OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Analysis of Conditions in Boundary Lubrications Using Bearing Materials

Shinde Sagar Vitthal[1], Ravindra R. Navthar[2]

[1](PG Student, Dept.of Mechanical Engineering, P.D.V.V.P. College, Maharastra, India)
[2](Asst.Prof. Dept.of Mechanical Engineering, P.D.V.V.P. College, Maharastra, India)

Abstract: *In order to clearly establish the tribological potential of these alloys as bearing materials, the tribological parameters of the RAR Zn-Al alloys are compared to parameters of the CuPb15Sn8 lead-tin bronze, as a widely applied conventional bearing material. Existing Bearing of connecting rod is manufactured by using non ferrous materials like Gunmetal, Phosphor Bronze etc.. This paper describes the tribological behavior analysis for the conventional materials i.e. Brass and Gunmetal as well as New non metallic material Cast Nylon. Friction and Wear are the most important parameters to decide the performance of any bearing. In this paper attempt is made to check major tribological parameters for three material and try to suggest better new material compared to conventional existing material. It could help us to minimize the problem of handling materials like Lead , Tin, Zinc etc.After Test on wear machine. Our experimental results are accessing efficient processing in bearing conditions in semantic data representation of extracted related data materials.*

Index Terms: *Friction, Wear, Cast Nylon, Artificial cooling, engine efficiency, Zn-Al alloys, bronze, tribological.*

I. Introduction

The basic motive of such an investigations is of course, of economic nature. Namely, the Zn-Al alloys are characterized by significantly lower price. Besides that, these alloys can successfully be machined by standard casting procedures, like sand casting, centrifugal, permanent and continual casting. Total savings of substitution bronzes with these alloys are estimated up to the level of 35…90%. The concept of application of Zn-Al journal bearings as substitution for the bronze ones is not new. The first experiences are related to the period of the Second World War, when different Zn-Al alloys (before, all with only 30 % Al) were used instead of bronze, primarily due to lack of copper. Besides bearings, the Zn-Al alloys were applied also for other machine elements, like the worm gears, components of hydraulic installations etc.

Special importance in development of Zn-Al alloys during the seventies and eighties has the International Lead and Zinc Research Organization. Based on their investigations and those of other research centers and manufacturers in this area, the Zn-Al alloys for casting were developed, marked as ZA-8, ZA-12 and ZA-27. Realized good carrying capacity and wear resistance enabled application of these alloys, especially for mining equipment and mechanization for tribo-elements, like the sliding radial and journal bearings, various bushings, nuts for the screwed spindles, guides, etc.

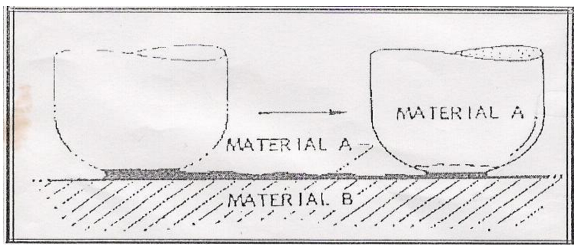

Figure 1: The mechanism illustration of adhesion wear.

There are several theories which were found to explain the phenomenon of adhesion wear, and from that the simple adhesion wear theory. The adhesive wear occurs when two surfaces are moving relatively one over the other, and this relative movement is in one direction or a successive movement under the effect of the load so that the pressure on the adjacent projections is big enough to make a load plastic deformation and adhesion. This adhesion will be at a high grade of efficiency and capability in relative to the clean surfaces, and adhesion will take place between a number of these projections whose sizes will be bigger and the area will be increased during movement. Wear resistance is one of the most important properties that journal bearings should possess. Several studies and investigations have been made in order to improve the wear resistance. The researchers investigate friction and wear behavior of materials because of the adverse effect observed in the performance and life of machinery components. Much of the research reported in the literature was carried out under the atmospheric conditions. However, some tribological behaviors have been recently investigated under the vacuum conditions. Especially, as a result of some new developments in aeronautic, space, electronic, material, metallurgy, chemistry, coating and manufacturing industrial areas necessitate the machinery components to be investigated under the different conditions.

These conditions are accessed efficient lubricants in semantic data progression in mechanical efficiency in recent year generation. Our experimental results show efficient processing between each bridge connection.

II. Back Ground Work

Wear Apparatus:

The rate of wear will be relatively small in most of the machinery and engineering tool, and mostly the value of the change in dimensions is only few microns every year (Halling, 1976), and for measuring wear they are using some apparatuses and instruments which give results about the rate of wear happening in the tools and machinery. From these apparatus which is used in high pressure contact tests where it is able to get very quick results by applying loads on very small areas of contact and to achieve this test there are some different engineering arrangement as shown in Fig.(2), and for each of these tests , the part (A) is the metal subjected to wear, then the measurement of wear will be known by one of the measurement methods.

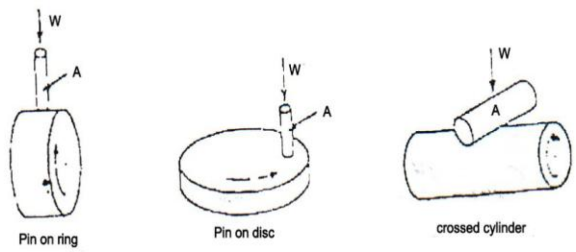

Figure 2: Three common methods to test wear (Halling, 1976).

In the current study the apparatus pin on disc has been used to study the specification of the adhesion wear. **Measurement Methods of wear:** The widely known methods in studying wear, depend on choosing the sliding surfaces, and then measuring, before testing the removal material, and after that, and any change taking place, will be attributed to the resulted wear (Rabinowicz,1965).

III. Boundary Lubrications

Every surface, however, smoothly appears, it will be rough in the microscopic scale and contains a range of tops and lows, and when two surfaces meet then this contact takes place at these projections which are little and relatively isolated; thus when applying a load on these surfaces, then locally there will be a high pressure and heat which will cause overtaking the elastic limits of one surface or both surfaces and the deformation of the projections in a plastic way, so that, the real contacting areas are increased to a limit to support the applied load. The contacting areas are inclined to be damaged under the effect of the relative movements between the two surfaces. The weariness occurs usually at one surface, because of the resistance of the in between surface to breaking and weariness due to the reaction of strain hardness during the adhesion of projections [18]. The removed substance (due to the shearing of projections) will take the shape of small foils which is usually transferred to the opposite surface or it is found separately between the two surfaces. The improvement of wear and corrosion resistance of RPS Ti-TiN coating by mean of thermal oxidation, and they found that the wear and its rate will be less in the specimens which were painted and oxidized and this will increase in the metals already coated without its oxidization also with the chemical corrosion. In the current research the effect of loads, sliding speeds and times on the wear rate for three different materials were investigated. The modeling of friction and wear is an important engineering problem. In the process of design of machine elements and tools operating in contact conditions, engineers need to know areas of contact, contact stresses, and they need to predict wear of rubbing elements. Friction, wear and contact problems are subjects of numerous experimental and theoretical studies. The very complex nature of tribological phenomena is a reason that many problems of contact mechanics are still not solved. The modeling of friction and wear can be carried out not only with the aid of laboratory tests but using also mathematical models and computer simulations. Due to computer simulation techniques, physical and mechanical phenomena in real objects can be reconstructed with a high degree of precision.

IV. Experimetnal Results

4.1. Tested Materials

For the tests there were prepared two types of RAR Zn-Al alloys with commercial marks RAR-12 and RAR-27, cast in ingot mold. RAR-12 and RAR- 27 alloys are in accordance with ZA-12 and ZA-27 alloys defined by ASTM B 669-89. In order to provide a comparative evaluation of RAR alloys, lead-tin bronze CuPb15Sn8 was used. Chemical compositions and physical-mechanical properties of hese materials are given in tables 1 to 3.

4.2. Wear Test Equipment

Tribometric tests were performed on the computer-supported tribometer (fig. 1). Computer support for the experiment was enabled by application of the Burr-Brown PCI 20000 data acquisition system integrated into PC computer and general-purpose

LABTECH NOTEBOOK software package. Based on requirements to realize the contact and relative motion type similarity on model and real system, for tribological modelling of sliding bearing was chosen (in tribometric practice, the most present) pin-on-disc contact scheme with continuous sliding. As in real tribological system bearing/journal, the tribologically critical contact element is the bearing, on the model, the stationary pin corresponds to it, which is due to a small degree of covering tribologically more critical contact element of the contact pair on the model.

Table 1. Chemical composition of RAR alloys.

Chemical elements, %	RAR-27	RAR-12
Al	26.20	14.4
Cu	2.30	1.3
Mg	0.02	0.018
Zn	Remaining	Remaining

Table 2. Chemical composition of CuPb15Sn8.

Chemical element	Percentage content
Cu	76.0
Sn	7.63
Pb	12.31
Others	Remaining

Table 3. Physical-mechanical properties of alloys.

Physical-mechanical properties	Tested materials		
	RAR-27	RAR-12	CuPb15Sn8
Hardness, HB	115	94	90
Tensile strength, MPa	451	305	188.9
Extension, %	16.7	10.2	7.85
Yield strength $R_{p0.2}$, MPa	353	210	131.7
Elasticity modulus, GPa	137.6	1	110
Density, kg/dm^3	5.0	6.1	8.28

In conducted tests pins of cylindrical form were used, with diameter of 2.5 mm, with flat, ground front (contact) surface (nominal contact area 5 mm2), and made of tested bearings materials. Rotational discs of diameter 100 mm were made of construction Chromium-Nickel-Molybdenum steel C 4732 which was thermally treated, having a hardness of 38 HRC. Contact surfaces were machined by grinding, under the same conditions. The machined contact surfaces quality of pins and discs is characterized by roughness at the level of approximately *Ra* = 0.3 µm. The selected wear specimens were tested in conditions of 0.15 m/s sliding speed, 3, 5 and 7 MPa contact pressure, respectively. These parameters provide "p·v" characteristics of 450, 750 and 1050 [kN/m2 (m/s)], that correspond to the typical values of journal bearing applications with boundary lubrication.

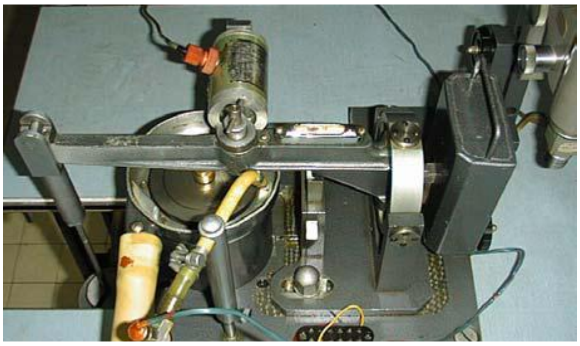

Figure 3: Pin-on-disc testing device.

The tests were performed in conditions of room temperature.

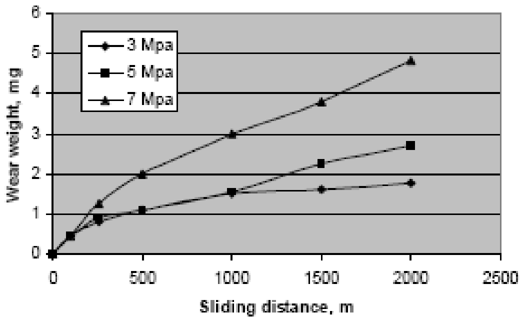

Figure 4: Wear curves of RAR-27 alloy.

The lubricant used for tests was ISO grade 68 hydraulic oil, a multipurpose lubricant recommended for industrial use in plain and antifriction bearings, electric motor bearings, machine tools, chains and gear boxes, as well as high-pressure hydraulic systems. The oil was heated up to 50 °C. Individual tribometric tests for each of combinations of the contact conditions were conducted for 4.5 hours, what corresponds to the friction distance of 3000 m.

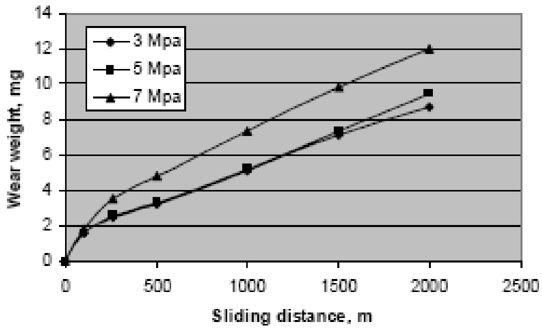

Figure 5: Wear curves of RAR-12 alloy.

The graphical representation of the wear results obtained from the tests for RAR-12, RAR-27 and lead-tin bronze CuPb15Sn8 are shown in figures 4 and 5 The data used for graphs were taken from the average of five measurements. The standard aviation was below 5%. These wear curves represent the functions of the wear mass loss versus the friction distance for the varied levels of pressure. Results of wear tests of CuPb15Sn8 samples obtained by 7 Map of pressure were not accepted as significant, because of a great dissipation of values.

V. Conclusion

The established level of tribological characteristics, both from aspect of wear and aspect of friction, shows that RAR Zn-Al alloys represent respectable tribological materials. Considering the simulated conditions of tribological interactions, the results nominated these alloys as candidates for bearing's materials for conditions of boundary lubrication, that are characteristic for high loads and low sliding speeds. With respect to bronze they have better antifrictional characteristics, higher resistance to wear and lower price costs. bodies decreases the flow stresses of the rubbing materials to a certain extent, which results in an increase in the plastic zone size in the subsurfaces of the rubbing bodies. Consequently, the friction coefficient as well as wear rate increases with increasing sliding speed when the normal load is over certain levels.

VI. REFERENCES

[1.] Blok H. Surface temperature under extreme pressure lubricating conditions. Proc. Second World Petr. Cong. 1937, 3, 471-484

[2.] Block H. Measurement of temperature flashes on gear teeth under extreme pressure conditions. Proc. Instn. Mech. Engrs. 1937, 2, 14-20

[3.] Jaeger, J.C. Moving sources of heat and the temperatures at sliding contacts. Proc. Roy. Sot. N.S.W. 1942, 26, 203-224

[4.] Barber, J.R. Distribution of heat between sliding surfaces, Mech. Eng. Sci. 1967. 9, 351-354 5. **Savaskan T., Murphy S.,** 1987, Mechanical properties and lubricated wear of Zn-Al based alloys, Wear, 116, pp. 211-224.

[5.] **Babic M., Rac A.,** Ninkovic R., 1999, Theory and practice of Zn-Al sliding bearings, Proc. Of. BALKANTRIB'99, Romania, pp. 127-133.

[6.] **Ninkovic R., Babic M., Rac A.,** 2000, Yugoslav Zn-Al Alloys as Bearing Material, Tribology in Industry, no. 1 & 2, pp. 14-18.

[7.] **Rac,A., Babi□, M. and Ninkovi□, R.,**2001, Theory and Practice of Zn-Al Sliding Bearings, Journal of the Balkan Tribological Association, 7, 3-4, pp.234-240.

[8.] **Babic M., Ninkovic R.,** 2004, Zn-Al alloys as tribomaterials, Tribology in industry, Vol. 26, no. 1&2, pp. 3-7.