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# Study of Mechanical Properties of Metal Matrix 212 Microns of Red Mud

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**ABSTRACT**
Red mud emerges as the major waste material during production of alumina from bauxite by the Bayer's process. It comprises of oxides of iron, titanium, aluminium and silica along with some other minor constituents. It is generally agreed that resistance to tensile, hardness of MMC is created by reinforcement and also the mechanical properties are improved remarkable by introducing hard intermetallic compound into the aluminium matrix. The reinforcing materials are generally Sic, Al2O3, TiB2 etc and are costly. Experiments have been conducted under laboratory condition to assess the Tensile, Hardness, mechanical characteristics of the aluminium red mud composite under different working conditions. This has been possible by fabricating the samples through usual stir casting technique. To enhance the tensile, hardness, the samples were also subjected to heat treatment ($400^0$ C). The worn surfaces of the samples were studied under optical microscope to get an idea about the effect of particulate reinforcement on the behaviour of the composite.
**Key Words - Red mud, Al6061, Stir casting, Pre heating.**

## 1. Introduction
Composites are recognized to be the nicely superior and relevant substances in engineering discipline. Composite offers shape, environmental corrosion, durability, stiffness, electricity. Application of composite substances performs a large rule in vehicle enterprise, aerospace enterprise and lots of different engineering due to their fantastic electricity to weight and weight ratio. Aluminium 6061In the prevailing study, liquid metallurgy method is followed and Al6061, which famous fantastic casting houses and affordable strength, used because the base alloy with suitable strength, being appropriate for mass manufacturing of light-weight metal castings. Red mud is a waste received after the elimination of aluminium from its ore. Its EDS evaluation exhibits the presence of oxides of iron, silicon, titanium, zirconium, etc. It behaves as a ceramic material. It is received from Kamatgi mining's, Bagalkot district, Karnataka. High demand on materials to increase the overall performance of automotive and aerospace components has forced the development of composite materials [1]. Aluminium 6061 is going to be increased with increased in the concentration of bamboo charcoal and the tensile strength is going to be decreased with increased in the concentration of bamboo charcoal [2]. The results demonstrate the capacity of steel machining chips powder to serve as a reliable cost effective and technically efficient reinforcement material for the development of Aluminium 6061composites [3]**.** Mechanical properties were evaluated to know the impact of multi micro particles addition on the hardness, ultimate strength, yield strength, and ductility behaviour of Al7075 alloy composites [4]. To determine the mechanical properties of Aluminium 6061 reinforced with red mud. To study the microstructure of composites with the help of image analyser. To examine the stresses developed by the composites. To experience the strength and harness of the evolved composites.

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**Fig-1Aluminum6061.**

**Fig-2 Red mud.**

**Table No1 Composition of Aluminium 6061 with Red Mud.**

| Sl. No | Aluminium6061 | Red mud |
|---|---|---|
| 01 | Pure Al6061(100%) | 0% |
| 02 | Al6061 88% | 12% |
| 03 | Al6061 86% | 14% |
| 04 | Al606184% | 16% |
| 05 | Al606182% | 18% |
| 06 | Al606180% | 20% |

## 2. Method

### 2.1 Experimental Work

Sieve test is simple method of separating particles of varying sizes. The red mud to pass through a series of sieves of progressive smaller mesh size 212 and weighing the amount of red mud collected. Red mud is dried first to remove moisture contain in red mud then it is sieved for 212 microns. Aluminum6061 is in solid form it is heated in electric furnace to convert solid form into liquid form. Aluminium 6061 bar is kept in the furnace at the temperature of $750^0$C for 2 hours. After melting of Aluminium 6061 the red mud of 212 microns is added to the melted aluminium 6061.This process is called stir casting in which red mud is added manually by stirring the rod. Degaser and cover flux is added while mixing red mud into molten alloy to remove impurities. After stir casting process the melted metal is poured into the die to make specimen. After that the casted specimen removed from the die After pouring the molten metal into die the specimen removed from the die. The figure shows the casted specimen. After the completion of casting, the casted specimen is preheated in preheating electric furnace. The specimens are kept in furnace for half an hour (30minutes) at temperature of $400^0$ C. Preheating is done to increase the strength and reduce porosity. After preheating air cooling is done at room temperature.

**Fig-3: Sieve test.**

**Fig-4:Melting Al6061.**

**Fig-5: Stir casting.**

**Fig-6: Pouring in die.**

**Fig-7: Preheating at $400^0$C.**

**Fig-8: Casted piece**

**Fig-9: Tensile specimen**

**Fig-10: Micro and Hardness specimen**

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## 3. Result and Discussion

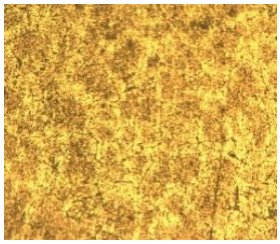

**Fig:11Pure Aluminum6061 with 0% of red mud.**

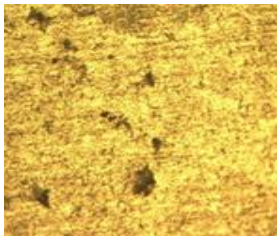

**Fig:12 aluminum6061 with 12% of red mud.**

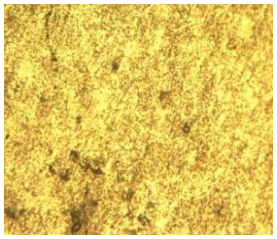

**Fig:13Aluminum6061 with 14% of red mud.**

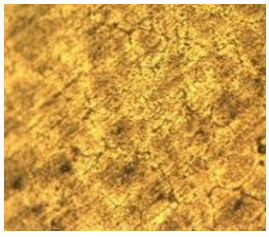

**Fig:14Aluminum6061 with 16% of red mud.**

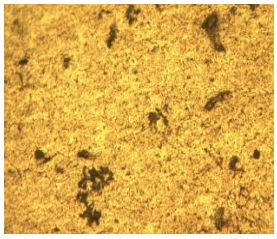

**Fig-15 Aluminum6061 with 18% of red mud**

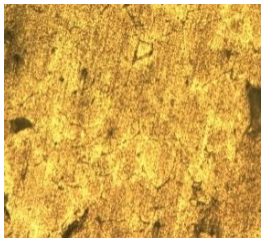

**Fig-16 Aluminum6061 with 20% of red mud.**

The microstructure and interface structure of the particle reinforced red mud with aluminum 6061 metal matrix composites have been studied by optical micros copy. The above figure shows the microstructure images with different composition of aluminum 6061 with red mud. Figure 11 shows the microstructure image of pure aluminium6061 with no addition of red mud, figure12,13,14,15,16 shows image of 14%,16%,18%,20% of red mud with the addition of 12% of red mud. Adding % of red mud i found the changes in microstructure in images we can easily find the difference

### 3.1 Tensile Test Result

**Table No.2 Tensile results**

| Material composition | UTS(MPA) | %Elongation | Load (KN) |
|---|---|---|---|
| Base (PureAl6061) | 108.05 | 9.4 | 5.43 |
| Al6061+12%Red mud | 131.02 | 8.5 | 6.58 |
| Al6061+14%Red mud | 156.05 | 7.5 | 7.84 |
| Al6061+16%Red mud | 177.01 | 7.01 | 8.90 |
| Al6061+18%Red mud | 190.04 | 6.8 | 9.55 |
| Al6061+20%Red mud | 220.01 | 6.6 | 11.05 |

The fig.17 shows the variation in ultimate tensile stress vs weight % of red mud in aluminium 6061. From the graph its clearly shows that by increasing the weight % of red mud the ultimate strength of the composite increases gradually. As per results it come to know that by adding red mud to the Al6061 the strength increases. It also shows better bonding between matrix and reinforcement material due to finest of 212 microns of dispersed red mud.

The above fig.18 shows the percentage of elongation versus weight% of red mud. The above graph gives the decrease in % of elongation by adding the weight % of red mud. For the pure aluminium 6061 alloy when heat treated % of elongation decreases.

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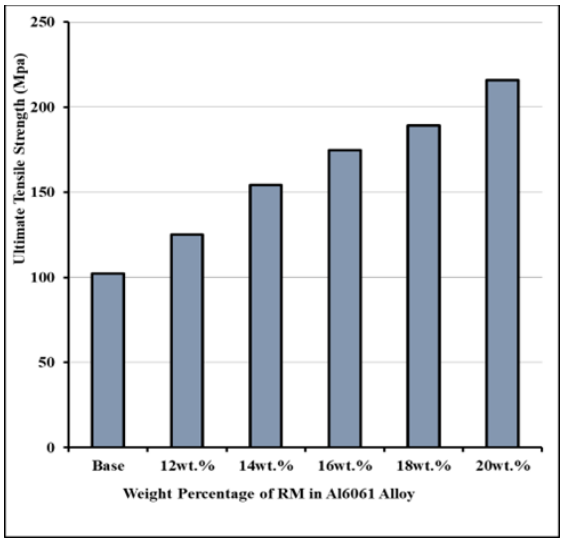


**Fig -17: UTS vs weight % of RM in Al6061 Alloy**

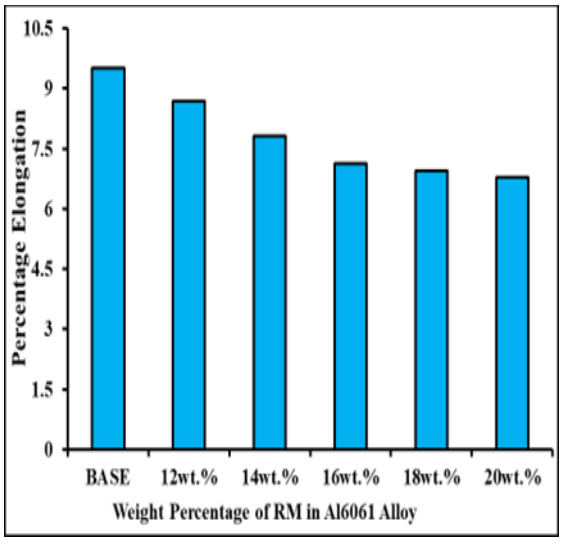


**Fig -18: Elongation vs weight % of RM in Al6061 Alloy**

### 3.2 Vickers Hardness Test

**Table No.3 Hardness results**

| Material composition | Load F (Kgf) | Diagonal length of indentation d(mm) | HV=1.8544F/$d^2$ (Kgf/$mm^2$) |
|---|---|---|---|
| Base (PureAl6061) | 30 | 0.794 | 88.2 |
| Al6061+12%Red mud | 30 | 0.709 | 110.5 |
| Al6061+14%Red mud | 30 | 0.694 | 115.3 |
| Al6061+16%Red mud | 30 | 0.665 | 125.5 |
| Al6061+18%Red mud | 30 | 0.640 | 135.5 |
| Al6061+20%Red mud | 30 | 0.620 | 144.68 |

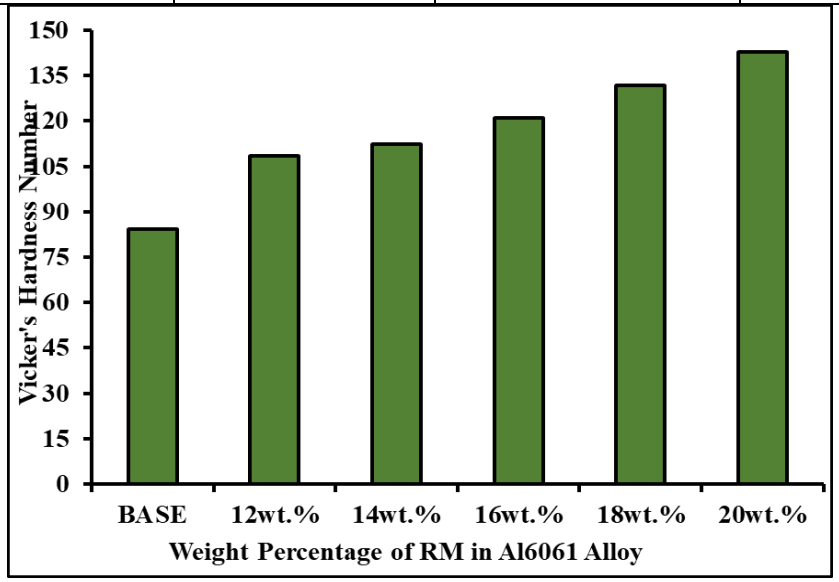


**Fig-19: VHN vs weight% of RM inAl6061 Alloy.**

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The above graph shows the vicker's hardness number versus weight % of red mud. Here the hardness number increases by adding different percentage of red mud. When red mud is reinforced in Al6061 MMC's the hardness increases tis is due to presence of red mud particulates in the composite.

## 4. Conclusion

When Al6061 is reinforced with red mud of microns 212 particulates good mechanical properties are obtained. When Al6061 is reinforced with 12%, 14%, 16%, 18%, 20% of red mud, there will be increase in strength, hardness. It is clearly concluded by increasing the weight % of red mud, the strength, hardness of the composite is increased. The microstructure of composite clearly shows a uniform distribution of red mud in aluminium6061 alloy matrix.

## 5. Acknowledgment

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