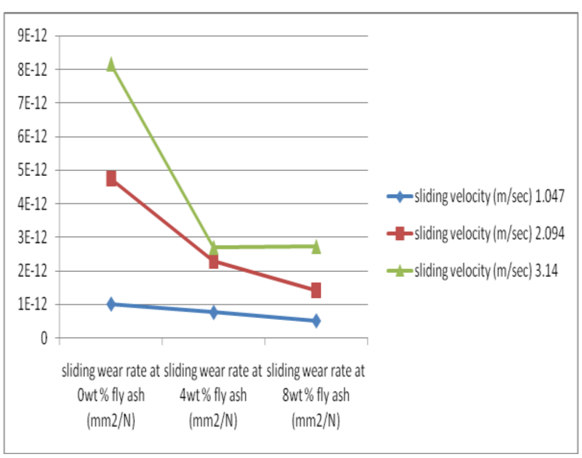

Figure 2 sliding wear load at different velocity (load 15 N and time 16 min)

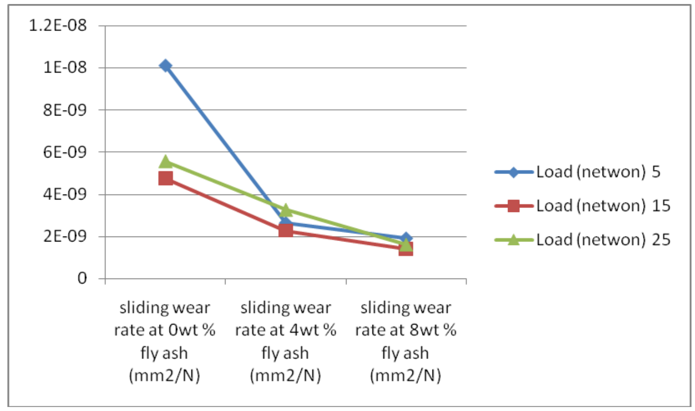

Figure 3 sliding wear load at different load (velocity 2.094 and time 16 min)

From above table, sliding wear rate is minimum when sliding velocity 1.047 m/sec, filler content 8%, load 15 N and time 960 sec.

5. INFLUENCE OF LOAD ON SLIDING WEAR RATE

Table4 sliding wear rate at different load and different filler content (velocity 2.094 m/sec and time 16 min)

	5	**15**	**25**
Sliding wear rate at 0%	1012.5×10^{-11}	474.96×10^{-11}	555.01×10^{-11}
Sliding wear rate at 4%	264.8×10^{-11}	226.95×10^{-11}	325.32×10^{-11}
Sliding wear rate at 8%	191.4×10^{-11}	140.34×10^{-11}	160.77×10^{-11}

For above table sliding wear rate decrease up to 15 N and after that it is increase. Sliding wear rate is minimum at 15 N load and 8% filler material (velocity is 2.094 m/sec and time period is 960 sec).

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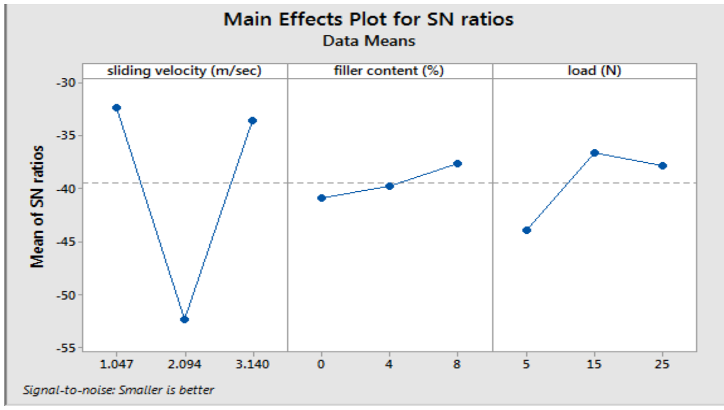
OPTIMIZATION OF SLIDING WEAR RATE USING TAGUCHI METHOD

S. N	Sliding velocity (m/sec)	Filler content (%)	Load (N)	Sliding wear rate (mm^2/N)	SNRA	MEAN
1	1.047	0	5	75	-37.5012	75.00
2	1.047	4	15	25.21	-28.0315	25.21
3	1.047	8	25	38.29	-31.6617	38.29
4	2.094	0	15	475.01	-53.5341	475.01
5	2.094	4	25	325.33	-50.2465	325.33
6	2.094	8	5	459.36	-53.2431	459.36
7	3.140	0	25	37.51	-31.4829	37.51
8	3.140	4	5	113.52	-41.1014	113.52
9	3.140	8	15	25.52	-28.1376	25.52



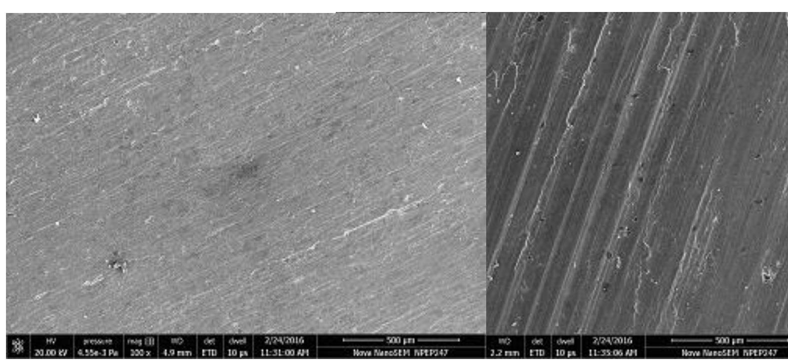
Sliding wear rate is minimum when sliding velocity is 1.047m/sec, filler content is 8% and load apply is 15 N.

III. RESULT

Table 3 and Table 4 show sliding wear rate is minimum when load apply 15 N, sliding velocity 1.047 m/sec and filler content is 8%. This result is also obtaining Taguchi method with the use of L_9 orthogonal array.

IV. SEM ANALYSIS ON SLIDING WEAR

Before sliding wear **After sliding wear**



owt% of fly ash

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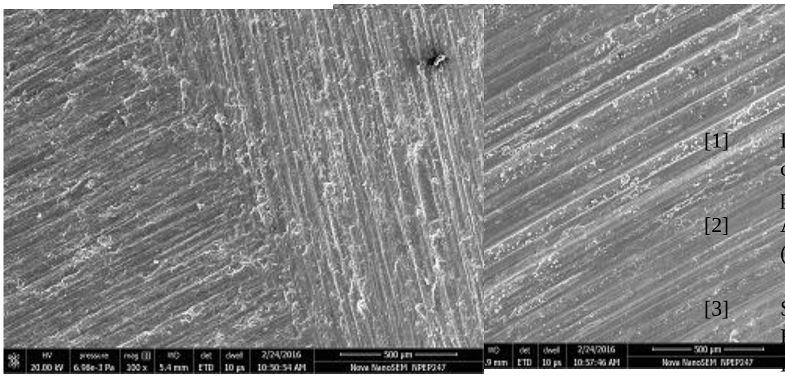
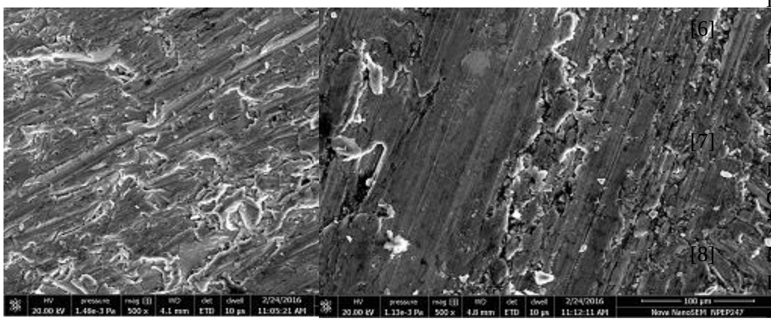


4wt% of fly ash



8wt% of fly ash

Figure 4 SEM graph for different wt% of fly ash before and after sliding wear where load (15N) and time (16 min) and sliding velocity 2.094 m/sec.

V. CONCLUSIONS

Stir casting s successfully applied to develop fly ash filled metal matrix composite. The surface topography was successfully investigated by scanning microscopic analysis. This investigation clearly shows the uniform distribution of fly ash in metal matrix composite. Sliding wear reduce with increase of fly ash content in metal matrix composite.

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