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WEAR RATE OF (ALUMINIUM) AL-6061 ON DIFFERENT LOADS

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Abstract

Wear is the important factor for various applications in automobile and aeronautical industries. Various researches are going on to improve the wear by either alloying the material or using the composite material. Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. The research work summarized in this thesis present an experimental investigation on the effect of abrasive wear rate of the material Al-6061 alloy on various load. The experiment was carried out in the laboratory using an experimental set up for the analyzing the wear rate of selected material. The experiment for analyzing the wear rate conducted on various load as well as various orientation against grinding disc. Here we study the working life of an engineering component is expired when dimensional losses exceed the specified tolerance limits. The abrasive wear behavior of selected material is analyzing at different loads and four different orientations. In the above paper I have analyzed the abrasive wear of selected material, which shows the estimated life of said material.

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OBJECTIVE OF THE STUDY: To analyzing the wear rate for different load and different orientation for ma selected material during abrasive wear rate. This shows the material life against the selected load.

INTRODUCTION- In materials science, wear is erosion or sideways displacement of material from its "derivative" and original position on a solid surface performed by the action of another surface.

Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface Rabinowicz, E 1995 [1]. The need for relative motion between two surfaces and initial mechanical contact between asperities is an important distinction between mechanical wear compared to other processes with similar outcomes. Williams, J.A.2005[2].

The definition of wear may include loss at the interface between two sliding surfaces. However, plastic deformation such as yield stress is excluded from the wear definition if it doesn't incorporates a relative sliding motion and contact against another surface despite the possibility for material removal, because it then lacks the relative sliding action of another surface. Impact wear is in reality a short sliding motion where two solid bodies interact at an exceptional short time interval. Previously due to the fast execution, the contact found in impact wear was referred to as an impulse contact by the nomenclature. Impulse can be described as a mathematical model of a synthesized average on the energy solids in opposite converging contact. Cavitations wear is a form of wear where the erosive medium or counter-body is a fluid. Corrosion may be included in wear phenomenon, but the damage is amplified and performed by chemical reactions rather than mechanical action.

Wear can also be defined as a process where interaction between two surfaces or bounding faces of solids within the working environment results in dimensional loss of one solid, with or without any actual decoupling and loss of material. Aspects of the working environment which affect wear include loads and features such as unidirectional sliding, reciprocating, rolling, and impact loads, speed, temperature, but also different types of counter-bodies such as solid, liquid or gas and type of contact ranging between single phase or multiphase, in which the last multiphase may combine liquid with solid particles and gas bubbles.

When surfaces in contact move relative to each other, the friction between the two surfaces converts kinetic energy into heat. This property can have dramatic consequences, as illustrated by the use of friction created by rubbing pieces of wood together to start a fire. Kinetic energy is converted to heat whenever motion with friction occurs, for example when a viscous fluid is stirred. Another important consequence of many types of friction can be wear, which may lead to performance degradation and/or damage to components. Friction is the component of science of tribolgy.

Friction is not a fundamental force but occurs because of the electromagnetic forces between charged particles which constitute the surfaces in contact. Because of the complexity of these interactions, friction cannot be calculated from first principles, but instead must be found empirically. Some factors affecting wear rate such as Coefficient of friction, Specific energy of material, Material removal rate. This includes the width of the grinding wheel, Depth of cut, Feed rate of the specimen, power unit- torque & speed. In recent decades, aluminum alloy based metal matrix are gaining important role in several engineering applications. Al6061 alloy has been used as the matrix material because of its good formability, excellent mechanical properties and manufacturing properties. Wide spectrum of the applications in the commercial and industrial sectors.

Chemical composition of the Al6061 alloy are as

Elements	Cu	Mn	Mg	Si	Fe	Cr	Ti	Zn
Wt %	0.15-0.40	0.15	0.8-1.2	0.4-0.8	0.7	0.04-0.35	0.15	0.25

Aluminum alloy(Al6061)- By the adopting the suitable treatment, mechanical properties of wear resistance of Al composites can be improved. Studying wear is characterized by many different aspect and it is mostly influenced by the complexity of materials interaction on a functional surface as well as by operation conditions. In machine element, there are gradual wear in the result of friction. Therefore, we have to search for the possibilities to prevent it thus extending the technical life of a component.

LITERATURE REVIEW-

- **Chang Chongyi Wang Chenggu and Jin Ying 2010**[14] They conducted their study on numerical method to predict wheel/rail profile evolution due to wear. A wheel/rail profile wear prediction methodology was developed and applied to the wheel/rail disc test about the wear of flange and gauge. Three-dimensional nonlinear finite element dynamic analysis code ABAQUS was also used in the simulation of wheel/rail disc rolling contact process. The simulation results are compared with measurements of laboratory wear test and the effectiveness of the wear prediction methodology was verified.
- **Dharma R. Maddala, Arif Mubarok and Rainer J. Hebert 2010**[15] conducted study on Sliding wear behavior of $Cu_{50}Hf_{41.5}Al_{8.5}$ bulk metallic glass. Sliding wear behavior of a copper-based bulk metallic glass ($Cu_{50}Hf_{41.5}Al_{8.5}$) was investigated for both as-cast and annealed samples. The wear resistance increased during isothermal annealing near the glass transition temperature. Nano crystals developed during the annealing for annealing times up to 300 min. A linear relation between hardness and wear resistance was observed during the early stages of devitrification, but at longer annealing times the wear resistance increased less than the hardness.
- **H.C. How and T.N. Baker 1997**[18] In their investigation of wear behavior of Al6061-saffil fiber, concluded that saffil are significant in improving wear resistance of the composite.
- **Liang Y. N. et. al. 1995** [19] Reported that the MMCs containing SiC particles exhibit improved wear resistance.
- **Basavarajappa S., et. al. 2005** [20] Stated that the micro structural characteristics, applied load, sliding speed and sliding distance affect the dry sliding wear and friction of MMCs. However, they conclude that, at higher normal loads (60N), severe wear and silicon carbide particles cracking and seizure of the composites occurs during dry sliding. Liang Y. N. et. al. Reported that the MMCs containing SiC particles exhibit improved wear resistance.

- **Chandramohan G., et. al**[22]. Reported that the sliding distance has the highest effect on the dry sliding wear behavior of MMCs than that of the load and sliding speed.
- **Y. Reda et.al**[23] Vol.9, No.1 Studies on Al6061-SiC and Al7075 - Al2O3 Metal Matrix Composites 45 and **R. Clark et. al**.[24] In their studies on Al7075 reported that, pre-aging at various retrogression temperatures improves the hardness, tensile properties and electrical resistivity.
- **Surappaet al 1982** [25]**.** Noted that aluminum reinforced with 5 % alumina possessed an adhesive wear rate comparable to that of Al-11.8Si or AI--S1 hypereutectic alloys. Other work published by the same workerss4 involving Al, Al-11.8Si, Al-16Si alloys and Al reinforced with A1203p (5%) indicated that increased silicon content reduced the wear rate.
- **Hoskings et al.1982** [26]reported a decrease in adhesive wear rate with increasing particle content (at constant particle size) and dimension (at constant volume fraction) for Al 2014 and 2024 alloys reinforced with Al,O,p and SiCp (1-142 pm) of various weight fractions (2-30 %). SIC was shown to be more effective than alumina in resisting wear, when tested in a ball-on-disc rig. These findings were in disagreement with those reported by Surappa.54 However, it should be noted that the former work involved only a small reinforcement content (5 %).

ABRASIVE WEAR:

Abrasive wear occurs when a hard rough surface slides across a softer surface.[1] ASTM International (formerly American Society for Testing and Materials) defines it as the loss of material due to hard particles or hard protuberances that are forced against and move along a solid surface. Standard Terminology Relating to Wear 1987 [9].

Abrasive wear is commonly classified according to the type of contact and the contact environment. The type of contact determines the mode of abrasive wear. The two modes of abrasive wear are known as two-body and three-body abrasive wear. Two-body wear occurs when the grits or hard particles remove material from the opposite surface. The common analogy is that of material being removed or displaced by a cutting or plowing operation. Three-body wear occurs when the particles are not constrained, and are free to roll and slide down a surface. The contact environment determines whether the wear is classified as open or closed. An open contact environment occurs when the surfaces are sufficiently displaced to be independent of one another ASM Handbook Committee 2002 [10].

There are a number of factors which influence abrasive wear and hence the manner of material removal. Several different mechanisms have been proposed to describe the manner in which the material is removed. Three commonly identified mechanisms of abrasive wear are:

1. Plowing
2. Cutting
3. Fragmentation

Plowing occurs when material is displaced to the side, away from the wear particles, resulting in the formation of grooves that do not involve direct material removal. The displaced material forms ridges adjacent to grooves, which may be removed by subsequent passage of abrasive particles. Cutting occurs when material is separated from the surface in the form of primary debris, or microchips, with little or no material displaced to the sides of the grooves. This mechanism closely resembles conventional machining. Fragmentation occurs when material is separated from a surface by a cutting process and the indenting abrasive causes localized fracture of the wear material. These cracks then freely propagate locally around the wear groove, resulting in additional material removal by spalling.

Abrasive wear can be measured as loss of mass by the Taber Abrasion Test according to ISO 9352 or ASTM D 1044.

RESULT AND DISCUSSION:

Effect of orientation on wear

- It is observed that as the orientation of the specimen changes from 0^o to 60^o, the wear mass (Wt. Loss) decreases from 0.798 gm to 0.626 gm when applied load is 5N.
- It is observed that the wear mass follows the same pattern as in graph 6.1.The wear mass decreases from 0.914gm to 0.737gm as the orientation changes from 0^o to 60^o when applied load is 10N.
- Similarly it is observed that wear mass decreases from 0.937 gm to 0.778 gm the orientation of the specimen changes from 0^o to $60^o$when applied loads is15N.

Effect of load on wear

- It is observed that the wear mass increases from 0.798 gm to 0.937 gm as the applied load on the specimen increases from 5N to 15N when orientation of the specimen is 0^o.
- It is observed that the curve follows the same pattern as in graph 6.5.The wear mass increases from 0.750 gm to 0.886 gm as the applied load on the specimen increases from 5N to 15N when orientation of the specimen is 30^o.
- It is observed that the wear mass increases from 0.707 gm to 0.853 gm as the applied load on the specimen increases from 5N to 15N when orientation of the specimen is 45^o.

It is observed that the wear mass increases from 0.626 gm to 0.778 gm as the applied load on the specimen increases from 5N to 15N when orientation of the specimen is 60^o.

CONCLUSION: The study of this experimental analysis is an overview of research work on abrasive wear of selected material at different load. It will give you full information about the abrasive wear, its important factors, and techniques used to minimize the wear of aluminum alloy. On the basis of experimental work the following conclusion can be drawn:

- Maximum wear occur when the test specimen is held at 0^o angle for given applied load.
- Minimum wear occur when the specimen is held at 60^o angle for given applied load.
- As the orientation of the specimen changes from 0^o to 60^o, the wear mass decreases from 0.798 gm to 0.626 gm when applied load is 5N.
- The wear mass decreases from 0.914gm to 0.737gm as the orientation changes from 0^o to 60^o when applied load is 10N.
- Wear mass decreases from 0.937 gm to 0.778 gm as the orientation of the specimen changes from 0^o to 90^o when applied loads is15N.
- Minimum wear occur when load applied on the specimen is 5N for given orientation load.

- Maximum wear occur when applied load is 15N for the given orientation of the specimen.
- When applied load is varied from 5 N to 15N the wear mass increases from 0.798 gm to 0.937 gm for 0^o orientation.
- When applied load is varied from 5N to 15N the wear mass increases from 0.750 gm to 0.886 gm when orientation of the specimen is 30^o.
- When applied load is varied from 5N to 15N the wear mass increases from 0.707 gm to 0.853 gm when orientation of the specimen is 45^o.
- When applied load is varied from 5N to 15N the wear mass increases from 0.626 gm to 0.778 gm when orientation of the specimen is 60^o.

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