A Review On Dry Sliding Wear Analysis On Brass Using Taguchi Technique

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ABSTRACT

In this study, wear behavior of the brass pin (85%Cu, 5%Sn, 5%Pb, 5%Zn) is examine on Pin-on-Disc wear test, which is perform on wear and friction monitor machine. Pin of brass is produce by sand casting process. The EN31 steel disc (hardness 60 HRc and surface roughness 1.6 Ra.) is attach with motor of machine and varying the rotation speed. The Pin of brass is fit in the pin holder of wear and friction monitor machine. An attempt has been made to study the influence of wear parameters like sliding speed (rpm), contact time (second), applied load (N). output parameter of wear is reduction in pin length (µm). We also study change in temperature and friction force. A design of experiments (DOE) is base on the Taguchi techniques. An orthogonal array and the analysis of variance (ANOVA) is employee to investigate the wear behavior. The wear test is measure with linear variable displacement transducer (LVDT).

INDEX TERM : *taguchi technique, wear, DOE, ANOVA,*

I. INTRODUCTION

Brass is nowadays considered as one of the most important copper based alloys. In addition, due to the fact that the amount of zinc in such alloys can vary considerably, ranging from 5 to 45 wt%, a wide variety of brass alloys with different technological properties for various commercial and industrial applications can be produced. In particular, up to date brass alloys have been extensively used in automotive, electronic, energy, construction and marine applications by virtue of their corrosion resistance in non acidic environments, good mechanical properties and fabricability, high thermal and electrical conductivity and low cost. However, during the last decades there is an increasing research interest focusing on the tribological properties of brass alloys[1]. Whenever there is contact between solid bodies, surface phenomena, designated by friction of wear, are developed. By friction we mean the resistance to the relative motion between bodies rolling or sliding, in open or closed loop, with dissipation of energy. The frictional force is a tangential force that is common in the frontier of the bodies in contact. By wear it is understood the progressive lost material of the active surface of a body, by direct action of relative motion in that surface. These are phenomena that, in general, lead to a loss of efficiency of the mechanical components where they occur, with relevant economical implications. This reason led to the development of a large number of studies on these types of problems. Therefore, the precise knowledge of the influence of the mechanical parameters, the sliding velocity, load and the temperature of the contact, the wear and the coefficient of friction, is extremely important.

The techniques of Taguchi consist of a plan of experiments with the objective of acquiring data in a controlled way, executing these experiments and analysing data, in order to obtain information about the behaviour of a given process. These techniques use orthogonal arrays to define the experimental plans. The treatment of the experimental results is based on the analysis average and the analysis of variance (ANOVA)[2].Khaled Elleuch et al, were carried out “Sliding wear transition for the CW614 brass alloy”. They were performed dry sliding wear tests on a CW614 brass alloy using a pin-on-ring configuration. Wear kinetics were measured within a load range of 20–80 N and sliding velocity ranging from 1 to 7 m/s. Chemical compositions, morphologies and microstructures of worn surfaces and wear debris were characterized by scanning electron microscope (SEM) and energy dispersive X-ray spectrometer (EDS). Two main wear regimes have been observed: severe wear and mild wear. The results of wear tests and metallographic investigations on worn surfaces have been summarised in a wear mechanism map. It was found that there is a very close correlation between friction coefficient and temperature rise at the contact. Also, a good correlation is noted especially between wear and contact temperature[3].H. Mindivan et al, were carried out “Microstructures and wear properties of brass synchroniser rings”. In their study, the wear behaviour of synchroniser rings produced from a (α+β) high-strength brass was investigated under dry sliding conditions by pin on disc and reciprocating wear tests.

Pin on disc tests were conducted on M2 quality high speed tool steel and 120-mesh Al2O3 abrasive papers. AISI 52100 quality steel balls were used in reciprocating tests as counterface. A correlation between microstructure, hardness and wear resistance was established for the investigated synchroniser rings. Finaly they found that, An increase of α-phase from 8 to 23 vol.% decreased the hardness from 281 to 250HV and increased the wear resistance. Depending on the type of wear test and counterface, the increment in wear resistance is found in between 15 and 80%[4].Hassan and Al-Dhifi improved the surface roughness and hardness of brass components with the aid of a burnishing process, under different forces and number of tool passes. In addition, they observed that such processes can also improve the wear resistance of the brass components and studied the effect of burnishing force and velocity on the wear characteristics of the same alloy[5].Satpal kundu et al, were carried out "study of dry sliding wear behavior of aluminium/SiC/Al2O3/graphite hybride metal metrix composite using taguchi technique". They made a pin of (Al6061T6/10%Sic/10% Al2O3/5% Graphite MMC) by stir casting process. After that they cut pin from cast with 12mm diameter and 30mm length. For wear test they take input parameter were load, sliding speed and sliding distance and output parameter was weight loss of pin. They examine pin, on pin on disk wear testing machine. During test, the pin was held pressed against a rotating EN32 steel disk (hardness of 65HRC). The design of experiment (DOE) approach using taguchi method was employed to analyze the wear behavior of hybrid composite. Single-to-noise ratio and analysis of variance (ANOVA) were used to investigate the influence of parameter on wear rate. Finally they conclude that (1) Wear rate was highly influenced by applied load, sliding speed and sliding distance respectively and interaction term L*S (Load*Speed) [27.08%] was found most predominant among different interaction parameters. (2) Coefficient of friction was highly influenced by applied load, sliding speed and sliding distance respectively and interaction term L*D (Load*Distance) [18.78%] was found most influencing term among different interaction parameters[6].

A. Baradeswaran et al, were carried out "A Statistical Analysis of Optimization of Wear Behaviour of Al-Al2O3 Composites Using Taguchi Technique". Their work deals with the effect of Al2O3 on wear properties of AA7075 metal matrix composite and the results were optimized by Taguchi technique. The composites were prepared by conventional liquid casting method with varying the Al2O3 content. The wear test was conducted with pin-on-disc apparatus with the controlling parameters were, applied load of 10, 20, 30, and 40N and sliding distance of 1200 m with regular interval of 200m at 0.6m/s sliding speed. The micro structural investigation on the worn surfaces was performed by Scanning Electron Microscope. A statistical analysis of wear test was conducted using Response Surface Methodology, and Taguchi technique under Design of Experiments with Regression Equation using MINITAB software. From these results they conclude that the wear resistance of the composites increased with addition of the Al2O3 particle content. And the coefficient of friction decreases with addition the Al2O3 content, and reaches a minimum of 0.44 at 6 wt. % of Al2O3 composite[7].

S. Basavarajappa et al, were carried out "Application of Taguchi techniques to study dry sliding wear behaviour of metal matrix composites". In this study Aluminium metal matrix composites reinforced with SiC (Al 2219/Sic 15%wt) and graphite (Gr) (Al2219/SiC 15%wt + Gr3%wt) particles was prepared by stir casting process. Dry sliding wear behaviour of the composite was tested and compared with Al/SiCp composite. Experiment was done on pin on disk wear testing machine, where EN32 steel, hardness 65HRc disk was used. Output parameter was weight loss of pin. A plan of experiments based on Taguchi technique was used to acquire the data in a controlled way. An orthogonal array and analysis of variance was employed to investigate the influence of wear parameters like as normal load, sliding speed and sliding distance on dry sliding wear of the composites. After experiment they conclude that (1) adding of graphite partical in aluminium increase wear resistance of aluminium. (2) in SiCp composite sliding distance 57.57%, load 24.34% and sliding speed 6.8% effect on wear.(3) in SiCp-Gr composite sliding distance 57.24%, load 22.58% and sliding speed 9.66% effect on wear[8].Sakip Koksal et al. were carried out "Experimental optimization of dry sliding wear behavior of in situ AlB2/Al composite based on Taguchi's method". A wear rate prediction model for aluminum based composites reinforced with 10 and 30 wt.% in situ aluminum diboride (AlB2) flakes was developed using Taguchi's method by considering the parameters of sliding velocity, normal load, sliding distance and reinforcement ratio. Having produced the in situ reinforced bulk of composite, the final shape of the test samples was given through stir casting process. The wear behavior of the specimen was investigated using pin-on-disk. where the pin sliding against a steel disk (AISI 4140 steel) under different conditions. The orthogonal array, signal-to-noise ratio (S/N) and analysis of variance (ANOVA) were employed to study the optimal testing parameters on composite samples. The experimental results demonstrate that (1) The applied load generated the highest influence on the wear rate while sliding distance was of no significant effect. (2) The specific wear rate was influenced primarily by applied load (58.2%), the amount of reinforcement phase (32.40%), and sliding speed (7.44%). (3)The higher the rate of reinforcement, the better is the ability of the samples to resist wear[9].

R. N. Rao et al, were carried out "Dry sliding wear behaviour of cast high strength aluminium alloy (Al–Zn–Mg) and hard particle composites" Their investigation describes the results of dry sliding wear tests of aluminium alloy (Al–Zn–Mg) and aluminium (Al–Zn–Mg)–10, 15 and 25 wt.% SiCp composite was examined under varying applied pressure (0.2 to 2.0MPa) at a fixed sliding speed of 3.35 m/s.

The sliding wear behaviour was studied using pin-on-disc apparatus against EN32 steel counter surface, giving emphasis on the parameters such as coefficient of friction, rise in temperature, wear and seizure resistance as a function of sliding distance and applied pressure. It was observed that the wear rate of the alloy was noted to be significantly higher than that of the composite and is suppressed further due to addition of silicon carbide particles. The temperature rise near the contacting surfaces and the coefficient of friction followed reversed trend. The wear mechanism was studied through worn surfaces and microscopic examination of the developed wear tracks. The wear mechanism strongly dictated by the formation and stability of oxide layer, mechanically mixed layer (MML) and subsurface deformation and cracking. The overall results indicate that the aluminium alloy–silicon carbide particle composite could be considered as an excellent material where high strength and wear resistance are of prime importance[10].

D. E. Lozano et al, were carried out “Tribological behaviour of cast hypereutectic Al–Si–Cu alloy subjected to sliding wear”. The aim of the their study is to evaluate the wear performance of the new hypereutectic Al–Si–Cu alloy using a pin-on-disk tribometer. For this purpose, samples taken from a V6 aluminium engine blockwere tested. Metallurgical characterization was assessed using Light Optical and Scanning Electronic Microscopy. The wear evaluation was carried out at different loading conditions (10, 30, 50, 120 N), various sliding speeds (0.5, 1.0, 1.5 m/s), and various sliding distances (5, 10, 20 km), under lubricated and unlubricated conditions. After experiment they conclude that, (1) at 30 N force, in presence of lubrication and sliding distance is 5km, wear rate is similar at sliding speed 0.5 m/s, 1.0 m/s, and 1.5 m/s. (2) at 120 N force, in presence of lubrication as sliding speed increase volume loss decrease. (3) at 10 N force, in absence of lubrication, wear rate and coefficent of friction is highest[11].

Feng Tang et al, were carried out “Dry sliding friction and wear properties of B4C particulate-reinforced Al-5083 matrix composites”. Pin-on-disk dry sliding wear tests at sliding speeds ranging from 0.6 to 1.25 m/s and under loads ranging from 3.98 to 6.37MPa (50–80 N) were conducted for pin specimens of composites with Al-5083 matrices reinforced with 5 and 10 wt.% B4C particles. The wear rate of the composite with 10 wt.% B4C was approximately 40% lower than that of the composite with 5 wt.% B4C under the same test condition. Two stages were observed in the reduction of pin length/sliding distance curves in several specimens, with the length reduction rate in the first stage being one to two orders of magnitude lower than that in the second stage. The low length reduction rate in the first stage corresponded with a flat stage with a low coefficient of friction (COF) in the COF/sliding distance curve[12].

S. BASAVARAJAPPA et al, were carried out “Dry sliding wear behavior of Al 2219/SiC metal matrix composites”. The present study deals with investigations relating to dry sliding wear behaviour of the Al 2219 alloy, reinforced with SiC particles in 0–15 wt. % in three steps. Unlubricated pin-on disc tests were conducted to examine the wear behaviour of the aluminium alloy and its composites. The tests were conducted at varying loads, from 0 to 60 N and a sliding speeds of 1.53 m/s, 3 m/s, 4.6 m/s, and 6.1 m/s for a constant sliding distance of 5000 m. The results showed that the wear rates of the composites are lower than that of the matrix alloy and further decrease with increasing SiC content. As the load increases, cracking of SiC particles occurs and a combination of abrasion, delamination, and adhesive wear is observed. The samples were examined using scanning electronic microscopy after wear testing and analysed[13].Tiejun Ma et al, were carried out “Dry sliding wear behavior of cast SiC-reinforced Al MMCs”. Dry sliding block-on-ring wear tests were performed on a squeeze cast A390 Al alloy, a high pressure die cast 20%SiC_ Al MMC, and a newly developed as-cast 50%SiC_ Al MMC. The testing conditions spanned the transition that control the mild to severe wear for all materials. The results show that the sliding wear resistance increases as SiC particle volume fraction increases. The critical transition temperature, at which wear rates transit from mild to severe, also increases with increasing SiC content. Examination of the wear surfaces, the subsurface characteristics, and the wear debris indicate that a hard ‘mechanically alloyed’ layer, high in SiC content, forms on the sliding surface of the 50%SiC composite. This layer prevents the surface adhesion wear mechanisms active in the A390 alloy, and it inhibits delamination wear mechanisms that control the mild wear of the 20%SiC composite. As a result, mild wear of the 50%SiC composite occurs by an oxidation process. In the 20%SiC material, severe wear occurs as a consequence of material removal by a flow-related extrusion-like process. In contrast, the high SiC content prevents plasticity in the 50%SiC composite, which eventually is susceptible to severe wear at very high temperatures (: 450 8C) due to a near-brittle cracking processes[14].

J. Rodriguez, et al, were carried out “Dry sliding wear behaviour of aluminium–lithium alloys reinforced with SiC particles”. Several wear tests were carried out at different pressures and temperatures on Al-8090 and Al-8090 + 15 vol.% SiCp.Worn specimens and debris were also examined using SEM and EDX techniques to identify the dominant wear mechanisms.

Wear rate increases about two orders of magnitude when temperature is above a critical one. The transition from mild to severe wear is dependent on nominal pressure. The composite transition temperature is higher than that of the unreinforced alloy. Within the mild wear regime, the wear rates for both materials exhibit a minimum over 100 ◦C and are higher for the composite material than for the Al-8090 below the transition temperature. It has been also observed that the presence of mechanically mixed layers (MML) on the wear surface with varying morphology and thickness influenced the wear rate. The morphology and composition of the wear debris also change with the wear mechanism[15].Y. Iwai et al, were carried out “Dry sliding wear behavior of Al2O3 fiber reinforced aluminum composites”. Dry sliding wear behavior of die-cast ADC12 aluminum alloy composites reinforced with short alumina fibers were investigated by using a pin-on-disk wear tester. The Al2O3 fibers were 4 mm in diameter and were present in volume fractions (Vf) ranging from 0.03 to 0.26. The length of the fiber varied from 40 to 200 mm. Disks of aluminum±alumina composites were rubbed against a pin of nitrided stainless steel SUS440B with a load of 10 N at a sliding velocity of 0.1 m/s. The unreinforced ADC12 aluminum alloy and their composites containing low volume fractions of alumina (Vf _ 0.05) showed a sliding-distance-dependent transition from severe to mild wear. However, composites containing high volume fractions of alumina (Vf>0.05) exhibited only mild wear for all sliding distances. The duration of occurrence of the severe wear regime and the wear rate both decrease with increasing volume fraction. In MMCs the wear rate in the mild wear regime decreases with increase in volume fraction, reaching a minimum value at Vf=0.09. Beyond Vf=0.09 the wear rate increases marginally. On the other hand, the wear rate of the counterface (steel pin) was found to increase moderately with increase in Vf. From the analysis of wear data and detailed examination of (a) worn surfaces, (b) their cross-sections and (c) wear debris, two modes of wear mechanisms have been identi®ed to be operative, in these materials and these are: (i) adhesive wear in the case of unreinforced matrix material and in MMCs with low Vf and (ii) abrasive wear in the case of MMCs with high Vf[16].

II. EXPERIMENT

In this experiment brass pin with 8 mm diameter and 32 mm length is use that is shown in fig. 1. Chemical composition of brass pin is 85%Cu, 5%Sn, 5%Pb, 5%Zn.

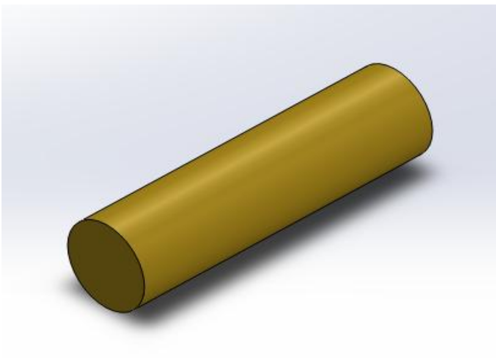

fig. 1. pin of brass

The pin-on-disk test apparatus is apply to the wear and friction monitor machine. It is shown in fig. 2. which is used to investigate the dry sliding wear characteristics of brass. Input parameters are sliding speed (rpm), load (N), contact time (sec). Output parameter of wear is reduction in pin length (μm). In this investigation pin is stationary and disk is rotating at varies speed. Design of experiment (DOE) is prepare by Taguchi technique.

Fig. 2. wear and friction monitor machine

III. CONCLUSION:-

This investigation give information about
1. Influence of wear parameters on wear rate.
2. One best set of parameters where wear rate is very low.
3. change in friction force and temperature as wear parameter is change.

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