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A Review on Tribological Wear Behaviour of Journal Bearing on PEEK Composite Material.

Mr. M. G. Deshmukh[1], Prof. V. S. Aher[2]

P.G.Student, AVCOE, Sangamner, India[1]

Professor Department of Mechanical Engineering, AVCOE, Sangamner, India[2]

Abstract: The present experimental study work is aimed at developing a new material for industrial application from product quality and identification surveying sugar factory from nearby areas. It is from that conventional bearing material (gun metal) leads to high wear rate as well as high coefficient of friction. Now a day gun metal is widely used by bearing material but problem with that composite. It subjected to high wear rate that can reduce. Influences of test speed and load values on the friction and wear behaviour of PEEK composite. Friction and wear experiment wear run under ambient condition in a pin-on-disc arrangement. PEEK and its composites used in this investigated the friction coefficient decreases with the increasing load PEEK and composite showed a very low friction coefficient and wear rate increase in the normal applied load sliding distance decreases wear rate. While increasing applied load and sliding distance decreases wear rate with a PEEK and PTFE composite he coefficient of friction is decreases but the trends in wear performance is differ. The specific wear rate PEEK and PTFE composite inclusion followed wear rate continuously decreases for selecting composite. Worn surface wear investigated the friction coefficient and wear rate of PEEK composite decreases gradually with addition of fillers.

Keyword: Wear, Friction, Journal Bearing, PEEK Composite.

I. INTRODUCTION

Composite materials are used in large volume in various engineering structures including spacecrafts, airplanes, automobiles, boats, sports' equipments, bridges, buildings and Industrial. Widespread use of composite materials in industry is due to the good characteristics of its strength to density and hardness to density. The possibility of increase in these characteristics using the latest technology and various manufacturing methods has raised application range of these materials. Application of composite materials was generally use at manufacturing industry. Meanwhile, the automotive industry considered as a mother one in each country, has benefited from abilities and characteristics of these advanced materials. Along with progress in technology, metallic automotive parts are replaced by composite ones.A Properly installed and maintained, journal bearing should have infinite life. It permits a relative motion between the contact surfaces of the members, while carrying the load with little loss of power due to friction. In order to reduce the frictional resistance and wear, and to carry away the heat generated, a layer of fluid which is known as lubricant has to provide to the bearing. Materials used in tribological applications are, for the most part, common materials used for general engineering applications. There are some materials designed specifically for bearings, characterised by high loads, low sliding velocities and large contact area. Polymers are used for dry sliding applications where the soft materials aid for self-lubricating properties. Polymers with such capabilities should be evaluated for precise tribological characteristics such as friction and wear rate. The friction and wear rates are commonly obtained from small scale pin-on-disc mechanical tests are preferred due there low cost or time and easy handling of the test specimens. These methods provide fundamental information about friction and wear mechanisms and are useful for preliminary material classification. However, the global characteristic of material in real scale is unknown unless the commencement of failure in real components.

II. LITERATURE REVIEVE

S. M. Muzakkir, Harish Hirani[1] Experimental investigation has been carried out to identify the effect of grinding direction on the wear of the sliding surfaces subjected to heavy load and low sliding velocity with molybdenum disulphide MoS2 as additive in commercial lubricant. The conformal block and disk test setup has been used to conduct experiments on conformal blocks with two grinding directions: one along the direction of sliding and other across the direction of sliding. The wear of the block is measured as its weight loss after the test. David L. Burris, W. Gregory Sawyer [2] PEEK is a high strength engineering thermoplastic that suffers from a high friction coefficient and a friction induced wear mode. A compositional grading of PEEK and PTFE is implemented in this study to create a bulk composite with the functional requirements of component strength, stiffness and wear resistance while providing solid lubrication at the sliding interface. The tribological performances of three functionally graded PEEK components were evaluated on linear reciprocating, rotating pin-on-disk.

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H. Unal, A. Mimaroglu [3] has studied and explored the influence of test speed and load values on the friction and wear behaviour of pure Poly tetra fluoro-ethylene (PTFE), glass fibre reinforced (GFR) and bronze and carbon (C) filled PTFE polymers. Friction and wear experiments were run under ambient conditions in a pin-on-disc arrangement. Tests were carried out at sliding speed of 0.32-, 0.64-, 0.96- and 1.28-m s_1 and under a nominal load of 5-, 10-, 20- and 30-N. The results showed that, for pure PTFE and its composites used in this investigated, the friction coefficient decrease with the increase in load. Jayashree Bijwe, Sukanta Sen [4] The optimum composition of PEEK–PTFE blends for the best possible combination of mechanical and tribological properties in the adhesive wear mode. Nothing is reported in this context on low amplitude oscillating/fretting wear mode. Moreover, the influence of increasing amounts of PTFE in the blend on abrasive wear behaviour along with a correlation with strength properties is not reported. Hence, in this work, five injection-moulded blends of PEEK with PTFE (in the range of 0–30 wt.%) were evaluated on a pin-on-disc configuration on an SRV Optimol Tester for their tribo-behaviour in the low amplitude oscillating wear mode.

Sung-Won Yoon , Yun-Hae Kim [5]The friction and wear behaviour of carbon fiber and PEEK sheet composites, and the validity of using them as alternatives to the metal-based materials used for artificial hip joints. Moreover, this work evaluated the friction coefficient according to the fiber ply orientation, along with the fractured surfaces of the carbon/PEEK composites. The unidirectional composites had higher friction coefficients than those multidi-rectional composites. Sonam M. Gujrathi, Prof. L.S. Dhamande [6] The research work is aimed at developing a new material for industrial application. From literature review and surveying sugar factories from nearby area, it is found that conventional bearing material (Babbitt and bronze) leads to high wear rate as well as high coefficient of friction. Now a day's pure PTFE (poly tetrafluoroethylene) is widely used as bearing material which is self lubricating and subjects to lower coefficient of friction, but problem with PTFE is that, it subjects to high wear rate, which can be reduced by adding suitable fillers. In this study, the effects of varying load, sliding distance, sliding velocity and filler content in PTFE are experimentally examined. A comparative analysis of three composites (PTFE, PTFE + 25% C and PTFE + 35% C) is presented showing how properties of PTFE can be improved by addition of filler content. A plan of experiment based on Taguchi technique, was performed to acquire data in controlled way. The results of experiments are presented in table which prove that the wear is strongly influenced by the composition of filler content. It was found that, by varying the different parameter like Load, Velocity and Sliding distance the PTFE containing 35% carbon percentage have the better wear performance.

Peeyush Vats, B.C. Sharma [7] A journal bearing is designed for specific application. The bearing is designed according to the data available for the given bearing understudy. This analysis can usually be done with the advanced designed tool like FEA. This papers deal with the theoretical thermal analysis of a journal bearing by showing temperature distribution, heat generated and heat dissipated through the surfaces of the journal bearing. S. M. Muzakkir, Harish Hirani [8] Slow-speed journal bearings subjected to heavy loads operate in a mixed/boundary lubrication regime. Clearance and lubricant play very important roles in reducing the wear and friction in these bearings. In the present article, an experimental study on heavily loaded slow-speed journal bearings with various radial clearances lubricated with three different lubricants is presented. Lubricants with varying viscosities and containing different percentages of anti wear additives have been used. Bearing surface roughness and out-of-roundness are treated as noise parameters. The results of friction coefficient and total wear have been reported. The experimental results suggest that a lubricant with high viscosity and anti wear additives significantly reduces the coefficient of friction and amount of wear under varying bearing clearances, circularity, and cylindricity. The use of such a robust lubricant may obviate the effect of manufacturing uncertainties. This results in reduction of manufacturing and measurement costs.

M. Conte n, A. Igartua [9] A comparative analysis of seven PTFE composites is presented showing how properties of PTFE can be improved even if the most attractive characteristic of low friction is lost due to the presence of hard particles in the polymer matrix. How the use of both soft and hard phases in a polymer matrix enhances the self-lubricating and the load-carrying properties of the matrix improving the tribological properties of the PTFE is presented.

Wojciech Wieleba [10]The state of strain varies in a polymer material during sliding against steel. The reasons for this are, among other things, imperfections of shape of the surface of the contacting steel element and the oscillatory character of the friction force. The viscoelastic nature of polymer materials (considerable internal friction) means that under such conditions a certain amount of friction energy is dissipated in the form of heat inside these materials, contributing to their heating up. For this reason the internal friction for selected PTFE composites has been investigated, as well as the temperature distribution on the surface of PTFE samples sliding against steel under dry friction conditions. It was observed (using a thermo vision system) that the highest temperature occurred inside the polymer material, at some distance from the friction surface. That testifies to the generation of heat during friction, not only on the contact surface of the sliding materials but also inside the polymer material.

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Sung-Won Yoon, Yun-Hae Kim [11]The friction and wear behavior of carbon fiber and PEEK sheet composites, and the validity of using them as alternatives to the metal-based materials used for artificial hip joints. Moreover, this work evaluated the friction coefficient according to the fiber ply orientation, along with the fractured surfaces of the carbon/PEEK composites. The unidirectional composites had higher friction coefficients than those multidi-rectional composites. This was caused by the debonding between the carbon fiber and the PEEK sheet, which was proportional to the contact area between the sliding surface and the carbon fiber. The friction test results showed that there was no significant differences in relation to the fiber ply orientation. However, in a case where the speed was 2.5 m/s, the friction coefficient was relatively large for configuration

Géraldine Theiler, Thomas Gradt [12] Thetribological experiments carried out with polye theretherketone(PEEK), filled with carbon fibres and solid lubricants (poly tetra fluoroethylene (PTFE), graphite or MoS2), against steel discs. Oscillating sliding tests were performed in high vacuum environment in the temperature range between -40°C and +160°C. Results indicate that MoS2 filled PEEK show the best tribological performance in vacuum. Particularly, in the lower temperature range and at higher loads the friction behaviour is improved by the MoS2 content.

Mr. Mankar N.A.Prof. Rijumon K [13] the development and characterization of a new class of hybrid polymer composites consisting of Polyether-ether-keton (PEEK), polytetrafluoroethylene (PTFE), Bronze and MoS2. The effects of various contact temperatures on the tribological properties of PTFE/PEEK composites were studied under dry as well as wet friction conditions. Moreover, the influence of various pressures on the friction and wear behaviors of the PTFE/PEEK composites was investigated. PEEK is a semi-crystalline polymer used as special engineering plastic due to its excellent mechanical capacity, good chemical and thermal stability. PEEK composites are often used as compressor piston rings or valve slices for their outstanding mechanical and thermal performance at high temperature conditions, where PTFE composites may fail to service. However, high friction coefficient and wear rate of pure PEEK limit its wider use many researchers found that PEEK is good in mechanical characteristic but less good performances of tribological properties. However PTFE shows better performances of tribological properties. The effect on the friction and wear behaviors of PEEK polymer composites has been improved, with addition of PTFE at room temperature. There are various operation performed in industry by different machine parts such as high pressure compressor, bearings, impeller etc. which causes wear due to heavy loading conditions and at ambient temperature.

III. METHODOLOGY AND MATERIAL

1. TAGUCHI TECHNIQUE

The Taguchi technique is a powerful design of experiment tool for acquiring the data in a controlled way and to analyze the influence of process variable over some specific variable which is unknown function of these process variables and for the design of high quality systems. This method was been successfully used by many researchers in the study of wear behavior of PEEK composites materials. Taguchi creates a standard orthogonal array to accommodate the effect of several factors on the target value and defines the plan of experiment. The experimental results were analyzed using ANOVA to study the influence of parameters.Taguchi technique is a powerful tool for the design of high quality systems. It provides a simple efficient and systematic approach to optimize designs for performance, quality and cost. The methodology is valuable when design parameters are qualitative and discrete. Taguchi parameter design can optimize the performance characteristics through the setting of design parameters and reduce the sensitivity of the system performance to source of variation. This technique is multi-step process, which follow a certain sequence for the experiments to yield an improved understanding of product or process performance.

2. EXPERIMENTAL DETAILS

2.1 Materials

In this experiment PEEK Composites material pin with 10 mm diameter and 30 mm length is use that is shown in fig. 1

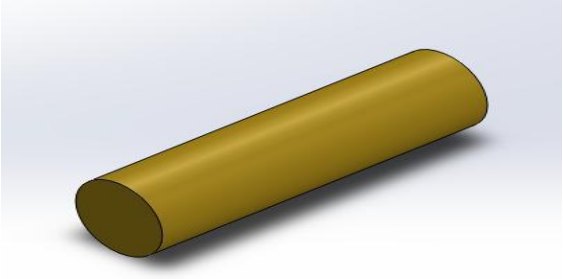

Fig. 1.Pin of PEEK Composites

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Chemical composition of PEEK Composites materialin Table 1. The material were compounded by injection moulding standard test bar.

Table 1.Composition of the material (Vol %)

Material	PEEK	PTFE	C.F.	Bronze	MoS2	G.F.
A	60	15	15	10	-	-
B	60	15	15	-	10	-
C	60	15	15	-	-	10

2.2 Test Parameters

Pin on Disc friction and wear monitor TR 20L is used to investigate wear characteristics of PEEK composites as per ASTM G 99 standards. The disc used is EN-31 stainless steel with hardness 60 HRC, 140mm trac diameter and 8mm thick, with surface roughness of 0.3Ra. Complate arrangement of Experimental set up is shown in fig.2. below.

Fig. 2. Pin on disc Set Up

IV. WEAR TESTING

The TR-20LE Pin on disc wear testing machine represents a substantial advance in terms of simplicity and convenience of operation, ease of specimen clamping and accuracy of measurements, both of Wear & Frictional force. The machine is designed to apply loads up to 200N and is intended both for dry and lubricated test conditions.

Load:- It is a common knowledge that the friction force is proportional to the normal applied load (the first law of friction).Load is applied through the lever and the pulley arrangement. Considering the pressure of 38.67 N/mm²to 49.21 N/mm² in the application between sugar mill journal & bearing in this particular experimental set up is applied by the weight of 13.63Kg to 17.63 kg.

Velocity: It is agreed that the friction force is independent of the sliding velocity. This proposal is valid with a good approximation only in the case where the contact temperature varies insignificantly and, as a result, the interface does not change its behaviour. The unit is equipped with a 1.5 HP, variable speed motor with a ± 0.5% accuracy (full scale) configured for 220 V, single phase, 50 Hz. The motor drives the upper vertical shaft on which the base disc is placed. The speed is controlled using control potentiometer with speed ranges from 80 to 2000R.P.M. Considering the rotational speed of journal as 4.5 R.P.M. with 1000 mm diameter the linear velocity is around of 0.235m/s. The same was achieved in this particular experimental setup by varying the distance of pin from the center of disc (radius of rotation) and by varying the R.P.M.

Temperature: Polymers as viscoelastic materials are very sensitive to frictional heating. It is well known that friction is a typical dissipative process in which mechanical energy is converted into heat. The thermal state of friction contact is frequently a decisive factor when evaluating the performance of a friction unit. In this particular experimental work no such facilities were available for the test rig. The room temperature during the test condition was kept about 27°C.During the test the environmental temperature can be recorded.

Contact Area: Contact area between the pin and disc Contact area between the pin and disc is 58.265 mm². (Diameter of pin is 10 mm.)

Sliding Distance: Sliding distance was constant throughout the experiment for different mating surfaces for all conditions.

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V. CONCLUSION

The Tribological concepts have been successfully applied in developing a new design of the sugar mill journal bearing which was able to operate in mixed lubrication of the bearing as well as the journal from the analysis of the dry sliding wear of the PEEK composites

1. PEEK composites have much good mechanical and Tribological properties as compare to plain PEEK.
2. Wear rate is directly proportional to load applied.
3. Coefficient of friction is inversely proportional to the load applied.
4. Wear increases as roughness of counter surface increases.
5. Change in friction force & temp. As wear parameter is change.

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