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Thermal Properties of Aluminium-Fly Ash Composite

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ABSTRACT: Metal matrix composites [MMC] are most important materials used for recent works in the industry and engineering applications. Fly ash particles are used in metal matrix composites are low cost, low density and available in large quantities of waste byproduct in power plants. The adding of fly ash with aluminium reinforcement by using stir casting process it can reduces the cost and density of aluminium material. Metal composites pocesses are improved thermal properties like thermal expansion, thermal cracking, thermal resistance compared to other metals. In study an aluminium and fly ash chemical analysis. Hence, to study the composites in fly ash with aluminium reinforcement in physical and thermal properties of aluminium-fly ash metal matrix composite. In this aluminium fly ash metal matrix composites are widely used in the aerospace craft and automotive application.

KEYWORDS: Aluminium, fly ash, thermal properties, MMC and stir casting.

I. INTRODUCTION

As we know that the metal-matrix composites having extremely hard, abrasion resistance and mostly light weighted which are useful for the preparation of the high temperature and speed parts like pistons, axles, high speed wheels and so on. Composites are one of the most advanced & adaptable engineering materials. A fast progress in the field of material science & technology has given birth to these fascinating & wonderful materials. Composite are heterogeneous in nature. Composite material is composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents. The matrix may be me metallic, ceramic or polymeric in origin.
To overcome these shortcomings and to meet the ever increasing demand of modern day technology, composites are most promising materials of recent interest. Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, 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. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for wide spread applications in automotive and small engine applications. It is therefore expected that the incorporation of fly ash particles in aluminium alloy will promote yet another use of this low-cost waste by-product and, at the same time, has the potential for conserving energy intensive aluminium and thereby, reducing the cost of aluminium products[1-3].
In the present work, fly-ash which mainly consists of refractory oxides like silica, alumina, and iron oxides is used as reinforcing phase. Commercially pure aluminium was also melted and casted. Then particle size and chemical composition analysis for fly-ash was done. Mechanical, physical and wear properties of the composite were evaluated and compared with the commercially pure aluminium. Moreover, the composite was characterized.

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II. EXPERIMENTAL WORK

1. RAW MATERIALS

The matrix material used in the experiment investigation was commercial aluminium. The fly ash was collected. The particle size of the fly as received condition lies in the range from (0.1-100 μm). Fly ash is sieved in the sieves with availability of microns from 2059microns to 53microns.

2. MELTING AND CASTING

The aluminium fly ash metal matrix composite was prepared by stir casting route. For this we took 500gm of commercially pure aluminium and desired amount of fly ash particles. The fly ash particle was preheated to 300^0C for three hour to remove moisture. Commercially pure aluminium was melted in a resistance furnace. The melt temperature was raised up to required temperatures. Then the melt was stirred with the help of a mild steel turbine stirrer. The stirring was maintained between 5 to 7 min at an impeller speed of 200 rpm .The melt temperature was maintained 700^0C during addition of fly ash particles. The dispersion of fly ash particles were achieved by the stir casting method. The melt with reinforced particulates were poured into the preheated permanent metallic mold. The pouring temperature was maintained at 680^0C.The melt was then allow to solidify the moulds. The composites were made with a different amount of fly-ash (i.e.5, 10, 20, wt. %).

3. THERMAL CONDUCTIVITY

Thermal conductivity is a property of the material and may be defined as the amount of heat conducted per unit time through unit area, when a temperature difference of unit degree is maintained across unit thickness.

Fig. 1 Thermal Conductivity Apparatus

4. WORKS DONE

1. Commercially pure Al was melted and casted.

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2. Al- fly ash composite was fabricated by stir casting method.
3. Thermal properties was carried out for both commercially pure Al sample and Al- fly ash composite sample.
4. The Thermal characteristics of both commercially pure Al and Al- fly ash composite was evaluated and compared.
5. Thermal conductivity of the composites was determined by using thermal conductivity tests. As we increase the amount of ash the thermal conductivity gradually decreased up to some level i.e. Sample2 but after this it diminishes.
6. Fly ash up-to 20% by weight can be successfully added to commercially pure aluminium by stir casting route to produce composites.

III. RESULTS AND DISCUSSIONS

1. CHEMICAL ANALYSIS OF FLY ASH

Table 4.1 Chemical Analysis of Fly Ash

COMPONENTS	PERCENTAGE (%)
Silicon dioxide (SiO_2)	67.15
Aluminium oxide (Al_2O_3)	29.5
Iron oxide (Fe_2O_3)	0.15
Calcium oxide (Cao)	1.5
Magnesium oxide (Mgo)	1.7

2. THERMAL PROPERTIES OF ALUMINIUM FLY ASH COMPOSITE MATERIAL

2.1 Thermal Conductivity

Table 4.2 Thermal Conductivity of Composite Material

SAMPLE	THERMAL CONDUCTIVITY (W/m-k)
Al-20% fly ash	98.3
Al-15% fly ash	104.6
Al- 10% fly ash	110.5
Al- 5% fly ash	122.4

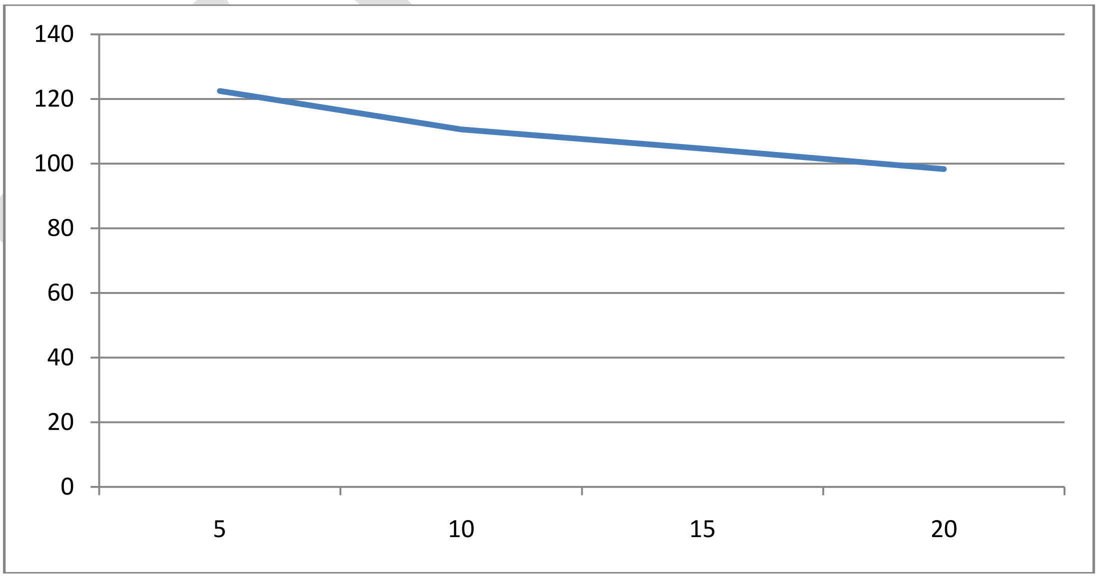

Fig.4.1 graph showing variations in fly ash vs. thermal conductivity

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The above graph shows that incorporation of fly ash particles in Aluminium matrix causes reasonable decrease in Thermal conductivity. The strengthening of the composite can be due to dispersion strengthening as well as due to particle reinforcement. Thus, fly ash as filler in Al casting reduces cost, decreases density and decrease in Thermal conductivity which are needed in various industries like automotive etc.

IV. CONCLUSION

1. Thermal properties like thermal expansion, specific heat, thermal conductivity are studied. As we increased the amount of ash up to Sample2 it decreases the thermal expansion.
2. The density of the composites decreased with increasing ash content. Hence these light weight composites can be used where weight of an object maters as like in the aero and space industries.
3. From the above results we find the Sample2 having an, and also having the low density comparatively alloys without reinforcement. So that these composites could be used in those sectors where light weight and good mechanical properties are required as like in automobile and space industries.
4. From the study it is concluded that we can use fly ash for the production of composites and can turn industrial waste into industrial wealth. This can also solve the problem of storage and disposal of fly ash.
5. Hardness of commercially pure aluminum is increased from 58BHN to 86BHN with addition of fly ash.
6. The Ultimate tensile strength has improved with increase in fly ash content. Whereas ductility has decreased with increase in fly ash content.
7. The wear resistance of composites is much greater than the commercially pure aluminums.
8. Different wear mechanisms were found to operate under the test conditions of variation of normal loads, composition, and sliding velocity .They are oxidation abrasion and delamination.
9. Increased normal load and sliding velocity increases magnitude of wear and frictional force.

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