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EFFECT OF BORON CARBIDE PARTICLE IN WEAR CHARACTERISTIC OF CAST ALUMINIUM A356 COMPOSITE

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ABSTRACT :*The experimental investigation of A356 matrix reinforced with boron carbide particle was fabricated by stir casting technique. The abrasive wear behavior of composite was studied by dry sliding pin on disc machine. The different parameters like applied load, sliding speed, and weight percentage of boron carbide particle were taken for this study. The wear rate in terms of weight loss per unit load as well as wear volume has been obtained. The composite are found to posses very high wear rate at 9% reinforced material. The result shows that the wear rate and wear volume is found increasing by increase in load and weight percentage of boron carbide.*

Keywords: *A356 alloy, boron carbide, Wear rate, Wear volume.*

1. INTRODUCTION

Aluminum alloy-base metal-matrix composite (MMC) materials are used in the design of ground transportation vehicles and aircraft. Compared with conventional unreinforced alloys, composite materials usually exhibit higher strength, both at ambient and elevated temperatures, as well as good fatigue strength and wear resistance. **Satpal Kundu etal** investigated the hybrid metal matrix composites with Sic, Al_2O_3 and graphite reinforced aluminum 6061alloy composites which have been processed by stir casting method. Dry Sliding Wear tested was conducted on the composite material and it was found that it had been increased considerable when compared to Al6061 T6 alloy. The parameters such as load, sliding speed and sliding distance were identified will affecting wear rate [1]. **Shouvik Ghosh** investigated the wear behavior of Aluminum LM6 alloy with Sic particle. The material is synthesized by stir casting process and the wear study was done by multitribo tester using block on roller configuration. An experiments based on L_{27} Taguchi orthogonal array is used to acquire the wear data in a controlled way. ANOVA is employed to investigate the influence of four controlling parameters. The optimal combination of the four controlling parameters is also obtained for minimum wear. The microstructure study of worn surfaces indicates nature of wear to be mostly abrasive [2].**Straffelini *et al*.** studied the effect of applied load and temperature on the wear behavior of the composite and it was found that by increasing the load the contact temperature increases beyond 1500^{o}C which increases the wear rate of the material[3]. **Rao and Das** considered the effect of sliding distance on the wear behavior of Al-Sic and reported that wear rates increase with increase in load and sliding speed while wear resistance improves with heat treatment[4].**Sharma *et al*.** studied the effect of volume fraction of reinforcement Sic A volume fraction range of 1% - 5% was chosen and wear tests were carried out at varying loads and sliding speeds. The result shows that wear rates decrease with increase in weight fraction of Sic, but increase with increase in applied load and sliding speed [5].**P. Shanmughasundaram** et al investigated the dry sliding wear behavior of eutectic Al-Si alloy-graphite composites and employed a pin-on-disc wear test rig. Results show that the wear and friction coefficients decreased linearly with increasing weight percentage of graphite particles. Wear resistance of the composite increased considerably with increasing sliding velocity at constant load [6].**N. Natarajan etal** discussed, the wear behavior of aluminum A356 reinforced with 25% of SiC particles. His investigation shows that the MMCs have considerable higher wear resistance than conventional grey cast iron while sliding against automobile friction material under identical conditions. The friction coefficient increase with increase in applied load for both cast iron and Al MMC materials. However, in all the tests it is observed that the friction coefficient of Al MMC is 25% more than the cast iron while sliding under identical conditions [7].

From the existing literature survey it is apparent that many studies have been carried out on the wear behavior of Al-Sic particulate composite, but rare study is available on cast Al-B_4C The effect of boron carbide on the composite were studied by considering load (L), sliding distance, weight percentage of b4c and the distance travelled and the wear rate and wear volume were investigated.

2. MATERIALS AND EXPERIMENTAL SET UP

Aluminum A356 which contains silica and magnesium as major constituent was used as matrix material and its composition is given in Table 1.Boron carbide was used as a reinforcing material. By varying the weight percentage of boron carbide (3%, 6%, 9%, 12%) aluminum composite were produced by stir casting technique.

Table 1. Chemical composition of A356 alloy

Si	***Fe***	***Cu***	***Mn***	***Mg***	***Ni***	***Zn***	***Ti***	***Al***
6.58	*0.16*	*0.06*	*0.06*	*0.57*	*0.01*	*0.01*	*0.14*	*balance*

2.1 WEAR TEST

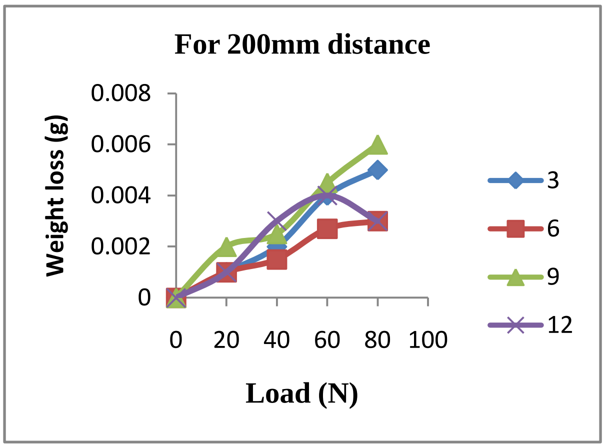
Dry sliding wear experiments were conducted in air at room temperature using a pin-on-disc machine. During the experiment the sliding between pin and disc may result in wear in both the contact surfaces. The specimen size of 6 x 6 x30 mm was cut from the cast samples (ASTM G99). The wear test have been conducted under different load s 20, 40, 60, 80 N and the sliding speed of 0.5, 1.0, 1.5, 2 m/s. Pin weight loss has been measured at each loading conditions. Weight loss data has been converted to volume loss data using the density of aluminum A356.

3. RESULTS AND DISCUSSIONS

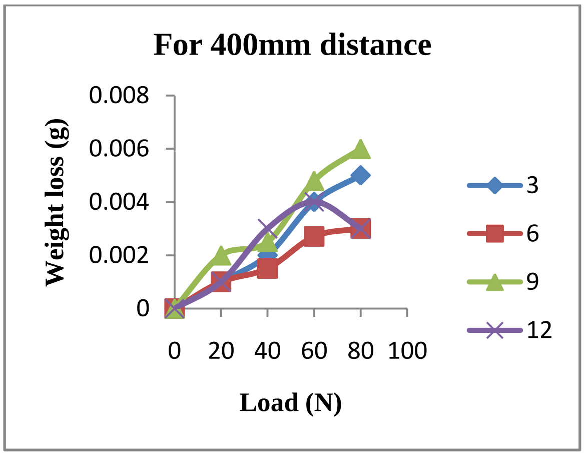
3.1 EFFECT OF LOAD AND DISC SURFACE ON WEIGHT LOSS

The load on wear test plays an important role in wear and it is shown in fig.1 for various weight proportion. The graph shows weight loss for various weight proportions of the composite material and it is presented for 20N, 40N, 60N, 80N at various distance travelled viz. 200mm, 400mm, 600mm, 800mm.

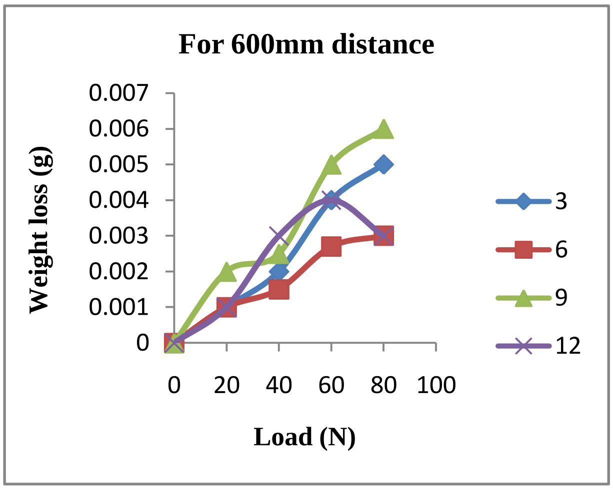
From the above graph shown in Fig.1 it is observed that with the increase in load the weight loss also increase by increasing the reinforcement of boron carbide. Also when there is increase in distance travelled there is increase in weight loss of the material. It was observed that the wear rate falls suddenly when the reinforcement material increased to 12%. The aluminum composite with 9% reinforcement shows greater weight loss when compared to other weight percentage of boron carbide



(a)



(b)



(c)

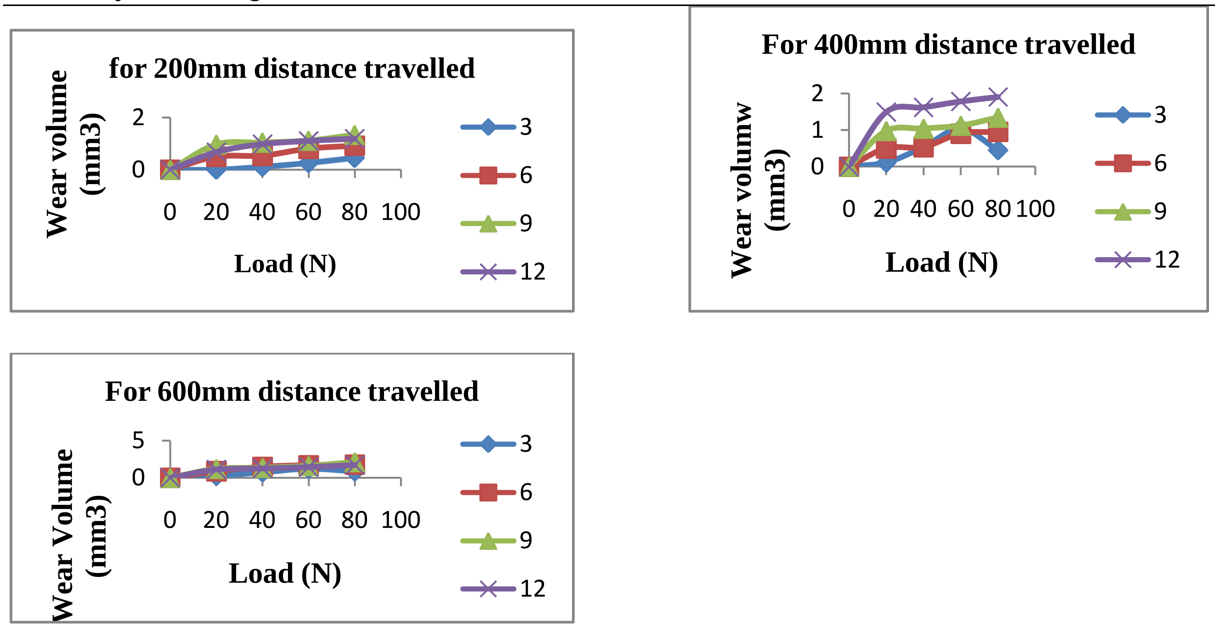
Fig.1 Weight loss as a function of sliding distance (a) 200mm (b) 400mm (c) 600mm

3.2 EFFECT OF LOAD AND DISC SURFACE ON THE WEAR VOLUME

The wear volume is calculated as follows

Wear Volume = Cumulative weight loss/Density of composite

The calculated wear volumes were plotted against the load for the materials investigated at different distance travelled. Fig 2 shows wear volume vs. load for varying distance. From the graph shown if Fig.2 it was observed that the wear volume is less when the reinforcement is less i.e. for Aluminum with 3% reinforcement of boron carbide. With the increase in load there is consistent increase in wear volume. But when the reinforcement increased to 12% the wear volume falls down.

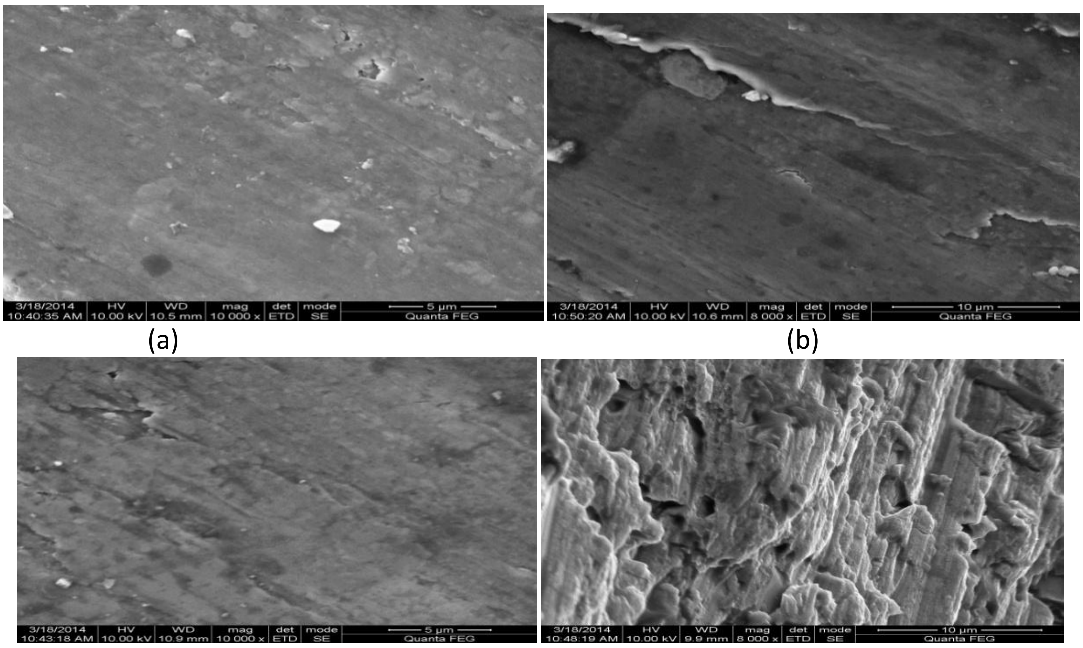


(c)

Fig.2.Wear volume as a function as load (a) 200mm (b) 400mm (c) 600mm

3.3 WEAR SURFACE STUDIES USING SEM

SEM images of wear surface of A356-B_4C composite is shown in fig.3. It shows the worn out surface and the track of material removal.



(a) (b)

(c) (d)

Fig.3 (a-d) SEM image of A356+b4c composites

The wear surfaces features of the composites are shown in fig. were it gives the details of wear track and the process of material removal.

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4. CONCLUSION

From the above discussion it is clearly explained that the wear rate of the boron carbide reinforced aluminum 356 composite increases with the increase in applied load. The wear rate is found to increase with the load compared to that of the A356 material. It is due to heating effect to thermal softening and seizure. Also it brings more sliding contact and thereby causes enhanced wear. The wear rate increases up to 9% reinforcement and when it considered for 12% reinforcement the wear rate decreases with the applied load. The wear volume also increases up to 9% reinforcement of boron carbide particle, later when it reaches 12 % reinforcement it decreases with the applied load.

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