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The Influence of Heat Treatment, Sliding Velocity and Load on the Volumetric Wear Rate and Coefficient of Friction of Al25Mg2Si-2Cu-4Mn Alloy

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***Abstract-* In this paper, the influence of the heat treatment, load and sliding velocity on the volumetric wear rate of Al25Mg2Si-2Cu-4Mn alloy was evaluated using a pin-on-disc wear testing machine. Dry sliding wear test were conducted for four different loads (1, 2, 3 and 4kg) for four different velocities (1, 2, 3 and 4m/s). It was observed that the volumetric wear rate decreased with increasing load at constant speed and at constant load with increasing speed the volumetric wear rate increased and coefficient of friction in inversely proportional to load and sliding speed. The result reveals that the normal load is the most influencing the wear resistance followed by the heat treatment and sliding velocity.**

***Index Terms-* Heat treatment, sliding velocity, volumetric wear rate, coefficient of friction.**

I. INTRODUCTION

During the last fifty years vast strides have been made in the advance of metallurgy. As a result, now the availability of material is in wide range for engineers. Amongst them which are most of alloys showing a vast increase in strength and in resistance of fatigue which leads in saving of weight in aero planes and automobiles. Alloys having a high resistance to corrosion and others possessing significant strength at elevated temperature is invaluable for chemical plants and for the boilers which are working at high temperature and pressure. As the result the rate of production has increased due to these new alloys and new tool steels. By using of such new alloys, however, often presents problems of new methods in the forge, heat-treatment or machine shop. If the full advantages are obtain then it is very necessary to the engineer be prepared with the detail information as to the peculiar characteristics of the material he is using. The engineer is the one who is concerned with the mechanical properties of the material that he uses, but the composition, casting, shaping and heat-treatment have a tremendous effect on the ultimate behavior of the new alloys. Consequently, to the modern engineer it has became more and more essential of having some knowledge of metallurgical theory and practice which involves the things such as microscope examination of metals and the interpretation o the structures revealed.

Wear can be distinct as corrosion of the material of a solid surface when it comes in action to another sliding surface. And be capable of contact among solid surface at its working environment which results in the loss of dimension of solid. Loads such as impact loads, rolling, reciprocating and unidirectional sliding and temperature, varying speed, and the types of contact and also state of matter used such as solids, liquids or gas are the some aspects of working environment which affects the wear.

In the field of aerospace and many other engineering sectors, the aluminum silicon alloys has become attractive or more suitable material due to its special characteristics properties such as light weight, high thermal conductivity, electrical conductivity, wear and hot tearing resistance etc. Due to these properties of aluminum silicon alloys they are applicable in the production of components like pistons, engine blocks, connecting rods, air compressors, cylinders liners etc.

II. BACKGROUND

In an industry the major problem occurred is that the wear and the estimation of its straight price which vary between 1 to 4% of gross national product. Due to this many ways and techniques are developed to reduce the wear of tool and other engineering machinery. These involves amendment of surface treatment, bulk properties of materials and application of the coating etc. wear of the surface in sliding contact and the mechanism is understood by the effort made since last few years.

An alloy can be defined as, it is combination of two or more chemical elements of which at least one is a metal and it is a material which has metallic properties. The metallic bond must dominate in its crystal structure and metallic atoms in its chemical composition. From the component elements, alloys have different properties. The engineering properties such as shear strength and tensile strength may be differ from those of the constituent materials but where as physical property such as conductivity and density of an alloy is not different than those from its component elements.

III. MATERIAL AND EXPERIMENTAL METHOD

An Al25Mg2Si-2Cu-4Mn alloy is the new composition prepared by the different weight percentages and produced by melting process and samples were prepared, and those samples are studied by conducting the wear behavior test. The coefficient of friction was studied by using various parameters such as load, speed and time. The experiment carried out by heat treating for as cast material. As cast Al25Mg2Si-2Cu-4Mn composition alloy is prepared in the form of ingots by melting process. These as cast ingots are first preheated in the muffle furnace for 25min of soaking time at 420°C. After 25min the ingots are removed from the furnace and quenched in ice cold water. Next these ingots are converted into required pins. The ingots are machined on lathe machine and are converted into pins of 10mm diameter and 33mm height as shown in below figure. Now the 32 pins are produced and are ready for the further tests.

Fig 1: As cast ingots and pins

A. Heat treatment

All the heat treatment experiments in this work were carried out in a muffle furnace with a temperature accuracy of ±2°C.

Fig 2: Muffle furnace used for heat treatment

The samples as cast Al-25Mg2Si-2Cu-4Mn alloy ingots are subjected to heat treatment. Initially the preheating process is carried out by soaking the as cast ingots in muffle furnace at 420°c for 25minutes and rapid quenching in ice cold water is done. The cycle of heat treatment is continued with the homogenization process. Before starting the process first the ingots are turned into pins of 33mm height and 10mm diameter. In this process the 32 pins are required so that four groups can be made where each group contains 8 specimens which are further subdivided for wear test. For the homogenizing process initially muffle furnace should be set at 210°C after temperature reaching to 210°C all the 32 specimens are place in the furnace in the form of four rows and each row contains 8 specimens. Now the soaking time starts by maintaining the furnace temperature at 210°C and then 1, 2, 3 and 4th row of specimens are removed for 1, 3, 5 and 7hours respectively, further they are cooled in the room temperature.

B. Wear test

Tests were carried out at different loads as 1, 2, 3 and 4kg and sliding speed of 1, 2, 3, 4m/s were used with combination with four different loads. The time in minutes and sliding speed in rpm are set and test is carried out and after the wear debris is collected for the further test. After the test the load and pin is removed and all the readings are recorded systematically for the further calculation and plotting the graphs. Lastly the final weight of pin and frictional force is recorded by the reading obtained with the help of linear variable differential transformer(LVDT) connected to pin-on-disc wear testing machine and weight loss, volumetric wear rate and coefficient of friction is calculated and studied.

Fig 3: pin-on-disc wear testing machine

IV. RESULTS AND DISCUSSION

The wear test is carried out by using different parameters such as speed (m/s), load (kg) and time (min), the coefficient of friction is obtained by frictional force and volumetric wear rate is obtained from the weight loss after the wear test. The comparison is done at constant speed and constant load and finally graphs are obtained.

4.1 Volumetric wear rate at constant speed 4 m/s and constant load 4kg.

As observed in the fig 4.1 (a) the graphs plotted are at constant speed 4m/s, volumetric wear rate is low at the initial loads. There is sudden increase in volumetric wear rate at second load and then again there is slowly decrease in the graph. Finally at 4kg load the graph is in steady condition.

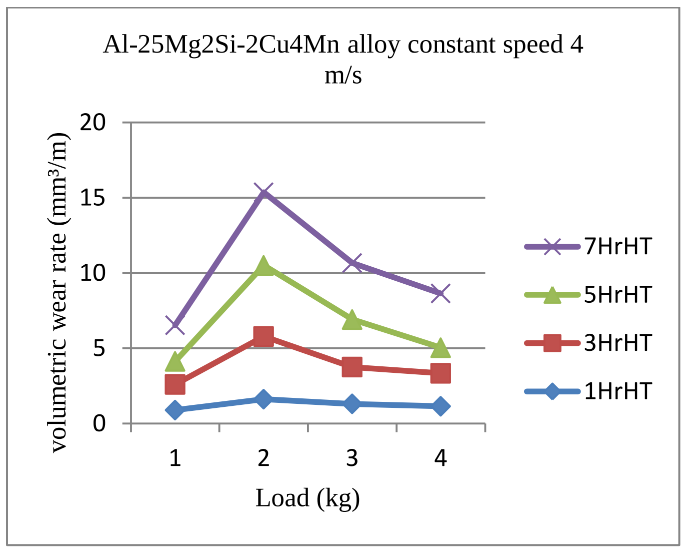

Fig 4.1(a): Volumetric wear rate at constant speed

Next figure 4.1 (b), shows that the volumetric wear rate is increasing at every speed. Finally there is increase in the volumetric wear rate at constant load conditions.

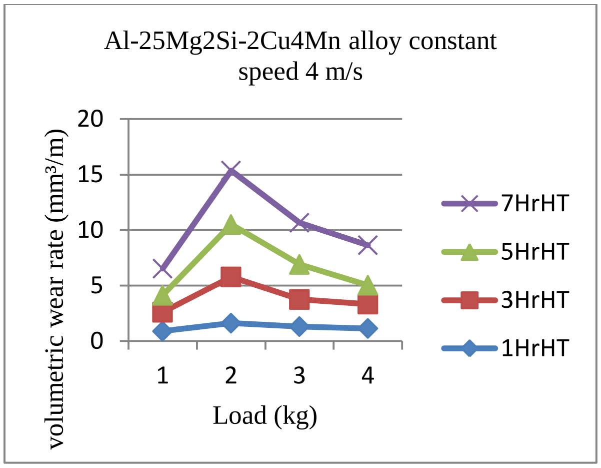

Fig 4.1(b): Volumetric wear rate at constant load

4.2 Coefficient of friction at constant speed 4m/s and constant load 4kg

As observed in the figure 4.2(a), the value of friction coefficient for all the conditions increases with increase in load. In the figure 4.2(b) the values of coefficient of friction decreases at constant load of 4kg with increase in speed.

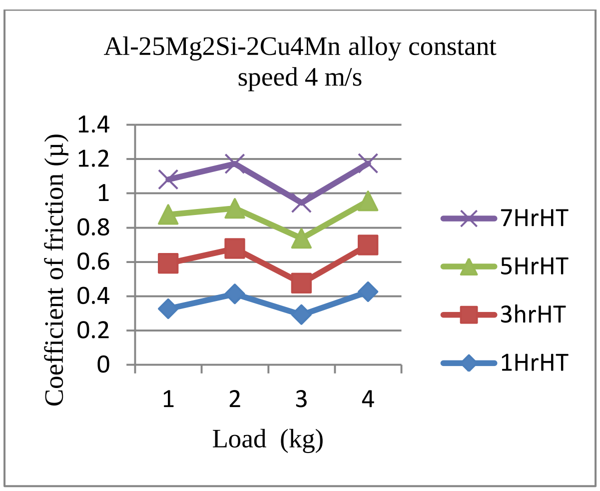

Fig 4.2(a): Coefficient of friction at constant speed

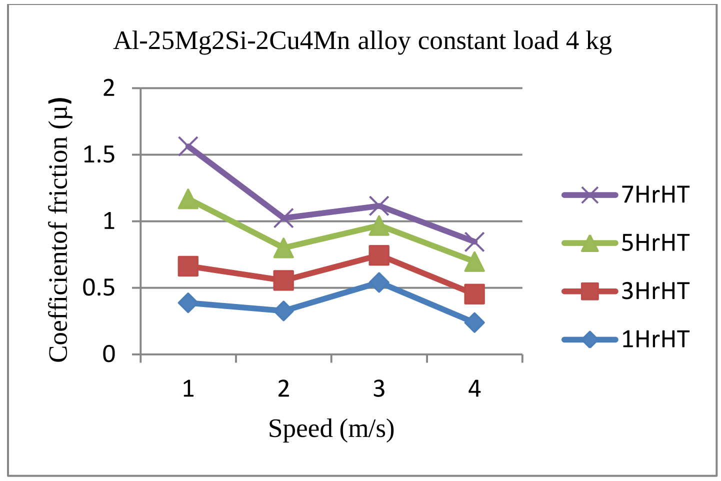

Fig 4.2(b): Coefficient of friction at constant load

V. CONCLUSION

It was observed that the volumetric wear rate is increased with increasing load at constant speed and at constant load with increasing speed the volumetric wear rate decreased. The result reveals that the constant load is the most influencing the wear resistance followed by the heat treatment and sliding velocity. The values of coefficient of friction are increasing with increase in load and decreasing with increasing of speed. Therefore the coefficient of friction is inversely proportional to load and sliding speed.

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