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# To Study the Mechanical Properties of Slag and Fly Ash Reinforced As 2024 Composites

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**ABSTRACT-** Metal matrix composites (MMCs) possess significantly improved properties compared to unreinforced alloys. There has been an increasing interest in composites containing low density and low cost reinforcements. In view of the generation of large quantities of solid waste by products like fly ash and slags, the present study is discarded, new methods for treating and using these solid wastes are required. Hence, composites with fly ash and Granulated blast furnace slag as reinforcements are likely to overcome the cost barrier for wide spread applications in automotive and small engine applications. In the present investigation, AA 2024 alloy – 5 wt. % fly ash and slag composites separately were made by stir casting route. Phase identification and structural characterization were carried out on fly ash and GBF slag by X-ray diffraction studies.The hardness and compression tests were carried out on all these alloy and composites. The reinforcement Improved hardness and mechanical properties were observed for both the composites compared to alloy; this increase is higher for AA2024-Fly ash composite than AA2024- Granulated blast furnace slag composite.

**KEYWORD-** Aluminium alloys; MMCs; Fly Ash; slag; Stir casting.

## I. MATERIALS AND METHODS

In the present study AA 2024 alloy was chosen as matrix material because of its wider applications in the family of aluminium-copper alloys. This alloy has a higher tensile and yield strength with lower elongation. Typical uses of this alloy are aircraft structures, rivets, hardware, truck wheels and screw machine products. At present very limited information is available on the GBF slag reinforced AA 2024 alloy composites. Therefore, the present work makes an attempt to the fly ash and GBF slag reinforced AA 2024 alloy composites by stir casting route; later these composites were characterized in terms of their microscopic studies, density and Mechanical properties.

Table 1: Chemical composition of Al - 4.5% Cu – 2 Mg alloy, wt. %(AA2024)

| Cu | Mg | Si | Fe | Mn | Ni | Pb | Sn | Ti | Zn | Al |
|---|---|---|---|---|---|---|---|---|---|---|
| 4.52 | 1.938 | 0.066 | 0.663 | 0.131 | 0.075 | 0.029 | 0.021 | 0.013 | 0.118 | balance |

Table 2: Chemical composition of as received Granulated Blast furnace slag, wt. %

| $SiO_2$ | CaO | FeO | $Al_2O_3$ | MgO | MnO | $TiO_2$ | CaS |
|---|---|---|---|---|---|---|---|
| 34.2 | 34.34 | 0.37 | 18.9 | 9.67 | 0.34 | 0.72 | 1.46 |

Figures 1: a) SEM micrographs of fly ash particles SEM of AA 2024 alloy -% fly ash b) Stir Casting Set-up used for fabrication of Composites and the fly ash powder of pre heat condition GBF) slag powder and fly ash

Synthesis of Fly Ash and Granulated Blast furnace slag reinforced composites

The synthesis of Al-fly ash and AA2024-- Granulated blast furnace slag composites were carried out by stir casting technique. Cylindrical fingers (18 mm diameter and 170 mm length) of AA 2024 alloy were taken into a graphite crucible and melted in an electric furnace. After maintaining the temperature at 770°C, a vortex was created using mechanical stirrer made of graphite. While stirring was in progress, the preheated fly ash and blast furnace slag particulates at 5000C for 2 hrs were introduced individually to make the fly ash and blast furnace slag reinforced composites respectively. Care was taken to ensure continuous and smooth flow of the particles addition in the vortex. The molten metal was stirred at 400 rpm under argon gas cover; stirring was continued for about 5 minutes after addition of reinforcements to get the uniform distribution in the melt. During stirring small pieces of magnesium (0.5 wt. %) were added to the molten metal to enhance the wettability of reinforcement particles with melt. While the melt was in stirring condition the melt with the reinforced particulates were bottom poured into preheated (200 0C) S.G. iron mould of 18 mm diameter and 170 mm height, as shown in figure Homogenization treatment was carried out at 200 0C for 24hrs to relieve the internal stresses and minimize the chemical inhomogeneity which may be present in the cast ingots.

Figure 2: As cast cylindrical fingers of Al based metal matrix campsite (a) Al-5% wt. GBF) slag reinforced composite (b) Al- 5% wt. fly ash reinforced (ALFA) composite

## II. RESULTS & DISCUSSION

### *A) Mechanical Properties Of Composites*

Hardness values of the AA 2024 alloy, AA2024- 5 wt. % Fly ash and AA2024- 5 wt. % GBF Slag composites in as cast condition are depicted in figure. It is evident from this figure that the hardness of the composites is significantly higher than that of the alloy. This increase was observed from 75 VHN for AA 2024 alloy to 124 and 120 VHN for AA 2024 – 5 wt. % fly ash and AA2024- 5 wt. % GBF Slag composites respectively.

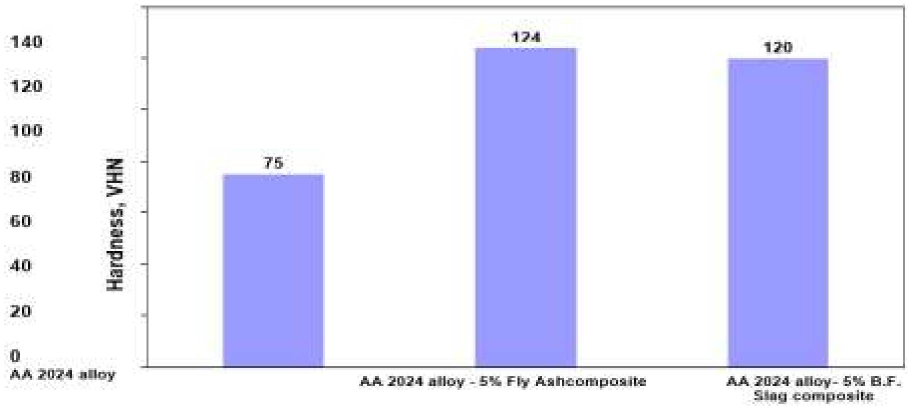


Figure 3: Comparative hardness values for AA 2024 alloy and composites

Table 3: Theoretical and measured densities of AA 2024 alloy and AA2024- 5 wt. % Fly ash and AA2024- 5 wt. % GBF Slag composites along with % porosity in respective alloy and composites

| Density (g/cm$^3$) | | | | |
|---|---|---|---|---|
| S. No | Specimen | | | % Porosity |
| | | Theoretical | Measured | |
| 1. | AA 2024 alloy | 2.68 | 2.68 | 0 |
| 2. | AA 2024 alloy - 5 wt. % Fly ash composite | 2.6696 | 2.57 | 3.74 |
| 3. | AA 2024 alloy - 5 wt. % GBF slag composite | 2.621 | 2.545 | 2.89 |

## III. CONCLUSIONS

Industrial wastes like fly ash and GBF slag were utilized successfully for the production of Al based MMCs. AA2024 - fly ash and AA2024-GBF slag composites were produced by stir casting route successfully. The hardness of the composites increased whereas the density of the composites decreased with presence of reinforcement than the base alloy. Higher hardness values were reported for AA2024- fly ash composite than AA2024- GBF slag composite. Enhanced mechanical properties were observed for both the composites than alloy.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

## REFERENCES

[1] Weiss, D.: Using Metal Matrix composite castings, Proc. Symp. On Processing, properties and applications of Cast Metal Matrix Composites, ed. P.K. Rohatgi (Cincinnati, 1996); 289.

[2] P.K. Rohatgi, R.Q. Guo, P. Huang, and S. Ray, Friction and Abrasion Resistance of Cast Aluminum Alloy-Fly Ash Composites, Metall.Mater. Trans. A, 1997; 28: 245-50.

[3] L.M. Flores-Ve´lez, J. Cha´vez, L. Herna´ndez, and O. Domı´nguez, Characterization and Properties of Aluminium Composite Materials Prepared by Powder Metallurgy Techniques Using Ceramic Solid Wastes, Mater. Manuf. Proc., 2001; 16(1): 1-16.

[4] Kumar, V., Abraham Zacharia, K., Sharma, P., Fly Ash Utilization: Indian Scenario & Case Studies. http://www.tifac.org.in/news/flyindia.htm