Experimental Investigation on influence of Mn on tribological properties of as cast Al25Mg_2Si-2Cu-4Mn Alloy at room temperature

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***Abstract*- In the present study the experimental investigation is done on hypereutectic Al-Si alloy. The objective is to know the influence of Manganese (Mn) on as cast Al-25Mg2Si-2Cu-4Mn alloy. Here weight loss technique is used for the evaluation of wear. Wear test is done on pin on disc wear testing machine (TR-20, DUCOM, PIN-ON-DISC MACHINE). The rotating disc is made up of low carbon alloy steel (EN-32 Steel, 160 mm diameter and 8 mm thickness) with hardness value of about 62RC. The linear variable differential transformer (LVDT) is used to record the wear loss and monitored by loss of length, due to wear of specimen of fixed diameter. The wear loss is measured in microns. For the more accurate results, the weight loss method is adopted. The influence of Mn on the tribological properties can be explained with this test. Rise in load increases the coefficient of friction and after reaching a peak value, it starts declining. The approximate estimate can lead to a conclusion from maximum number of speed curves is that, the load is varies with friction.**

***Index Terms*- Hypereutectic, Coefficient of friction, surface roughness, volumetric wear rate.**

I. INTRODUCTION

The advancement of technology has made the improvement of materials necessary, hence it has become need of the hour to study the materials and their properties for the application in various domains.

Due to high strength to weight ratio the aluminium alloy has gained importance in the various engineering domains like automotive, aerospace, marine and defence sectors. The research has shown that with various alloying, the aluminium can be improved. Therefore aluminium and its alloys are extensively used in the industrial applications, due to its low coefficient of thermal expansion, high thermal conductivity, high corrosion resistance, good cast performance, good weld ability etc. The replacement of ferrous components can be done with aluminium alloys in many tribological, aerospace, production sectors. There is a need for the improvement of wear properties of these alloys in the above mentioned engineering sectors. The cast form of aluminium alloy is used in rockers arms, pistons, brake drums, engine blocks, air conditioner compressors.The work is carried on Al-Si alloys, since the Al-Si alloys are most widely used in all type of manufacturing industries. Particularly in automobiles, aerospace, food-processing etc. Hence the wear and mechanical properties must be improved, which mainly depend on the shape, size, size distribution of the second phase particles in the matrix and microstructures. Also conditions such as sliding speed, sliding distance, temperature, load.To eliminate the problem of wear in the industry, to manufacture durable and reliable materials lots of efforts have been made and also methods to minimise the wear of the tools and engineering components. These consist of changes in bulk properties of material, surface treatments, applications of the coating etc. Research has been done over the last few years to understand the manners of the sliding surface contact and the parameters which cause wear.Hence, the hypereutectic Al-Si alloys are good enough to study the influence of manganese on the primary hypereutectic Al-Si alloys and to compare the same with the mechanical and tribological properties. The objective of the current work is to check the wear behaviour of Al-Si alloy without T6 heat treatment and the merits of the hypereutectic Al-Si system alloyed with elements like Cu, Mg and Mn. Present work aims at exploring the wear characteristics of as cast aluminium alloy.

The main objectives of the study are:

1) To prepare casting without T6 heat treatment.
2) To study the wear of as cast Al-25Mg2Si-2Cu- 4Mn alloy in different operating conditions and
3) To identify the dominant wear mechanism under various service factors like speed, load, and time.

The pins(Fig.1) are polished on emery paper to get the mirror finish or smooth surface. The surface of the pins are polished up to 1200 mm grit size, once after getting the smooth surface the pins are cleaned and are ready for the wear test. The polishing and cleaning of the pins are part of experimental procedure, disc type cloth polishing machine is used for cleaning the specimen.

Fig 1: As cast Al-25Mg2Si-2Cu-4Mn alloy ingots and pins used for wear test

II. WEAR TESTING MACHINE

This method uses the weight loss technique for the evaluation of wear. Wear test is done on pin on disc wear testing machine from Fig.2 (TR-20, DUCOM, PIN-ON-DISC MACHINE). The rotating disc is made up of low carbon alloy steel (EN-32 Steel, 160 mm diameter and 8 mm thickness) with hardness value of about 62RC. The linear variable differential transformer (LVDT) is used to record the wear loss and checked by loss of length, due to wear of samples (pins) of fixed diameter. The wear loss is measured in microns. For the more accurate results, the weight loss method is adopted. According to weight loss method, the weights of the pin before and after the test are noted down. The weight of the pin before the test is known as initial weight and weight after the test is known as final weight, and the difference of initial and final weight gives the weight loss due to wear.

The wear tests conducted on the pin on disc machine are under following conditions.

1. Dry sliding wear at constant speed conditions.
2. Dry sliding wear at constant load conditions.

Fig.2: Wear testing machine

Fig.3: Pin before test

Fig.4: Pin after test

III. RESULTS AND DISCUSSION

I) Wear test results for constant speed condition at room temperature.

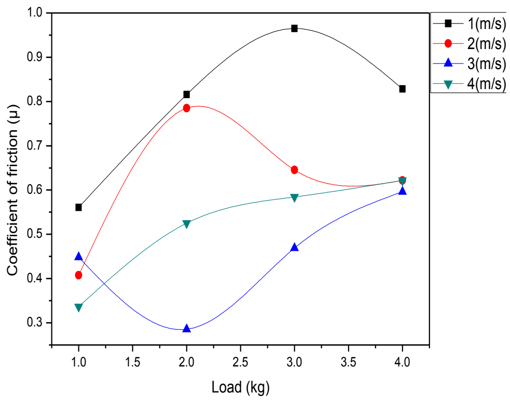

Fig.5: Load v/s Coefficient of friction

Results: As seen from the Fig. 5 at the lower loads coefficient of friction is low. For the 1 kg load and 1m/s speed curve the friction coefficient is least, similar thing is observed for 2 m/s and 4 m/s speed curves. Rise in load increases the friction coefficient and after reaching a peak value, it starts declining.

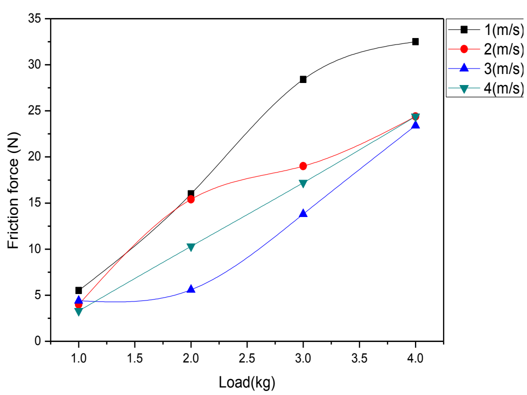

Fig.6: Load v/s Friction

Results: As seen from the Fig. 6 at the lower values of load for all the speed curves the friction is least or minimum. As the load increases, the friction starts increasing for all the speed curves. The approximate estimate can lead to a conclusion from maximum number of speed curves is that, friction increases with load.

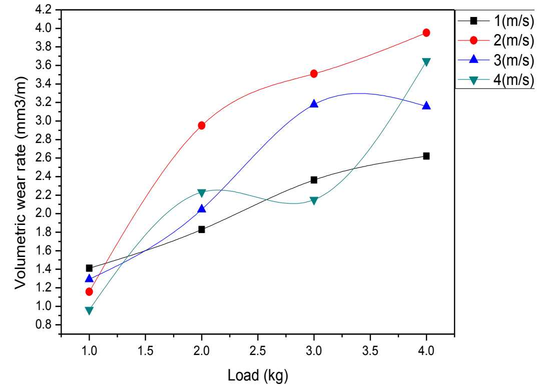

Fig.7: Load v/s Volumetric wear rate

Results: As seen from the Fig. 7, volumetric wear rate is lowest at 4 m/s speed at lower load value . Also all the speed curves show lower values of Volumetric wear rate at 1 kg load and as the load increases the Volumetric wear rate also increases slowly and steadily.

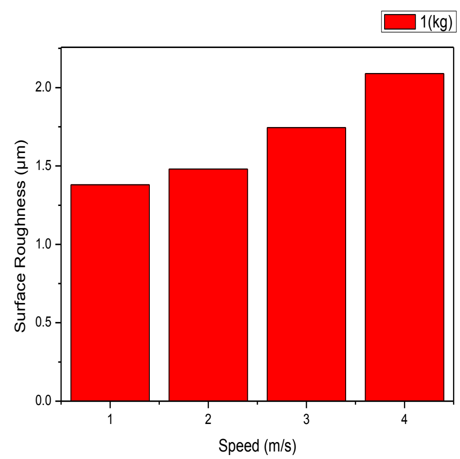

Fig.8:Speed v/s Surface roughness

Results: As seen from the Fig.8, the surface roughness of the pin varies with speed. It is observed that as the speed is increased the surface roughness increases. Also the increment is gradual, there is no sudden fluctuation in the bar graph. For the different speeds the surface roughness is found to be increasing at 1 kg load.

II) Wear test results for constant load condition at room temperature.

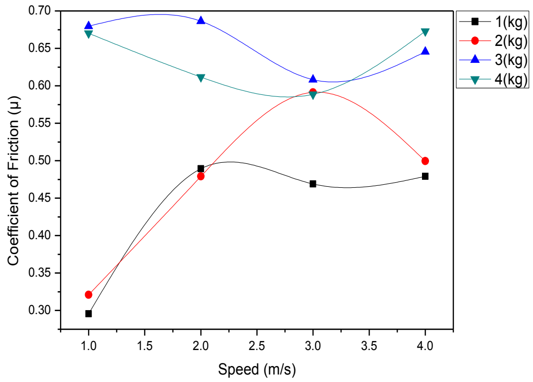

Fig.9:Speed v/s Coefficient of friction

Results: From the Fig. 9, we can say that for the lower load curves (1kg & 2 kg) the coefficient of friction is lowest at 1 m/s speed and vice versa. For lower load curves (1 kg & 2 kg) the graph shows the rise in friction coefficient & declines after particular speed value. But the higher load curves (3 kg & 4 kg) decreases as the speed rises and after a particular speed value (3 m/s from Fig 9) it starts increasing.

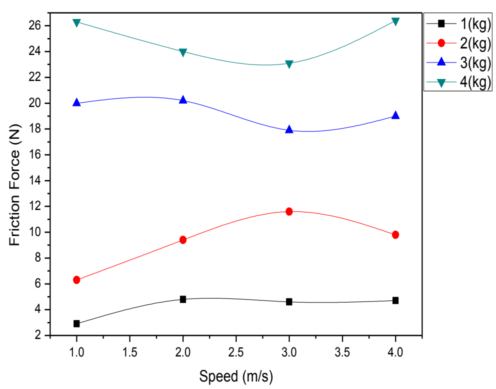

Fig.10: Speed v/s Friction force

Results: As seen from the Fig. 10, all load curves remains steady. All the curves are almost similar to straight line, not more fluctuations in curves are observed. At lower speeds the friction value is higher for higher loads. Same pattern is observed for all the speed values. As the speed increases the friction value remains in nearly same range showing less deviation. Hence, we can say that as the speed increases the friction remains steady for all the load values with minor fluctuations.

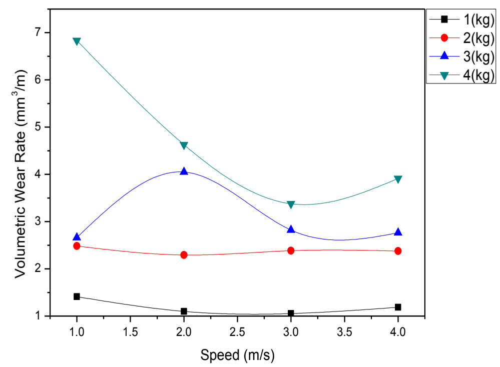

Fig.11: Speed v/s Volumetric wear rate

Results: As seen from the Figure 11, Majority of load curves shows higher value of volumetric wear rate at low speed of 1 m/s. The lower load curves (1 kg & 2 kg) are steady in nature with respect to speed. But, the higher load curves show variations in nature with increase in speed. No change is observed in volumetric wear rate values for lower loads with increase in speed. The higher load curves behave in opposite manner, the 4 kg load curve shows a decrement in volumetric wear rate with increase in speed and the 3 kg load curve shows increment in volumetric wear rate with increase in speed. After attaining a peak value at 2 m/s speed, the volumetric wear rate starts decreasing for 3 kg load curve.

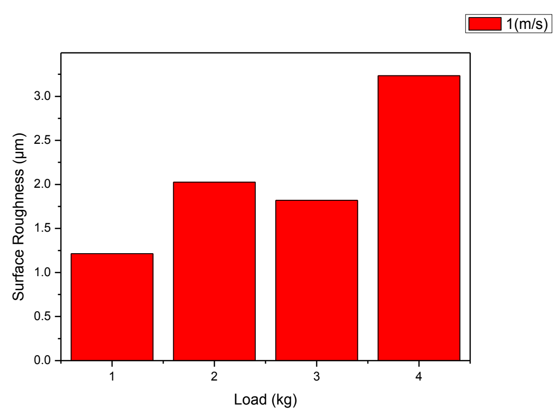

Fig.12: Load v/s Surface Roughness

Results: As seen from the Fig. 12, Surface roughness varies with load alternatively. That means for lower load of 1 kg, the surface roughness is less. Again for the load of 2 kg the surface roughness is higher than the initial one. The same pattern can be seen from the figure 12. The alternative decrement and increment in surface roughness values with increase in load, shows that surface roughness is higher for higher loads of 4 kg at 1m/s speed.

IV. CONCLUSION

I) Wear test conclusion for constant speed condition at room temperature.

1) Coefficient of friction: For lower values of load and speed the coefficient of friction are maximum, it reduces as the speed is increased.

2) Friction force: The approximate estimate can lead to a conclusion from maximum number of speed curves is that, the load is varies with friction.

3) Volumetric wear rate: For constant speed condition the Volumetric wear rate increases slowly and steadily with rise in load.

4) Surface roughness: We can deduce that as the speed is increased, the surface roughness increases. There is a possibility of surface to become smoother with respect to increment in load, the surface roughness decreases, due to rise in pin temperature.

II) Wear test conclusion for constant load condition at room temperature.

1) Coefficient of friction: Generally, we can say that for higher load (3kg & 4 kg) curves the friction coefficient decreases with rise in speed and for lower load (1 kg & 2 kg) curves the friction coefficient increases with increase in speed.

2) Friction force: We can deduce that friction force at constant load remains close to initial value, with minor fluctuations till the end with increase in speed.

3) Volumetric wear rate: We can conclude that at higher load values the volumetric wear rate is higher with respect to speed. At lower load values the volumetric wear rate remains unchanged for all speeds.

4) Surface roughness: The surface roughness has higher values at higher loads. There is a possibility of surface to become smoother with respect to rise in speed. The surface roughness decreases, due to change in pin temperature.

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