EXPERIMENTAL ANALYSIS OF DRY SLIDING WEAR BEHAVIOUR ON HYBRID ALUMINIUM METAL MATRIX COMPOSITE

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Abstract- *Composite materials are replacing the ordinary materials in recent trends for its better performance and properties. In this work, a Hybrid Metal Matrix Composite is chosen for analysis. The main aim of this work is to increase the strength and wear resistance of the composite material by reducing its weight. Aluminum is selected as the matrix material for this composite due to its less weight and low cost, while Graphite is added to increase the strength of composite. Silicon Carbide and Boron Carbide is added to this composite to increase the wear resistance. This composite material can be widely used in aerospace applications and manufacturing of pistons, cylinders, engine blocks and brake shoes. The composite is prepared by using stir casting technique where the powders are mixed in calculated proportion and casted to desired shape using the die. The prepared composite material is studied with Scanning Electron Microscope (SEM) image for analyzing the distribution of composite particles in it. The wear resistance of this composite is determined by conducting wear test by varying load, speed and time.*

Keywords – Metal Matrix Composites, Stir Casting, Aluminum, Graphite, Silicon Carbide, Boron Carbide, Pin-On-Disc, Scanning Electron Microscope (SEM)

I. INTRODUCTION

Composite material is a heterogeneous solid consisting of two or more different materials, both mechanically and metallurgically bonded, which are used to correct the weakness of one substance by strength in another. A combination of two or more substances exhibits characteristics different from the individual materials used to make the combination. Each of the different components retains its identity in the mix and maintains its characteristic structure and property. However, composite materials typically have properties such as rigidity, strength, weight, high temperature performance, corrosion resistance, hardness and conductivity, which are not possible with individual components. The various materials involved may be organics, metals or ceramics. Therefore, there is widespread freedom, and composite material can be designed to suit the desired engineering characteristics and characteristics.

There are many types of composite materials and many methods for classifying them. One such method is based on the geometry of three different families: laminar (or) layered composite, particle composite and fiber-reinforced composite.

The integrated aggregate distribution is characterized by a micro composition containing an elemental or alloy matrix inside which fine particles of 0,01 to 0.1m in diameter are dispersed uniformly in a volume path of 1 to 15%. The resulting thickness of the mixture is different from the aggregate dispersed as the dispersed size exceeds 1.0 μm and the dispersed dispersion exceeds 25. In Fiber composite material, the cement reinforcement phase covers all sizes, from a micron component to a few millimeters wide, and the entire volume connection range from a few percent to over 70%. The distinguishing feature of the fiber reinforced composite material is that its reinforcement has a single long axis, while the reinforcement particles of the other two composites do not. The strength of the composite particles of the composite material contained medium compared to the dissipation strengthened the matrix and fiber reinforced composite strength of both room temperature and high temperature.

Composite material is a composite text that is two or more separate and has many properties that are very different from those of any other element. Many standard materials (metals, alloys, doped ceramics and polymer additives) also have a small number of dispersed phases in their structures, however they are not considered as structural materials because their properties are similar to those of their basic properties (the metal material is similar to that of pure metal). The attractive features of the composite material are high durability and high strength, low durability, high thermal conductivity, high electrical conductivity and heat, dynamic thermal expansion, corrosion resistance, improved coating toughness etc.

From the literature review, it has been that the wear rate of Al based MMC composites is small and can be further enhanced by the addition of Silicon Carbide or Boron Carbide as reinforcement particles. In this work Hybrid Metal Matrix Composite (HMMC), Silicon Carbide, Boron Carbide and Graphite were selected as reinforced particles to further enhance the elastic resistance of the component. For the above problem, which will be treated in this paper, the sample is made of aluminum composite material by means of a casting method and after investigating the method used for experiments such as test design, hardness and SEM image.

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II. EXPERIMENTAL WORK

In this study dry sliding is introduced when done on a pin-on-disc machine. The hybrid composite consisting of Aluminum alloy as a matrix with SiC and graphite is a strength material. Aluminum alloy reinforced with a volume fraction of 5.9% SiC and a volume fraction of 2% graphite and 2.1% volume B4C fraction with a thickness of 12mm particles were used as reinforcement materials. The combination there is designed for a stream system. The melt was driven in an electric resistance furnace. Aluminum was first cooled at 600 ° C before melting. SiC, B4C and graphite were also coated at the required temperatures. Aluminum screws were first heated to a high temperature to melt completely, then slightly cooled below the liquid temperature to maintain the rigidity. The pre-mixing solid was mixed by hand and then the combined heat was heated to the liquid used, the final temperature was controlled to 800 ° C and the pouring temperature was controlled to 820 ° C. The melt was poured into a metal tube and allowed to cool to obtain a plate size -95mm x46mm x8mm. The part formation is shown in Fig. Material: Aluminum - 90%, Graph - 2%, Silicon Carbide (SiC) - 5.9% and Boron Carbide (B4C) - 2.1%.

Figure 1. Work Piece

Figure 2. Casting-Die

Figure 3. Stir casting machine

2.1. Wear Test–

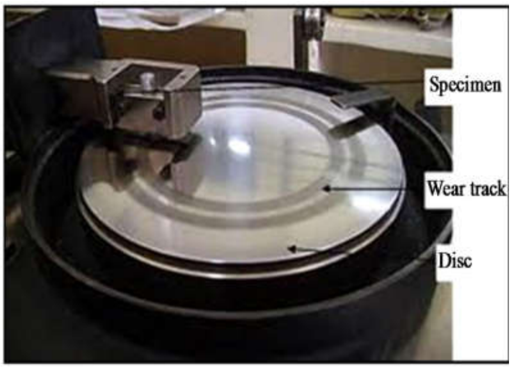

Figure 4. Pin-on disc apparatus

The wear test is performed on the Pin-on-Disc apparatus shown in the figure. In this test the only complete surface of the cylindrical specimen 8 mm thick and 40 mm long was inserted into the chuck jaws to protect the samples from rotation during the experiment. Axial load applied to the pins opposite the rotating disc plane. The edges of the writer are visible on paper with 1200 grit SiC emery paper and cleaned with acetone. The reported wear test is a measurement of two readings and is performed at room temperature. The standard disc used for testing is made of stainless steel ASE 1045 with a hardness of 263BHN and its maximum hardness is 0.2µm

III. Results and discussion

The microstructure for the composition contains 2% of graphite, 5.9% of silicon carbide and 2.1% of boron carbide and remaining 90% of aluminium. The microstructure shows the proper mixing of other materials in parent material (Aluminium). The microstructure for sample is shown Fig.

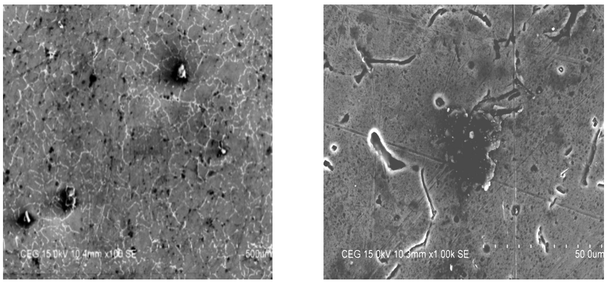

Figure 5. Microstructure of Al composite

The experimental results of various responses such as WR, COF and FF corresponding to give control parameter were shown in the Table 3.1.

Table 3.1 Measured output responses with respect to Input selected

Runs	**Block**	**Rotational speed rpm**	**Time duration secs**	**Load kg**	**Response 1 Wearrate**	**Response 2 Coefficient of friction**	**Response 3 Frictional force**
1	Block 1	800.00	60.00	1.50	4.4200E-08	5.44	1.95
2	Block 1	1200.00	60.00	2.50	5.1400E-08	6.26	1.59
3	Block 1	800.00	60.00	2.50	4.6100E-08	5.67	2.09
4	Block 1	400.00	90.00	1.50	4.7600E-08	5.88	2.32
5	Block 1	400.00	30.00	1.50	4.2700E-08	5.23	0.95
6	Block 1	1200.00	90.00	1.50	5.6200E-08	6.93	1.94
7	Block 1	1200.00	30.00	1.50	4.5800E-08	5.68	1.15
8	Block 1	400.00	90.00	3.50	5.0600E-08	6.68	1.86
9	Block 1	800.00	60.00	2.50	4.6800E-08	5.78	2.19
10	Block 1	1200.00	90.00	3.50	5.8900E-08	7.33	2.16
11	Block 1	800.00	60.00	2.50	4.6600E-08	5.76	2.17
12	Block 1	800.00	30.00	2.50	4.4500E-08	2.39	1.23
13	Block 1	400.00	60.00	2.50	4.2400E-08	2.19	0.98
14	Block 1	800.00	60.00	2.50	4.6300E-08	5.73	2.0
15	Block 1	800.00	60.00	2.50	4.6400E-08	5.74	2.12
16	Block 1	800.00	60.00	2.50	4.6300E-08	5.72	2.12
17	Block 1	800.00	60.00	3.50	4.9200E-08	6.73	1.83
18	Block 1	400.00	30.00	3.50	4.2200E-08	2.14	0.94
19	Block 1	1200.00	30.00	3.50	4.9200E-08	6.62	1.59
20	Block 1	800.00	90.00	2.50	5.0700E-08	6.76	1.90

IV.CONCLUSION

In this work, an attempt is made to fabricate Aluminum based MMC using Stir Casting technique and the machine ability evaluation is carried out using Response Surface Methodology. The following inferences are made from the results obtained. In this study the experiment was conducted by considering the three process parameters namely rotational speed, time duration and load applied. The objective was to optimize the Wear Rate, Coefficient of Friction and Frictional Force by varying the process parameters on the Aluminum based composite. The microstructure image had been taken for visualization of materials. The particles of SiC and B4C were uniformly distributed in the matrix. This optimal solution would be useful during manufacturing of aluminum based composite material for easier setting of the input parameters to get good responses out of the process.

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