CHAPTER 4

WEAR BEHAVIOR OF LM24/SILICATE/ FLY ASH HYBRID COMPOSITE USING PIN ON DISC MACHINE

4.1 INTRODUCTION

The most important problem that causes malfunctions of mechanical systems and that puts the construction equipment out of use is wear. Materials, including matrices and mechanical systems, that work in tandem with each other, and commonly used, wear over time as a result of friction. Therefore, the need to increase the wear resistance has gained immense importance. The wear behaviour of aluminum alloys has been considered substantial. Rough estimates indicate that, improved attention to wear could save the developed countries up to 1.6% of their GNP, or over a $100 billion annually in the USA alone. Aluminum alloys find a wide variety of uses in the industrial areas and daily life because of their remarkable combination of characteristics such as low density, high corrosion resistance, high strength, easy workability and high electrical and heat conductivity. However, low surface hardness and low wear resistance often limit their engineering applications.
4.2 WEAR STUDY OF LM24/SILICATE/ FLY ASH HYBRID COMPOSITE

The fly ash acts as a barrier to the movement of dislocations thereby increasing the strength and hardness of the composite. The addition of fly ash particles, to the aluminum melt, significantly increase its abrasive wear resistance. The improvement in wear resistance is due to the hard alumina silicate constituent present in fly ash particles. From the view point of material, influencing factors on friction force are the mechanical properties of the matrix, hardness, chemical stability of the particles, composition and strength of the interface. It is essentially the interaction between these and the tribological parameters (such as load and speed, environment and the properties of the counter face materials) which are responsible for the overall response. Thus incorporation of silicate particles with fly ash to aluminum alloy improves the sliding wear resistance. The effects of both applied load and sliding velocity were investigated as a function of percentage of silicate with fly ash in aluminum alloy. The wear rate of the LM24/4 wt. % Fly ash and varying wt. % of silicate hybrid composite is influenced by the load (15, 30, 45, 60, 75N) under sliding velocity (0.75, 1.5, 2.25, 3 m/sec) is illustrated in Figure 4.1 to Figure 4.4. When increasing the load from 15 to 75 N, a similar trend in wear rate could be observed. The applied loads significantly affected the wear rate of LM24/silicate/ fly ash hybrid composite, and the wear rate increased with an increasing condition of applied load. The wear rate increases with increasing sliding velocity and it is less for hybrid composites, as compared to base material LM24. However, at all load conditions the wear resistance of the hybrid composites was superior to the matrix alloy and wear rate was raised from LM24/4 wt. % silicate/ 4 wt. % fly ash hybrid composite compared to LM24/4 wt. % silicate/ 24 wt. % fly ash hybrid composite.
Figure 4.1 Influence of load under sliding velocity 0.75 m/sec

Figure 4.2 Influence of load under sliding velocity 1.5 m/sec
Figure 4.3 Influence of load under sliding velocity 2.25 m/sec

Figure 4.4 Influence of load under sliding velocity 3 m/sec
Figure 4.5  Influence of sliding velocity under load 15 N

Figure 4.6  Influence of sliding velocities under load 30 N
Figure 4.7  Influence of sliding velocity under load 45 N

Figure 4.8  Influence of sliding velocity under load 60 N
When load applied is low, the wear loss is quite small, which increases with an increase in applied load. It can be considered that it is quite natural for the weight loss to increase with load. The load further attains a transition value, at which wear mechanism changes from mild to severe wear. Figure 4.5 to Figure 4.8 illustrate the wear rates of the LM24/4 wt. % Fly ash and varying wt. % of silicate hybrid composite as a function of the sliding velocity 0.75, 1.5, 2.25, 3 m/sec, at applied load of 15, 30, 45 and 60 N, respectively. The wear rate of LM24/4 wt. % silicate/4 wt. % to LM24/24 wt. % silicate/4 wt. % fly ash hybrids composite increases with an increase in the sliding velocity. It was noted that the composite specimens exhibited significantly lower wear rates, than the base alloy specimen.

4.3 WORN SURFACE ANALYSIS OF LM24/SILICATE/ FLY ASH HYBRID COMPOSITE

Worn surface at 75 N loads with unreinforced, 4% reinforced and 16% reinforced is illustrated in Figure 4. The 16% silicate reinforced LM24/Silicate/ Fly Ash Hybrid Composite had good wear resistance during high load of 75 N at sliding velocity of 1.5 m/s, while the unreinforced as well as the 4% reinforced composites seized. Figure 4.9 shows the worn surface of the unreinforced material removal during the process, in the form of small pieces resulting in the formation of flake type debris. The morphology of the worn-out surface changes from fine scratches to distinct grooves while increasing reinforcement. The worn surfaces in some places reveal patches from where the material was removed from the surface of the material, during the course of wear as shown in Figure 4.10. This, confirms the positive effect of reinforcing silicate particles, and additionally its substance in decreasing wear rate of materials. As the 16% silicate reinforced is increased, the coefficient of friction decreases. The scanning electron micrographs of the
samples indicate uniform distribution of the reinforcement particles in the matrix as shown in Figure 4.11.

Figure 4.9  Worn surface for unreinforced of hybrid composite

Figure 4.10  Worn surface for 4% reinforced of hybrid composite
4.4 SUMMARY

Wear is a process of gradual removal of a material from surfaces of solid objects, on contact and sliding. Damages in contact surfaces are a results of wear. The wear depth profile of a surface is a useful measure of the removed material. The definition of the gap between contacting bodies takes into account deformations of bodies and evolutions of wear profiles. This chapter deals with the wear rate of the LM24/4 wt. % Fly ash and varying wt. % of silicate hybrid composite under load of (15, 30, 45, 60, 75N) and under sliding velocity of (0.75, 1.5, 2.25, 3 m/sec).