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Review Paper on Effect of SiC on AZ Alloy Composite

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Abstract- **The purpose of this work is to examine the effect of Silicon carbide on the wear properties of AZ alloys. The alloys were prepared from commercially pure aluminum(99.7%), high purity zinc (99.9%) specimen. In this process, matrix alloy was firstly superheated over its melting alloy in the semi-solid state at this temperature, the preheated SiC particles were introduced into the slurry and mixed. The percentage of SiC varies as 8%, 12%, 16% in three prepared sample. From literature survey and pre-experimentation, It was found that load, rpm, sliding distance are most influencing parameters on wear. It concludes that the wear resistance of the tested alloy increased with increasing SiC content.**

Keywords— **AZ Alloy, Sic, Taguchi Method, Array.**

I. Introduction

Wear which Though wear resistance is not a materials property, an understanding of the dominant wear mechanisms behind the continuing development in the field of advanced materials, in order to provide a solution for mitigating Tribological losses. Whenever there is contact between solid bodies, surface phenomena, designated by friction and wear, are developed. By friction we mean the with dissipation of energy. The frictional force is a tangential force that is common in the, by direct action of relative motion in that surfaces.This reason led to the development of a large the sliding velocity, load and the temperature of the contact, the wear and the coefficient of friction, is extremely important.

Need of Aluminium

The third most abundant element after oxygen and silicon is Aluminium. A broad

Variety of mechanical and physical properties can be procured from wrought Al. Some properties of this metal which are remarkable are:

1. The low density of Aluminium (which is 1/3rd of that of steel) makes it possible to reduce
2. weight of components and structures especially for applications like transport (aerospace prominently).
3. Ability to resist corrosion due to phenomenon of passivation. This is the formation of shielding oxide layer ($Al2O3$) which prevents the core from coming in direct contact with the environment.
4. This metal can easily be subjected to casting, drawing, extrusion and other forming

Need of Aluminium Alloys

Nomenclature of aluminium alloys are done as 4xxx, 5xxx and 6xxx series where the number represents the major alloying element. Al alloys have high specific modulus and high specific toughness, hence are used in automotive components for fuel saving and improving economy.

1. Al alloys are of great use in electrical industry as thermal conductivity is twice that of Cu.
2. Strength at low temperature: Brittle fracture problems do not occur with aluminum. As there is a decrease in temperature, the strength of Aluminium alloys increase without loss in quality making them particularly suitable for low temperature applications.
3. Resilience under static and dynamic loading: Aluminium products behave elastically under static and dynamic loading conditions. Thus they have the ability to restore both shape and size. This is good when flexible strength is required.

Need of AZ Alloy

Temel Savas¸kan, Osman Bican, Yasin Alemdag, Zinc-based ternary and quaternary alloys have been proven to be good bearing materials. However, the copper containing zinc-based ternary and quaternary alloys and copper-rich phases.

Friction

Friction experienced during a rolling condition is known as rolling friction the early investigations of Leonardo da Vinci, Amontons, Coulomb, and Euler, there is no simple model to predict or calculate the coefficient of friction of a given pair of materials

II. Objective & Methodology

Problem Statement

On this background the aim of this experimentation work is to investigate the effect of SiC on the wear properties of AZ alloys and to decide the optimum SiC content for above properties.

Objective

1. To reduce wear rate of AZ alloy by addition of SiC content.
2. To reduce coefficient of friction of AZ alloy by addition of SiC content.
3. To improve the seizure resistance of AZ alloy.

4. To optimize the thermal expansion coefficient.
5. To improve the damping capacity of AZ alloy.
6. To improve the life period of AZ alloy by addition of SiC content.
7. To improve the yield strength and ultimate tensile strength of AZ alloy.

Scope

Metal matrix composites (MMCs) have attracted considerable attention recently because of their potential advantages over monolithic alloys. which may be in the form of fibre, whiskers, or particulates. By adding ceramic reinforcement to matrix improves strength particulate reinforced MMCs offer several advantages such as improved anisotropy, ease of fabrication. Their main advantages are good tribo-mechanical properties, low weight; excellent foundry cast ability and fluidity, good machining properties, low initial cost, and environmental-friendly technology.As a result, in the recent years, metal matrix composites (MMCs) based on ZA matrix are being increasingly applied as light-weight. Aluminium composites with multiple reinforcements (hybrid AMCs) are finding increased yields aluminium matrix hybrid composites to possess better tribological properties over composites with single reinforcement.

Methodology

Material Selection

In the present investigation, Al-SiC alloy is chosen as the base matrix since its properties can be tailored through heat treatment process. The reinforcement is SiC, average size of 150 to 160 microns, and there are sufficient literatures elucidating the improvement in wear properties through the addition of SiC

Procurement of Material- purchase

With reference to above selected material composition the materials will be procured from various suppliers and samples will be prepared of required composition.

Preparation of Sample

In order to achieve high level of mechanical properties in the composite, a good interfacial bonding (wetting) and cost effective method to fabricate matrix. The reinforcements were preheated prior to their addition in the aluminium alloy melt. Degassing agent (hexachloroethane) is used to reduce gas porosities. The molten metal is then poured into a permanent cast iron mould of diameter 26mm and length 300mm. The die is released after 6 hours and the cast specimens were taken out.

ANOVA Analysis

The adequacy of the models is tested using the analysis of variance (ANOVA) testing.

It is a statistical tool for testing null hypothesis for designed experimentation, where a

Number of different variables are being studied simultaneously .ANOVA issued to quickly analyze the variances present in the experiment with the help of fisher test (F test).

Regression Analysis

Regression is nothing but the measure of the average relationship between two or more variable in terms of the original units of the data. To establish the correlation between the wear parameters (1) rpm, (2) Load, (3), Sliding distance, (4) weight percentage of SiC and the dry sliding wear loss the wear multiple linear regression model was obtained using statistical software “MINITAB R14”.The terms that are statistically significant are included in the model. Final Equation obtained is as follows ,

WEAR = - 0.133 + 0.000181 RPM + 0.0591 LOAD + 0.0550 SD - 0.00746 COMP ……………..(1)

Substituting the recorded values of the variables for the above equation (1) the sliding wear of the material can be calculated. The positive value of the coefficient suggests that the sliding wear of material increases with their associated variables. The magnitude of the variables indicates the weightage of each of these factors .It is observed from the Equation (1) that the Load has the more effect on wear of the composites, which is followed by Sliding distance, Weight percentage of Sic and rpm for the tested range of variables. The important factor affecting the sliding wear is the load and coefficient associated with it is positive. This suggests that the Load increases the penetration ability of the fractured particles, will increase and remove the material on the pin surface. The coefficient of Sliding distance is positive which indicates that increase in wear weight loss with increasing the Sliding distance. The coefficient of Sic content is negative which indicates that Sliding wear of composite decreases with increasing Sic content. The coefficient of rpm is positive which indicates that Sliding wear increases with increasing rpm for the tested range.

Validation of Experiment

The Taguchi method, which is effective to model the response function compared with the full factorial design of experiments. The experimental results are analyzed using analysis of means and variance to study the influence of factor

III. Design Of Experiment & Taguchi Method

To know the amount of wear undertaken, by direct contact of Al-Zn alloy with metal counter surface (EN 31 steel disc), it is necessary to experimentally evaluate and measure the corresponding friction and wear.

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The test to be carried out under various operating condition and under controlled conditions. With a view to generate new performance data, we have chosen three alloys viz**.** Experiments are to be carried out on standard pin-on-disc machine, at ambient temperature and under dry operating condition.

The aim of experiment is to measure the wear under different operating condition. Then the wear equation will be found out for all the materials experimented under various conditions. The methodology used is the Taguchi's method for design of experimentation using orthogonal array. Following the development to fa number of zinc aluminium based bearing alloys, investigation seen this field were converted towards the aluminium–zinc based alloys. In this context first step was taken to examine the structure and mechanical and tribological properties of Al–40Zn-based alloys. As a result of these investigations ternaryAl–40Zn–3Cu and quaternary Al–40Zn–3Cu–2Si alloys were developed. It was seen that in later studies Al–25Zn alloy had the highest hardness and tensile strength as compared to binary Al–Zn alloys. Therefore, the research was focused on the Al–25Zn based alloy and from above discussion it is clear that Al–25Zn–3Cu and quaternary Al–25Zn–3Cu–3Si new alloy. These type of alloys are much superior than conventional bearing bronzes and comparable to the zinc-based one eutectoid alloys as far as the mechanical and tribological properties are concerned. In addition they exhibited much smaller dimensional changes in this cast condition as compared to the zinc- based ternary alloys containing aluminium and copper. The tribological properties of the ternary alloy were investigated in detail under different test conditions.

Objectives of Experiments

The objective of experimentation is to find out the mathematical relationship between specific pressure, sliding velocity, sliding time/ sliding distance and the amount of wear for above alloys. There is possibility of temperature generation at the contacting interface, which affect the wear. Also, error in predicting the wear for all the cases has been calculated.

A Typical Orthogonal Array (OA)

While there are lots of orthogonal arrays available, each array having its own specific number of independent design variables and levels.

Standard notation for Orthogonal Arrays is

$$L_n\ (X^m)$$

Where, n=No. of experiments to be conducted

X=No. of levels
m= No. of factors

Common Orthogonal Arrays are listed below for quick reference

(2- Level arrays)--- $L_4\ (2^3)$, $L_8\ (2^7)$, $L_{12}\ (2^{11})$, $L_{16}\ (2^{15})$, $L_{32}\ (2^{31})$, $L_{64}\ (2^{63})$ etc.

(3- Level arrays)--- $\mathbf{L_9\ (3^4)}$, $L_{18}\ (2^1{*}3^7)$, $L_{27}\ (3^{13})$, $L_{54}\ (2^1{*}3^{25})$, $L_{81}\ (3^{40})$ etc.

(4- Level arrays)--- $L_{16}\ (4^5)$, $L_{32}\ (2^1{*}4^9)$ etc.

Note: Arrays $L_{18}\ (2^1{*}3^7)$, $L_{54}\ (2^1{*}3^{25})$, $L_{32}\ (2^1{*}4^9)$ etc. are for mixed level factors.

IV. Conclusion

1. The objective of experimentation is to find out the mathematical relationship between the variables in wear testing like Load, rpm, Sliding distance, material and the amount of wear for AZ alloys and to decide the optimum material content for the above properties.
2. There is possibility of temperature generation at the contacting interface, which affect the wear. Also, error in predicting the wear for all the cases has been calculated. The highest wear resistance can be found out with the Al-Zn alloy.
3. It was found that load, rpm, sliding distance are most influencing parameters on wear.
4. Wear resistance of tested alloy increased with increasing SiC content. Hardness of alloy increased with Sic content. SiC content of 16% is the harder material than 8 and 12% of SiC.

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