Analyzing the bearing properties by using composite materials

Mr. Chavan Pruthviraj B.#1, Dr. Navthar Ravindra. R.*2

 # P.G. Student, Department of Mechanical Engineering,

Dr. Vithalrao Vikhe Patil College of Engineering, Ahmednagar, Maharashtra-414111, India

** Professor, Department of Mechanical Engineering,*

Dr. Vithalrao Vikhe Patil College of Engineering, Ahmednagar, Maharashtra-414111, India

---***---

Abstract:- *This Study assesses the impact of autonomous parameters, for example, typical load(A), sliding distance(B), velocity(C), filler content (D) on wear execution of Molybdenum Disulphide (MoS2) strengthened with Polytetrafluoroethylene (PTFE) composites utilizing a measurable approach. Dry sliding wear tests is to lead utilizing a standard Pin on circle test setup following an all around arranged exploratory to limit the wear rate were resolved. It was discovered that the incorporation of MoS2 has significantly enhanced the wear obstruction property of the composites. Sliding separation (B) was observed to be the most critical factor influencing the wear rate took after by typical load (A), while filler content (D) if there should be an occurrence of Coefficient of contact.*

Key words: Composites, PTFE, MoS2, Coefficient of friction, Wear rate, Pin on disc tribometer.

1. INTRODUCTION

Bearing materials are extraordinary sort of materials, which convey a moving or pivoting part with slightest erosion or wear. One of the vital troubles in building up a decent bearing material is that the two essentially clashing necessities are to be fulfilled by a decent bearing material. The material must be delicate with to a great degree low shear quality and also it must be sufficiently solid to help substantial dynamic burdens. This is for the most part accomplished either by having an orientation material with a metallurgical structure innately fusing both hard and delicate constituents.

In an extensive number of general designing practices where greasing up conditions are moderately poor and administration conditions are not exceptionally demanding, thick strong course are utilized with a duplex structure. The kind of bearing relies upon the heap, speed and the working conditions in which it is to be utilized.

Thus, because of the relative delicate quality of PTFE, it is normal that its heap conveying capacity and its wear opposition may be expanded by the expansion of reasonable fillers. As needs be, a few fillers attempted in blend with this plastic including graphite, fiber glass, dental silicate, silicon, titanium of dioxide, silver, copper, tungsten and molybdenumdisulphide.

2. LITERATURE REVIEW

Koji Kato et al explained the Soft or hard film coating, multi-phase alloying and composite structuring have been developed to control wear and friction by improving materials and surfaces with some aspects for better properties of friction and wear. On the other hand, it is well recognized recently that the coefficients of friction and wear are not material properties but two kinds of responses of a tribo-system. They are always reasonably related with each other when the necessary functions of the tribo-system are well considered. Typical wear behaviors of representative materials of coatings, composites, metallic alloys and ceramics are reviewed in relation to their friction behaviours, and fundamental mechanisms of wear are confirmed for the technical development of wear control. Friction and wear are responses of a tribo-system. Friction and wear, as two kinds of responses from one tribo-system, must be exactly related with each other in each state of contact in the system, although a comprehensive simple relationship should not be expected. The purpose of this paper is to come to the general understanding of wear mechanisms by reviewing the characteristics of wear and friction of very different materials. For the technical development of wear control in the near future, the characteristics of wear of coatings, composites, metallic alloys and ceramics were reviewed in relation to their frictional characteristics. [1]

David L. Burris et al, explained in this paper PEEK filled PTFE composite that exhibits low friction and ultra-low wear. The lowest average friction coefficient of μ = 0.111 was obtained for three samples having a PEEK wt. % of The composite has a wear rate lower than unfilled PTFE and PEEK for every sample tested. The lowest wear rate of $K=2\times10^{-9}$ $mm^3/(Nm)$ was obtained for a 32 wt. % PEEK filled sample. This sample was 900 times as wear resistantas the unfilled PEEK and 260,000 times as wear resistant as the unfilled PTFE. Samples having PEEK content greater than 32 weight% had no wear transients. The wear rates were observed to increase with increasing PEEK content approaching that of unfilled PEEK. [2]

Talat Tevrüzet al, explained in this paper the coefficient of friction and the wear are strongly influenced by the thickness and composition of these films depending on the adhesion between steel and composite surfaces, the cohesive properties of the polymer used, pressure and the sliding distance. Taking into consideration the large number of factors, and their widely fluctuating characters and effects on the friction and wear; an optimum bearing construction may only be through experiments. [3]

Yunxia Wang et al, explained in this paper the PTFE-based composites containing 15 vol.% MoS2, graphite, aluminium and bronze powder, were respectively prepared by compression moulding at room temperature and subsequent heat treatment in atmosphere. Transfer films of pure PTFE and these composites were prepared on the surface of AISI-1045 steel bar using a friction and wear tester in a pin on disk contacting configuration. Tribological properties of these transfer films were investigated using another tribometer by sliding against GCr15 steel ball in a point-contacting configuration. Morphology of the transfer films and worn surface of the steel ball were observed and analysed using SEM and optical microscopy. It was found all these fillers improved wear resistant capability of the composites. Compared with pure PTFE, introduction of the fillers made the corresponding transfer films have longer wear life. This is mainly attributed to strongly adhering transfer film and smaller wear debris particles lead by addition of the fillers. These smaller debris particles are prone to stay longer at the contacting region during the friction process. Introduce of fillers is helpful to improve load bearing capability of the transfer films when sliding against steel ball which are also favourable to prolong the wear life of the transfer films. Tribological properties of these transfer films are sensitive to load change. Generally, increased load shortened wear life of transfer film. [4] **Wojciech Wieleba et al,** explained in this paper 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. Both thermo vision investigations and computations demonstrated the essential role that internal friction plays in polymer materials during their sliding against metals. The amount of energy dissipated as a result of internal friction during the cyclic strain of PTFE composites is sufficient to heat up the polymer material by about 12 °C. Though a computation of the amount of energy dissipated is approximate because of the assumptions made; it reflects the importance that internal friction has in the process of heat generation in polymer materials during sliding against metals. The imperfections of the surface of the steel element and the oscillatory character of the friction force contribute to the formation of a variable state of strains in the polymer material during its rubbing against steel. Combined with a high value of internal friction for these materials it causes additional internal heating of the polymer material. The result is the occurrence of a region of increased temperature inside the polymer material, at some distance under the sliding surface. Because of the low thermal conductivity of polymers, this area remains present all the time during the friction process of a sliding couple polymer–metal. Determination of the dependence between the parameters describing the surface roughness together with the errors of shape and the amount of internal heat generated in the process of polymer friction requires further detailed investigations. [5].

C.G. Dunckle et al, presented investigations on the tribological behaviour of PTFE composites against steel at cryogenic temperatures. It can be stated that thermal properties of the cryogenic medium have a significant influence on the tribological performance of the polymer composites. The generation of a gaseous film around the friction contact decreases significantly the cooling ability of the environment. Therefore, the effect of the low temperatures on the material properties was more clearly detected at low sliding speed, with a change in wear mechanism from adhesive to abrasive. Chemical analyses show the presence of iron fluorides down to 4.2 K. The XPS results suggested that these fluorides lay directly at the surface of the disc and are covered by a layer of PTFE. No influence of the metal fluorides on the tribological performance could be determined here, but results from other works suggest we should pursue these investigations. [6]

S. Manjunath Yadav et al, studied the influence of wear parameters like applied load, sliding speed, sliding distance on the dry sliding wear of polytetrafluroethylene (PTFE),PTFE + 25% glass and PTFE + 40% bronze composites. Experiments, based on the techniques of Taguchi, were performed to acquire data in a controlled way. An orthogonal array and the analysis of variance were employed to investigate the influence of process parameters on the wear of composites. The worn surfaces were examined using scanning electron microscope (SEM). The experimental results show that sliding distance and applied load were found to be the more significant factors among the other control factors on wear. The objective is to establish a correlation between dry sliding wear of composites and wear parameters. These correlations were obtained by multiple regressions. [7]

2.1 SUMMARY OF LITERATURE REVIEW:

In all above papers studied by different authors analyze the performance of bearing material in all varying conditions is limited to kind of three different compositions.

We are composing the fourth one material having 80% of PTFE with 20% of MoS2 and analyzing that whether the graph of coefficient of friction against increased percentage of MoS2.

3. OBJECTIVES OF PRESENT WORK

MoS_2 is considered as a filler material and is added to PTFE. It gives good sliding and wear characteristics, good thermal conductivity, low coefficient of friction and high pressure resistance. MoS2 has high wear resistance & relative hardness. When it is filled in PTFE it will reduce the wear rate. While forming the composite, it may increase the frictional resistance, but reduction in wear rate might have greater influence. Hence, problem is defined as follows:

To improve properties tribological of bearing material of plain PTFE & Analysis of composites PTFE material i.e. when 5%, 10%, 15% and 20% MoS_2 is filled in it, using wear testing machine.

3.1 OBJECTIVES:

1) To find the effect of MoS_2 filler in PTFE.

2) To select optimum weight percentage of filler in base material to enhance its tribological properties.

3) To Study the wear behaviour of the selected materials and obtained coefficient of friction under the experimental conditions.

Thus, above are the different objectives of given project work.

4. PROPOSED METHODOLOGY

In the field of designing application metal to metal contact regularly happens amid relative movement of pivoting parts and these are subjected to wear and grinding. We will examine wear and contact attributes of bearing material with the assistance of "Wear Testing Machine".

The distinctive test strategies are utilized to reenact and think about the wear in genuine circumstance. The accompanying parameters in functional issues are recreated in the exploratory techniques:

1) Geometry of reaching surfaces

2) Materials for two reaching surfaces.

3) Lubricants

4) Sliding speed.
5) Load

Based on geometry of reaching surfaces we chose stick on plate strategy the rule of which is appeared in figure.

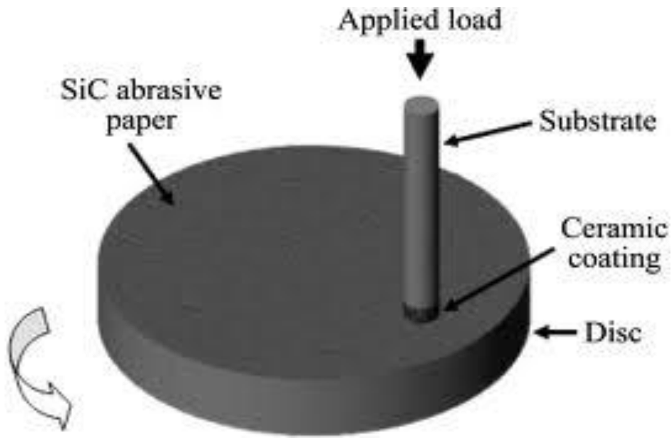

Fig -1: Pin on disc

Outline of trial is the effective investigation apparatus for demonstrating and breaking down the impact of the control factors on the execution yield. The most vital stage in the outline of investigation lies in the determination of the control factors. We completed the trial think about on Pin on plate set up.

5. EXPERIMENTAL STUDY

Experiment can be defined as the test or series of test in which forceful changes are made on input variable in order to obverse & analyze the changes in output parameter. In order to reduce the wear rate various filler materials are added to PTFE and these composites are tested on wear testing machine. Here is the brief introduction of wear testing machine.

5.1 WEAR TESTING MACHINE

In stick on-circle tribometer "TR-20", a level stick is stacked onto the test with a decisively known weight of 17.63 gr. The stick is mounted on a hardened lever, composed as a frictionless power transducer. The diversion of the profoundly firm flexible arm, without parasitic grinding, safeguards an almost settled contact point and along these lines a steady position in the erosion track. The grating coefficient is resolved amid the test by estimating the redirection of the flexible arm. Wear coefficients for the stick and plate material are computed from the volume of material lost amid the test. This basic strategy encourages the investigation of grinding and wears conduct of relatively every strong state material blend with or without oil. Moreover, the control of the test parameters, for example, speed, contact weight and differing time enable a nearby proliferation to the genuine states of viable wear circumstances.

It likewise encourages investigation of erosion and wear qualities in sliding contacts under wanted conditions. Sliding happens between the stationary stick and a turning plate.

Ordinary load, rotational speed and It wear track breadth can be shifted to suit the test conditions.

Digressive frictional power and wear are observed with electronic sensors and recorded on PC.

These parameters are accessible as elements of load and speed.

Particulars of pin on disk tribometer:

- Manufacturer : Magnum Engineering, Bangalore
- Pin Size :3 to 12 mm diagonal
- Disc Size :160 mm dia. X 8 mm thick
- Wear Track Diameter (Mean) :5 mm to 70 mm
- Sliding Speed Rang :0.25 m/sec. to 10 m/sec.
- Disc Rotation Speed :80 – 3000 rpm
- Normal Load :250 N max.
- Friction Force :0-250 N, digital readout
- Wear Measurement Range :4 mm, digital readout
- Power :230 V, 15A, 1 Phase, 50 Hz

SPECIFICATION OF PIN

- Materials : PTFE & MoS_2
- Filler content : 5, 10, 15 & 20%
- Pin diameter :12 mm
- Pin length :30 mm

SPECIFICATION OF DISC

- Manufacturer : Magnum Engg.
- Material :EN 32
- Disc Dial :160 mm
- Thickness : 8 mm

EN32 is low tensile strength steel suitable for lightly stressed components. Its constituents are:

Table -1: Constituetnts of EN32

Constituent	Percentage	Constituent	Percentage
Carbon	0.10-0.18%	Phosphorous	0.05% max
Manganese	0.60-1.00%	Sulphur	0.05% max
Silicon	0.05-0.35%		

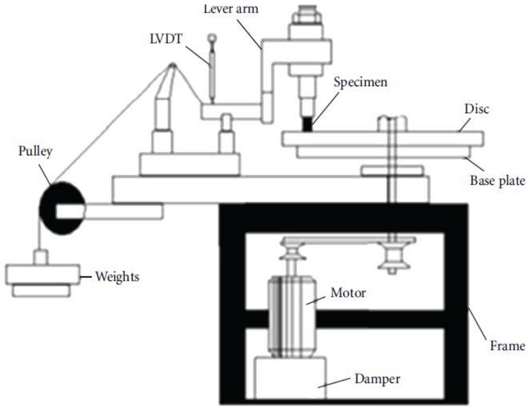

Fig -2: Experimental set up

5.2 VARIABLES IN WEAR TESTING

1) Velocity
2) Load
3) Contact Area
4) Surface Finish
5) Sliding Distance
6) Material

The TR-20 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.

5.2.1 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.

5.2.2 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.

Table -2: Assigning of levels to the variables

Level	Low	Medium	High
Load, (Kg) (A)	1	2	3
Speed (RPM) (B)	300	600	900
Sliding distance (cm) (C)	20	40	60

Table -3: Assigning code for four PTFE materials

Material	Chemical Composition in Wt.%
I	PTFE + 5% MOS2
II	PTFE + 10% MOS2
III	PTFE + 15% MOS2
IV	PTFE + 20% MOS2

5.2.3 Sliding Distance

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

6. DESIGN OF EXPERIMENT

It is approach in view of insights and other teach for touching base at a proficient and powerful arranging of tests with a view to get legitimate conclusion from the investigation of trial information. Outline of analyses decides the example of perceptions to be made with at least test endeavors. To be particular Design of examinations (DOE) offers an efficient way to deal with think about the impacts of different factors/factors on items/process execution by giving a basic arrangement of investigation in an outline framework. All the more particularly, the utilization of orthogonal Arrays (OA) for DOE gives a productive and successful technique for deciding the most noteworthy elements and associations in a given outline issue.

Outline of examination is a procedure to get the most extreme measure of decisive data from the base measure of work, time, vitality, cash, or other restricted assets. The data by and large includes the connection amongst item and process parameters and the coveted execution qualities. Taguchi's systems, Statistical relapse investigation, Minitabs, M. S. Exceed expectations are one the effective devices utilized as a part of the plan of investigations. Taguchi's parameter configuration can streamline the execution qualities through the setting of plan parameters and lessen the affectability of framework execution to the wellsprings of variety. Taguchi's trial strategy has been effectively connected for parametric evaluation in dry sliding wear investigation of polymer composites.

The benefits of Experimental outline are:

1. Improved process yields.
2. Reduced fluctuation and nearer conformance to the ostensible or target necessities.
3. Reduced advancement time.
4. Reduced general expenses.

Uses of Experimental outline in the Engineering Design are:

1. Evaluation and correlation of essential outline designs.
2. Evaluation of material choices.
3. Selection of plan parameters with the goal that the item will function admirably under a wide assortment of field conditions so the item will be vigorous.
4. Determination of key item plan parameters that have affect on the item execution.

Stages for planning Experiments are as recorded beneath:

1. Recognition of an announcement of the issue
2. Choice of components, levels and range
3. Selection of the reaction variable
4. Choice of exploratory outline
5. Performing the trial
6. Statistical examination of Data
7. Conclusions and suggestions

Exploratory outline is a basically imperative instrument in the Engineering scene for enhancing the execution of the assembling procedure.

7. CONCLUSION

From the above experiment, we will conclude about the followings.

1. Wear rate is directly proportional to load applied.
2. Coefficient of friction is inversely proportional to the Load applied.
3. White metal gives less wear rate as compared to other material when tested under similar working condition.
4. Coefficient of friction of white metal is very high as compared to other material when tested under similar working condition.
5. Pure PTFE gives very high wear rate as compared to composite PTFE.
6. Composite PTFE has much good mechanical and thermal properties as compared to plain PTFE.
7. Wear increases as roughness of counter surface increases.

REFERENCES

1. Koji Kato, “Wear In Relation To Friction a Review”, Wear 241 (2000). Page no. 151–157.
2. David L. Burris, W. Gregory Sawyer, “A Low Frictional and Ultra Low Wear Rate PEEK/PTFE Composite”, Wear 261, (2006) Page no. 410-418.
3. Talat Tevrüz, “Tribological Behaviors of Carbon Filled Polytetrafluroethylene (PTFE)Dry Journal Bearings”, Wear 221, (1998), Page no. 61–68.
4. Yunxia Wang ,Fengyuan Yan, “Tribological Properties Of Transfer Films of PTFE-Based Composites”, Wear 261 (2006) page no. 1359–1366.
5. Wojciech Wieleba, “The Role of Internal Friction in The Process of Energy Dissipation During PTFE Composite Sliding Against Steel”, Wear 258 (2005) page no.870–876.
6. C.G. Dunckle, M.Aggleton J. Glassman,P.Taborek, “Friction of Molybdenum Disulfide–Titanium Films Under Cryogenic Vacuum Conditions”, vol. 44(2011), page no. 1819-1826.