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Review on the Tribological Properties of PPS Composite Filled with various Additives for Journal Bearing of Sugar Mill

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Abstract: ***In gift paper the premature failure of journal bearings encountered in sugar mills has been analyzed. The of bearing failure square measure known by simulating the in-operation conditions and conducting controlled experiments on a totally automatic bearing check Rig (Pin on Disc) with provisions for varied combination (i.e. load, speed, and sliding velocity) of operating conditions. The results of performance behavior (i.e. coefficient of friction, modification in surface roughness and weight loss) of the bearings as ascertained in these experiments are according. The experimental results indicate the existence of boundary lubrication conditions in sugar mill journal bearings. The main objective of this paper is to study the influence of wear parameters like rotating speed, load and wear track on the wear rate and coefficient of friction of bronze. The tribological properties of bronze was measured and best parameters is obtained which supplies us minimum wear. For that matter we use the base materials is PPS and filled with Mos2, CF & Bronze for further testing with various composition.***
Keywords: Pin on Disc, bearing, PPS, CF, friction and wear

I. INTRODUCTION

Tribology is that the science of rubbing surfaces in relative motion. It is the study of the friction, wear and lubrication of engineering surfaces with a read of understanding surface interactions thoroughly so prescribing enhancements in given applications. One of the important objectives in tribology is the regulation of the magnitude of frictional force according to whether we require a minimum or a maximum. This objective can be understood only after a fundamental understanding of the frictional process for all conditions like load, sliding velocity, lubrication, surface finish, temperature and material properties.

Now a day there has been a significant growth in the large-scale production of polymers and polymer matrix composites. Polymer composites mostly used as structural components that are very often subjected to friction and wear loadings under use. In some situations, the coefficient of friction is of the highest importance, but mostly the mechanical load-carrying capacity and the wear life of components that determine their acceptability in industrial applications under different operating conditions.

Sr.No.	Materials
1	Polyphenylene sulfide (PPS)
2	Carbon Fiber (CF)
3	Molybdenum disulfide (MoS2)
4	Bronze (BZ)

Table no 1: list of materials

PPS and various composites against MOS2 filled distilled water were comparatively investigated by considering the parameters like loads and sliding velocity of existing bearing of motor. Wear tests are carried out by rubbing the test pin of PPS composites against stainless steel disc surface in wet condition using a pin-on-disc Tribometer.

The influence of normal load, percentage of Mos2 in distilled water and percentage of carbon fiber is discussed in results and discussion.

II. LITERATURE REVIEW

S. M. Muzakkir, Harish Hirani, G.D. Thakre, M. R. Tyagi Present the paper on Tribological failure of journal bearing of sugar mill (2011). The aim of research that avoid the failure of bearing and the neglect the wear by using various boundary condition [1]

Anuj kumar, Dr. S. S. Sen presented paper on to study Tribological effect of bearing materials (2016). The main objective of this paper is studying the influence of wear parameters like rotating speed, load and wear track on the wear rate and coefficient of friction of brass. The tribological properties of brass were measured and best parameters is obtained which gives us minimum wear. [2]

Harbansh singh, M. H. Sethi, O.S. Bhatia Present paper on Wear rate analysis of hydrodynamic journal bearing in different condition (2014). The main objective of this paper is wearing rate of white metal is more than the brass and also the frictional force is more observed in case of brass materials. [3]

N. D. Patil, P. P. Awate present paper on Design development of bearing failure project set up (2018). The aim of the project is Production of bearing industries are of high value which leads to the aspects of bearing life & application in more demanding situations. [4]

Satish C. Sharma, Vijay Kumar, S. C. Jain, R. Sinhasan, M. Subramanian Present paper on A study slot-entry hydrostatic/hybrid journal bearing using the finite element method (1999). The aim of paper is the comparative study indicates that asymmetric slot-entry journal bearings provide an improved stability threshold speed margin compared with asymmetric hole entry journal bearings compensated by capillary, orifice and constant flow valve restrictors. [5]

Sachin Shelke, Pradnya Kosbe Present paper on Failure analysis of bearing cup (2015). The main aim of this paper is the methodology adopted for finalizing the solution to this problem by means of the wear Test analysis And FEA analysis supported by logical reasoning. Various Heat Treatment processes are compared and it was found that Carbonitriding process is the optimum solution which will reduce the failure of bearing cup as well as reduce the overall manufacturing cost. [6]

Peng Liang, Changhou Lu, Wei Pan, Shiyi li Present paper on A new method for calculating the static performance of hydrostatic journal bearing (2014). The aim of paper is the results indicate that new analytical method has the advantage of simplicity and high computational accuracy. [7]

Din Zhang, Huimin Qi, Fuyan Zhao, Ga Zhang, Tingmei Wang, Qihua Wang Present paper on tribological performance of PPS composite under diesel lubrication conditions (2017). The main objective of this paper is solid lubrication of tribofilm and liquid lubrication of diesel, the hybrid nanocomposite exhibited the best tribological performance. [8]

Karen Stoeffler, Stefan Andgelic, Nathalie Legros, Judith Roberge, Steen B. Schougaard Present paper on PPS composite reinforced with recycled carbon fiber (2013). The main aim of this paper is the PPS composite reinforced with recycled carbon fibers exibit similar or better mechanical properties than equivalent commercial compound produced using industrial grade short virgin fibers. [9]

W.J.B. Grouve, L.L.Warnet, B.Rietman, H.A. Visser, R. Akkerman Present paper on Optimization of the tape placement process parameter for carbon-PPS composites (2013). The main objective of this paper Low interfacial fracture found for extremely high tape temperature. [10]

III. PROBLEM STATEMENT

India is the largest sugar producing country in the world & sugar industry in India is the second largest manufacturing industry. Presently Indian sugar industries are operating at different cane crushing capacity ranging from 1000 to 10,000 tons per day. In sugar trade juice from sugar cane is extracted in edge section. The sugar mills use number of running components fabricated with ferrous and non-ferrous alloys which requires frequent or continuous lubrication. These mills often suffer from corrosion related problems which in turn results in the need for large maintenance, thereby increasing the production cost. Now there is a scope to reduce the cost of sugar production and increase the efficiency of the sugar mills by replacing some of the conventional material components by those of newly developed light weight composites.

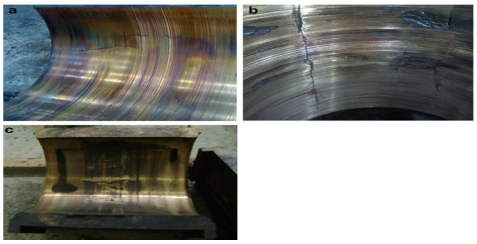

Fig:1 photograph of failed journal.

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IV. OBJECTIVE

Following are the objectives of the project work,

A. To suggest the best suitable self-lubricating PPS composite material for the journal bearing applications from the tested PPS composite materials for the existing hydrostatically lubricated gun metal or brass journal bearing used for Rolling mills.
B. To find out the behavior of the new composite material from wear & friction point of view and the effect of various sliding speeds and loads on it.
C. To develop relationship of total wear with the applied normal load, sliding velocity and percentage of by mathematical modelling using regression analysis.

V. METHODOLOGY

Design of experiment carried by Taguchi Technique with the help of Minitab software.
For the evaluation of tribological characteristic of materials under study is to be carried out on pin on disc apparatus.

A. Specimen Preparation
Specimens are used are as follows
a) *Pin:* Composite materials (PPS+CF+MoS2+Bz)
b) *Disc:* Forged Steel
1) *Polyphenyl Sulfide (PPS)*
a) Polyphenyl sulfide (PPS) is a partially crystalline, high temperature performance polymer.
b) This polymer has a high melting point of approximately 280°C.
c) Excellent chemical resistance and is inherently flame retardant.
d) Very low moisture absorption.
e) Excellent dimensional stability under most environmental conditions.
2) *Carbon Fiber (CF)*
a) High Strength to weight ratio.
b) Corrosion resistance
c) Fatigue Resistance
d) Fire Resistance/Not flammable
3) *Molybdenum Disulphide (MoS2)*
a) very good chemical stability and thermal stability.
b) It possesses a low friction coefficient, good catalytic activity, and excellent physical properties.
4) *Bronze (Bz)*
a) Versatile physical, mechanical, and chemical properties.
b) Corrosion resistance.
c) The melting point of bronze varies depending on the ratio of the alloy components and is about 950 °C.
d) Bronze is usually nonmagnetic, but certain alloys containing iron or nickel may have magnetic properties.

B. Taguchi Technique
A full factorial design will identify all possible combinations for a given set of factors if an experiment consists of m number of factors & each factor at levels, then number of trails possible (Treatment Combination) = Xm
As the Number of Factors Considered at Multi-Levels Increases, It Becomes increasingly Difficult to Conduct the Experiment with All treatment combination to reduce the number of experiments to practical level, only a small set from all the possibilities is selected. The method of selecting a limited number of experiments in which effect of applied load and distilled water filled with Mos2 as lubricant on tribological properties of PPS + variation of % Bronze and carbon fiber for wet condition produces the most information, is known as a practical fractional experiments , but there are no general guidelines for fractional experiments that cover many applications. This method uses a special set of arrays called orthogonal arrays. These standard arrays stipulate the way of conducting the minimal number of experiments, which could give the full information of all the factors that affect the performance parameters. The crux of the orthogonal array's method lies in choosing the level combinations of the input design variables for each experiment.

1) Selection Parameters

Sr.No	Process Parameters	Range	Level 1	Level 2	Level 3
1	Load	100 - 120 N	100	115	120
2	Sliding Velocity	0.10 - 0.20 m/s	0.10	0.15	0.20
3	% of CF	15 - 25 %	15	20	25

Table no 2: Process parameters with their values at corresponding levels

2) Taguchi Method of Orthogonal Arrays

Parameters: 03

a) Load- e.g. X, Y, Z

b) Sliding Velocity- e.g. A, B, C

c) Percentage of CF- e.g. L, M, N

Here there are total three levels for each parameter.

Therefor refer Taguchi table of orthogonal Arrays L9.

Experiments	Load(N)	Sliding Velocity(m/s)	% of CF
1	X	A	L
2	X	A	M
3	X	A	N
4	Y	B	L
5	Y	B	M
6	Y	B	N
7	Z	C	L
8	Z	C	M
9	Z	C	N

Table no 3: Layout of experiment design according to L9 Array.

C. Tribological Studies

Sr.No.	Composite Pin
1	PPS+15% CF+5% MoS2+5%Bz
2	PPS+20% CF+5% MoS2+5%Bz
3	PPS+25% CF+5% MoS2+5%Bz

Table no 4: Couterface part I (Pin)

content	C	Si	Mn	P	S	Cr	Ni
percentage	0.08	0.75	2.00	0.045	0.03	18	10

Table no 5: Couterface part II (Disc)

D. Experimental Setup

In this experimental work we test the tribological properties of PPS composite materials with combination of various additives on pin on disk apparatus.

Test Parameter Values	Test Parameter Values
Specimen pin size	3,6,8,10,12 mm dia. & 25–30 mm long
Wear Disc Size	Dia. 165 mm, 8 mm thick, 1.6 Ra surface roughness
Wear track diameter	Min: 50mm, Max: 100mm, In steps of 1mm
Disc rotation	Min: 200 rpm, Max: 2000 rpm, In steps of 1rpm
Sliding speed	0.5 to 10 m/s
Normal load	5N to 200N, In steps of 5N
Frictional force	0 to 200 N, L.C. of 0.1 N
Wear	Min:1 µm, Max: 2000 µm, L.C. of 1 µm
Temperature	Min: Ambient, Max:4000C, L.C. of 1OC

Table no 6. Technical specification of Pinon-Disc test rig.

Fig: 2 Pin on Disc Apparatus

VI. EXPECTED OUTCOME

The material has been replaced for the bearing is having following characteristics to having advantage over the existing materials like

A. Low friction and wear found in new composite materials
B. Self-lubrication done
C. Light in weight
D. Improved strength of materials as compare to existing materials

VII. ACKNOWLEDGMENT

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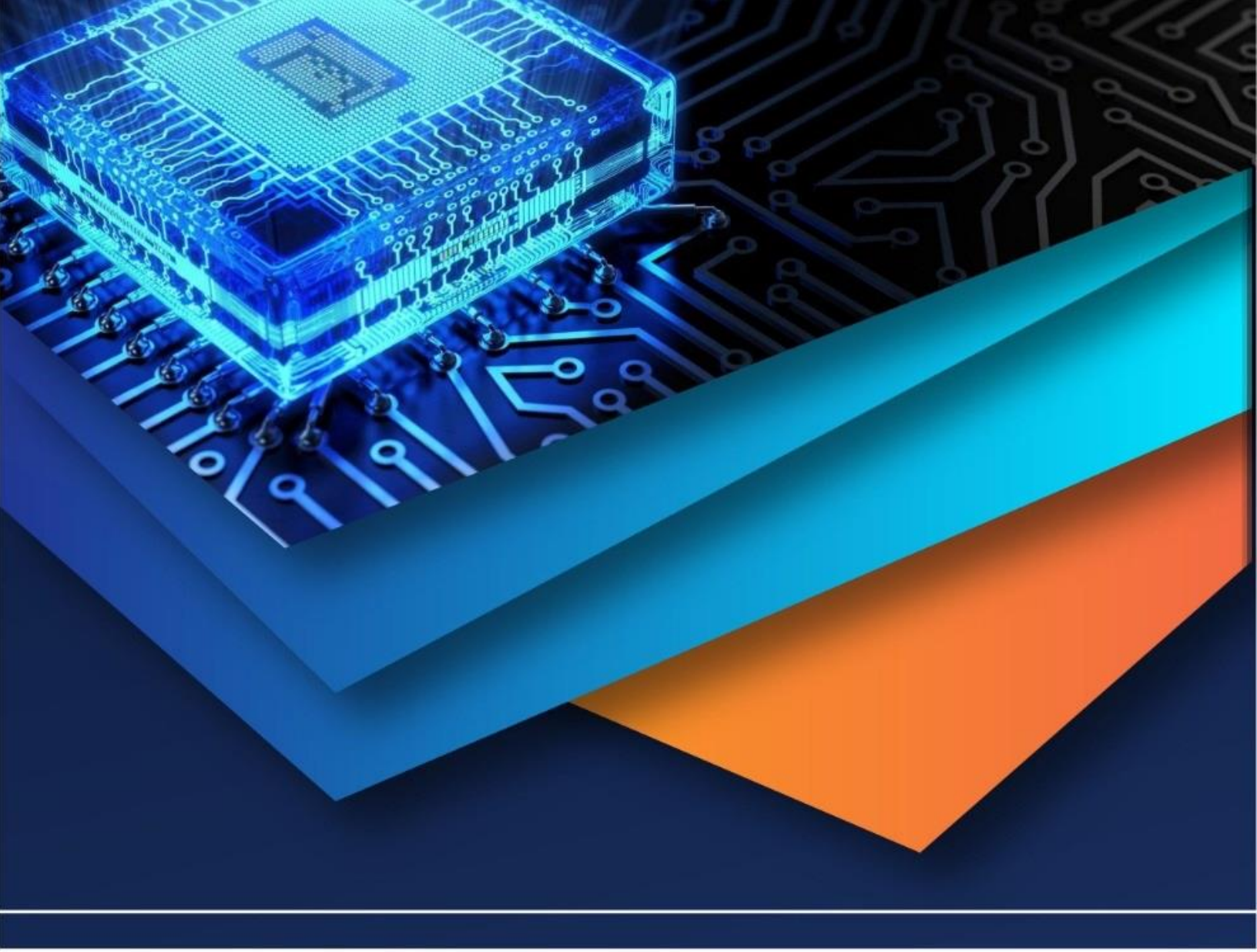

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