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Effect of Bronze on PTFE Composites Review

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Abstract - **The effect of the bronze, Mos2 on PTFE Composites has been reviewed. An overview of the problem of bearing material was given with respect to the processes and modes during abrasion with focus on Metal Matrix composites. The new aspect in the studies of bronze, Mos2 on PTFE composites were emphasized in this paper. Implementation of Design of Experiments and statistical techniques in analyzing the behavior of the composites. Recent findings on wear of various combination of bronze and Mos2 on PTFE composites were also presented.**

Keywords: Tribological properties, PTFE, Composite, Wear life, Friction coefficient.

I. INTRODUCTION

Polytetrafluroethylene (PTFE) is polymer based compound with white or gray in color. 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.[1]The attention was focused on the variation of crystallinity due to the presence of fillers and it was connected with the transition phases to which the PTFE is subjected. In particular, as simplified frictional heating calculation method was used for estimating the maximum contact temperature and results were connected with analyses(DSCs).[2] The results showed that the friction coefficient decreases with temperature down to 77 K, but did not follow a linear evolution further down to extreme low temperatures. It can be stated that the cryogenic environment has a significant influence on the tribological performance of the polymer composites. The effect of low temperatures was more clearly detected at low sliding speed, where friction heat is reduced. A change in wear mechanism from adhesive to abrasive was observed in this case. SEM and AFM analyses showed that the PTFE matrix composites investigated under these experimental conditions have transferred material into the disc down to very low temperatures. Chemical analyses indicate the presence of iron fluorides.[3] Effects of filler crystal structure and shape on the friction and wear properties of potassium titanate whisker (K2Ti4O9 whisker, K2Ti6O13 whisker), TiO2 whisker and TiO2 particle filled polytetrafluoroethylene (PTFE) composites under dry friction conditions were studied. [4] New 16 MnNb steel–PTFE composite (A) containing 60% area proportion of PTFE composite was developed. Another type of common solid lubricant embedded C86300 bronze–PTFE composite (B) containing 35% area proportion of PTFE composite was also selected for a comparative investigation under similar testing conditions. Friction and wear experiments were performed in an oscillating sliding tribotester at an oscillating frequency of 0.13 Hz, contact mean pressures from 15 to 80MPa and counter face roughness of 0.10 _m *R*a. The composites A and B slides against a 38CrMoAlA steel shaft. Results showed that the composite A exhibited low coefficient of dry friction and long wear life as compared to that of the composite B. It was found that the surface of PTFE composite was higher than that of steel backing at the intervals of testing.[5]The effect of two grades of carbon black (CB) on structure, strength and tribological behavior of PTFE-CB composites is studied in the filler range of 10% mass It is found that differences in surface properties of the fillers used to determine the type of super molecular structure evolved and patterns of variation of mechanical properties, friction and wear in response to increasing filler content. It is found that wear of low-filled PTFE-CB composites is dominated by delimitation mechanism and wear resistance changes correlate with structural transformations of the composites. [6]High tenacity expanded polytetrafluoroethylene (PTFE) filaments as both a fiber reinforcement and a reservoir for solid lubricants. The goal is to reduce the wear of the composites by regulating the PTFE transfer. Expanded PTFE films are a porous network of PTFE nodes and fibrils, while highly oriented e PTFE filaments are aligned crystalline fibers that are regarded as high-tenacity fibers that can be woven into threads or yarns. [7]Short fibre reinforced polymer composites are nowadays used in numerous tribological applications. In the present overview further approaches in designing polymeric composites in order to operate under low friction and low wear against steel counterparts are described. A particular emphasis is focused on special filler (including nanoparticle) reinforced thermoplastics and thermosets. Especially, the influence of particle size and filler contents on the wear performance is summarized..[8]In this paper, processes involved with the tribological wear of polymer materials under conditions of dry friction were discussed. The focus was on mechanical and adhesion reactions between co-operating surfaces. A mechanism accounting for additional heating of the material as a result of fluctuating friction force loading of the sliding metal/polymer pair and additional heating due to internal friction of the polymer materials was also presented.[9] Wear testing and SEM analysis showed that three-body abrasion was probably the dominant mode of failure for PTFE + 18% carbon + 7% graphite composite, while fiber pull out and fragmentation caused failure of PTFE + 20% glass fiber + 5% MoS_2 composite. The composite with 10% PPDT fibers caused wear reduction due to the ability of the fibers to remain embedded in the matrix and preferentially support the load. The dominant interactive wear mechanisms during sliding of PTFE and its composites are discussed in view of the present findings.[10] .

The aim of the present paper is that the review of the effect of bronze, mos2 on PTFE composites, for that use of design of experiment using Taguchi Method.

II. EXPERIMENTAL SETUP

A. Wear Test

For finding the friction and wear, tests will carried out using single pin type “Pin-on-disc friction and wear monitor “TR20”, Ducom make, Bangalore. Also hardness test will be carried out .and SEM will be done to find the effect of bronze and mos2.Fig. 2.1 show a diagram of pin on disc machine used for this work. As shown in figure, the machine consists of Steel disc, which is mounted on circular turn table. The turn table is mounted on a bearing housing which is provide the unidirectional motion to the turn table. The cylindrical pin is holed firmly in a holder, which is attaching to a pivoted loading arm. The loading arm is supported in bearing arrangement to allow load to be applied to the specimen. Frictional force and wear is measure by digital display. Specifications of pin on disc machine use are given in table 2.1. This machine also facilitates study of friction and wear characteristics in sliding contacts under desired conditions. Sliding occurs between the stationary pin and a rotating disc. Normal load, rotational speed and It wear track diameter can be varied to suit the test conditions. Tangential frictional force and wear are monitored with electronic sensors and recorded on PC. These parameters are available as functions of load and speed.

Fig. 1 Complete Arrangement of Experimental Set Up

Table 2.1: Specification of pin-on Disc friction and Wear Monitor TR-20

Make	Magnum Ltd., Bangalore, India
Pin Diameter Range	Φ3mm to 12mm
Disc Size	Φ160mm × 8mm thick
Wear Track Diameter	Φ5mm to150mm
Sliding speed Range	0.25 to 12 m/s
Disc Rotation Speed	100-3000RPM
Drive	1.1KWDC motor, Constant Torque
Motor Controller	Thyrister converter, with full motor protection
Frictional Force	0-250 N, Digital readout with recorder output
Normal Load	0 to250N
Disc Material	EN-31 with hardness 60 HRC and Ra 0.3.
Wear Measurement Range	±2 mm, Digital readout with recorder

III. SYSTEM DEVELOPMENT

A. Design Of Experiment

Design of experiments determines the pattern of observations to be made with a minimum of experimental efforts. To be specific Design of experiments (DOE) offers a systematic approach to study the effects of multiple variables / factors on products / process performance by providing a structural set of analysis in a design matrix. More specifically, the use of orthogonal Arrays (OA) for DOE provides an efficient and effective method for determining the most significant factors and interactions in a given design problem.

B. Introduction To Taguchi Method

A full factorial design will identify all possible combinations for a given set of factors. If an experiment consist of m number of factors & each factor at levels, then Number of trails possible (Treatment Combination) = Xm Ln (Xm) Where,

n=Number of experiments to be conducted

X=Number of levels

m= Number of factors

In this investigation work, which is carried out for 4 factors (Material, load, sliding velocity, and sliding distance), each factor at 3 levels, an L27 (313) orthogonal array is chosen for conducting the experiments. Table 3.1 shows an L27 (313). There are totally 27trials (experiments) to be conducted and each trial is based on the combination of level values.

C. Statistical Regression Analysis

Statistical regression analysis is the study of the relationship between two or more variables, used to establish the empirical equation relating input-output parameters, by utilizing least square method. Moreover, it is the most commonly used statistical modeling technique developed based on experimental data. The following steps are to be considered for carrying out statistical regression analysis of a process.

1. Identifying the important process control variables and finding their upper and lower limits.

2. Developing the design matrix (Statistical design of experiments).

3. Conducting the experiments as per the design matrix and recording the response parameters.

4. Developing the models and calculating the regression coefficients.

5. Checking the adequacy of the models.

6. Testing the significance of coefficients and arriving at the final models.

7. Presenting the direct and interaction effects of the process.

8. Analysis of Results.

IV. EXPERIMENTAL RESULT

Input Factors

1. Load (kg)

2. Sliding distance (km)

3. Velocity (m/s)

4. Material

Table-2 Level Values of Input Factors for group I

Sr.No.	Factors	Levels		
		1	2	3
1	Load (kg)	1	2	3
2	Sliding distance (km)	2	4	6
3	Velocity (m/s)	1.09	2.199	3.29
4	Material	PTFE + 15% Bronze+ 5%MoS_2	PTFE+ 25% Bronze+ 5%MoS_2	PTFE+ 40% Bronze+ 5%MoS_2

Table-3 Level Values of Input Factors for group II

Sr.No.	Factors	Levels		
		1	2	3
1	Load (kg)	1	2	3
2	Sliding distance (km)	2	4	6
3	Velocity (m/s)	1.09	2.199	3.29
4	Material	PTFE+ 15% Bronze+ 10%MoS_2	PTFE+ 25% Bronze+ 10%MoS2	PTFE+ 40% Bronze+10 %MoS2

The wear behavior and coefficient of friction is obtained by various load condition and different sliding speed, with different material is as follows.

Table 4 : Results of L27 (34) Orthogonal Array for Experimentations

Material 1- PTFE+15%Bronze+5%MoS2

Material 2- PTFE+25%Bronze+5%MoS2

Material 3- PTFE+40%Bronze+5%MoS2

Trial No.	Load (Kg)	SD (Km	Velocity (m/s)	Material	Wear	Time	RPM	COF
M1	1	2	1.09	15	15.95	30.58	300	0.1062
M2	1	2	2.199	25	15.2	15.16	600	0.11
M 3	1	2	3.29	40	14.45	10.13	900	0.13
M 4	1	4	1.09	25	29.03	61.16	300	0.16
M5	1	4	2.199	40	18.07	30.32	600	0.13
M6	1	4	3.29	15	13.17	20.26	900	0.11
M7	1	6	1.09	40	20.71	91.74	300	0.18
M8	1	6	2.199	15	22.16	45.45	600	0.0288
M9	1	6	3.29	25	9.36	30.39	900	0.13
M10	2	2	1.09	25	18.92	30.58	300	0.07
M11	2	2	2.199	40	27.03	15.16	600	0.21
M12	2	2	3.29	15	11.22	10.13	900	0.019
M13	2	4	1.09	40	17.62	61.16	300	0.074
M14	2	4	2.199	15	10.09	30.32	600	0.067
M15	2	4	3.29	25	13.29	20.26	900	0.69
M16	2	6	1.09	15	12.68	91.74	300	0.092
M17	2	6	2.199	25	8.45	45.45	600	0.12
M18	2	6	3.29	40	6.09	30.39	900	0.04
M19	3	2	1.09	40	13.45	30.58	300	0.041
M20	3	2	2.199	15	13.85	15.16	600	0.024
M21	3	2	3.29	25	10.94	10.13	900	0.12
M22	3	4	1.09	15	16.63	61.16	300	0.0.68
M23	3	4	2.199	25	18.28	30.32	600	0.064
M24	3	4	3.29	40	6.233	20.26	900	0.050
M25	3	6	1.09	25	14.94	91.74	300	0.101
M26	3	6	2.199	40	19.017	45.45	600	0.031
M27	3	6	3.29	15	5.23	30.39	900	0.060

Table 5: Results of L27 (34) Orthogonal Array for Experimentations

Material 1- PTFE+15%Bronze+10%MoS2

Material 2- PTFE+25%Bronze+10%MoS2

Material 3- PTFE+40%Bronze+10% MoS2

Trial No.	Load (Kg)	SD (Km	Velocity (m/s)	Material	Wear	Time	RPM	COF
M28	1	2	1.09	15	14.307	30.58	300	0.0961
M29	1	2	2.199	25	17.806	15.16	600	0.126
M30	1	2	3.29	40	12.210	10.13	900	0.143
M31	1	4	1.09	25	19.467	61.16	300	0.137
M32	1	4	2.199	40	16.606	30.32	600	0.135
M33	1	4	3.29	15	16.391	20.26	900	0.175
M34	1	6	1.09	40	14.895	91.74	300	0.145
M35	1	6	2.199	15	7.499	45.45	600	0.119
M36	1	6	3.29	25	23.583	30.39	900	0.174
M37	2	2	1.09	25	17.920	30.58	300	0.1576
M38	2	2	2.199	40	12.737	15.16	600	0.0460
M39	2	2	3.29	15	16.381	10.13	900	0.0877
M40	2	4	1.09	40	15.850	61.16	300	0.0593
M41	2	4	2.199	15	6.862	30.32	600	0.0796
M42	2	4	3.29	25	15.943	20.26	900	0.0704
M43	2	6	1.09	15	18.185	91.74	300	0.0779
M44	2	6	2.199	25	18.062	45.45	600	0.0936
M45	2	6	3.29	40	5.667	30.39	900	0.0517
M46	3	2	1.09	40	19.345	30.58	300	0.0380
M47	3	2	2.199	15	15.909	15.16	600	0.0645
M48	3	2	3.29	25	15.841	10.13	900	0.0489
M49	3	4	1.09	15	12.695	61.16	300	0.0681
M50	3	4	2.199	25	6.868	30.32	600	0.0707
M51	3	4	3.29	40	10.246	20.26	900	0.0476
M52	3	6	1.09	25	12.075	91.74	300	0.0678
M53	3	6	2.199	40	10.360	45.45	600	0.0486
M54	3	6	3.29	15	11.800	30.39	900	0.0576

V. CONCLUSION

It is observed that as per OA experiment will be performed on pin on disc machine, and studied the behavior of wear of composition on bronze, MoS2 with different compositions. PTFE also studied the friction on composites. Polytetrafluroethylene (PTFE) is polymer based compound with white or gray in color. 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. A change in wear mechanism from adhesive to abrasive was observed in this case. SEM and AFM analyses showed that the PTFE matrix composites investigated under these experimental conditions have transferred material into the disc down to very low temperatures. A mechanism accounting for additional heating of the material as a result of fluctuating friction force loading of the sliding metal/polymer pair and additional heating due to internal friction of the polymer materials was also presented.

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