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Effect of Bronze and MoS_2 on PTFE

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Abstract—The paper reviews the tribological behavior of polytetrafluroethylene (PTFE) composites with filler materials such as Bronze and MoS_2 under parameters like varying load, sliding distance, percentage of Bronze, Mos_2 and velocity on pin on disc apparatus. The highest wear resistance found for composites with containing PTFE+40% Bronze+5% MoS_2 composition.

Keywords- PTFE composites, Filler materials, Pin on disc, Wear, Analysis of variance.

I. INTRODUCTION

Polytetrafluroethylene (PTFE) is nowadays finding increasing utility in high performance mechanical seal due to unique properties like high chemical resistivity, low coefficient of friction and high temperature stability. But, Pure PTFE has high wear rate and abrasion resistance, leading earlier failure and leakage problem in the seals. The wear rate of PTFE can be significantly decreased by addition of suitable filler materials. In the past PTFE is filled with conventional filler materials such as glass fibers, graphite, carbon fibers, etc. To satisfy current increasing demand of PTFE in various fields its undesirable properties can be minimized by addition of filler materials. In present work PTFE is filled with Bronze and Mos_2 in various percentages. The wear resistance of PTFE composites is higher as compared to pure PTFE.

A.MATERIALS

Pure PTFE and two PTFE based composite materials were studied in present work. The composite material classified into following four groups.

Group I	Group II
Material 1-PTFE+10%Bronze	Material 1-PTFE+40%Bronze
Material 2-PTFE+20%Bronze	Material 2-PTFE+50%Bronze
Material 3-PTFE+30%Bronze	Material 3-PTFE+60%Bronze
Group III	**Group IV**
Material1-PTFE+15%Bronze+5%MoS	Material1-PTFE+15%Bronze+10%MoS_2
Material2-PTFE+25%Bronze+5%MoS_2	Material1-PTFE+25%Bronze+10%MoS_2
Material3-PTFE+40%Bronze+5%MoS_2	Material1-PTFE+40%Bronze+10%MoS_2

The material is purchased in the form of rectangular sheets with dimensions 100 mm X 100 mm X 3 mm.

B.EXPERIMENTAL PROCEDURE

A pin-on-disc Friction and Wear Monitor Tr-20 is used to investigate wear characteristics of pure PTFE and their composites as per ASTM G 99-95 standards. The disc used is En- 31 with hardness 60 HRC, 150 mm track diameter and 8 mm thick, with surface roughness of 0.3 Ra. Complete Arrangement of Experimental Set Up is shown in Figure .1 below.

Fig 1: Complete Arrangement of Experimental Set Up

Schematic diagram of Pin-on-Disc apparatus shown in figure 2.

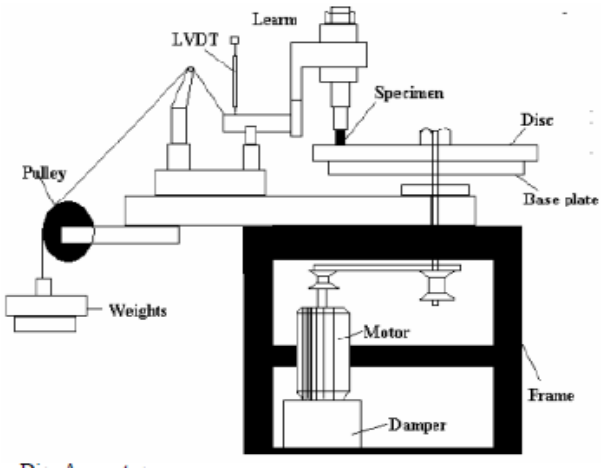

Fig 2: Schematic Diagram of Pin-on-Disc apparatus

The Specification of Pin-On Disc Friction and Wear Monitor Tr-20 are given in Table 1.

Table1. 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	Thyristor 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
Power	230V, 15A, 1phase, 50Hz AC

II. VARIABLES IN WEAR TESTING

1) Load 2) Velocity 3) Temperature 4) Contact Area 5) Surface Finish 6) Sliding Distance 7) Environment 8) Material 9) Hardness of counter face.

III. RESULT AND DISCUSSION

The experiments were conducted with an aim of relating the influence of applied load, sliding speed and sliding distance on wear of pure PTFE and PTFE composites under study.

A. Sample calculation

The sample calculations for various parameters used for study are shown below.

For Load, P= F/A ,

Where, P=Specific Pressure, MPa

F=Load (force) applied on Pin-on-disc machine, N

A=Cross-sectional area of pin, mm^2

For Load of 2 Kg,

$P= 2\times4\times9.81/\pi(10)^2$, $P=0.2498$ N/mm^2 or MPa

For sliding Velocity, $V = (\pi DN)/60$,

Where, V=sliding velocity, m/s,

D=Wear Track diameter, mm

N=RPM of disc of pin-on- disc machine

For 600 rpm of disc,

$V=\pi\times70\times600/60\times10^3$

V=2.198 m/s

B. Observations

Speed : 200 rpm, 300 rpm, 900 rpm

Weight : 1Kg, 2 Kg, 3 Kg.

Wear Track Radius : 35 mm

Pin Diameter : 10 mm

Pin Length : 30 mm

C. Result

Group I

Material 1-PTFE+10%Bronze

Material 2-PTFE+20%Bronze

Material 3-PTFE+30%Bronze

Table 2.Result for Group I PTFE Composites

Trial No.	Load (Kg)	SD (Km)	Velocity (m/s)	Material	Wear (µm)
1	1	2	1.09	10%Bronze	22.3
2	1	2	2.199	20%Bronze	11.6
3	1	2	3.29	30%Bronze	14.0
4	1	4	1.09	20%Bronze	32.9
5	1	4	2.199	30%Bronze	16.9
6	1	4	3.29	10%Bronze	29.6
7	1	6	1.09	30%Bronze	27.7
8	1	6	2.199	10%Bronze	20.5
9	1	6	3.29	20%Bronze	18.9
10	2	2	1.09	20%Bronze	16.0
11	2	2	2.199	30%Bronze	14.5
12	2	2	3.29	10%Bronze	15.0

13	2	4	1.09	30%Bronze	16.3
14	2	4	2.199	10%Bronze	15.3
15	2	4	3.29	20%Bronze	22.9
16	2	6	1.09	10%Bronze	41.3
17	2	6	2.199	20%Bronze	24.1
18	2	6	3.29	20%Bronze	20.6
19	3	2	1.09	30%Bronze	22.7
20	3	2	2.199	10%Bronze	14.3
21	3	2	3.29	20%Bronze	38.7
22	3	4	1.09	10%Bronze	16.3
23	3	4	2.199	20%Bronze	17.9
24	3	4	3.29	30%Bronze	17.8
25	3	6	1.09	20%Bronze	17.0
26	3	6	2.199	30%Bronze	19.1
27	3	6	3.29	10%Bronze	17.0

Table 3.Result for Group II PTFE Composites

Trial No.	Load (Kg)	SD (Km)	Velocity (m/s)	Material	Wear (µm)
28	1	2	1.09	40%Bronze	13.7
29	1	2	2.199	50%Bronze	23.7
30	1	2	3.29	60%Bronze	19.9
31	1	4	1.09	50%Bronze	24.3
32	1	4	2.199	60%Bronze	17.8
33	1	4	3.29	40%Bronze	13.2
34	1	6	1.09	60%Bronze	12.3
35	1	6	2.199	40%Bronze	20.3
36	1	6	3.29	50%Bronze	16.7
37	2	2	1.09	50%Bronze	20.2
38	2	2	2.199	60%Bronze	16.7
39	2	2	3.29	40%Bronze	14.0
40	2	4	1.09	60%Bronze	17.9
41	2	4	2.199	40%Bronze	16.0
42	2	4	3.29	50%Bronze	15.7
43	2	6	1.09	40%Bronze	19.7
44	2	6	2.199	50%Bronze	14.7
45	2	6	1.09	60%Bronze	15.3
46	3	2	3.29	60%Bronze	33.3
47	3	2	2.199	40%Bronze	15.7
48	3	2	3.29	50%Bronze	16.6
49	3	4	1.09	40%Bronze	22.1
50	3	4	2.199	50%Bronze	15.3
51	3	4	3.29	60%Bronze	14.3
52	3	6	1.09	50%Bronze	18.7
53	3	6	2.199	60%Bronze	16.9
54	3	6	3.29	40%Bronze	13.4

Table 4.Result for Group III PTFE Composites

Trial No.	Load (Kg)	SD (Km)	Velocity (m/s)	Material	Wear (µm)
M1	1	2	1.09	15%Bronze+5%MoS_2	17.3

M2	1	2	2.199	25%Bronze+5%MoS_2	22.8
M 3	1	2	3.29	40%Bronze+5%MoS_2	15.3
M 4	1	4	1.09	25%Bronze+5%MoS_2	23.3
M5	1	4	2.199	40%Bronze+5%MoS_2	23.2
M6	1	4	3.29	15%Bronze+5%MoS_2	14.2
M7	1	6	1.09	40%Bronze+5%MoS_2	21.1
M8	1	6	2.199	15%Bronze+5%MoS_2	18.1
M9	1	6	3.29	25%Bronze+5%MoS_2	14.6
M10	2	2	1.09	25%Bronze+5%MoS_2	16.7
M11	2	2	2.199	40%Bronze+5%MoS_2	18.0
M12	2	2	3.29	15%Bronze+5%MoS_2	11.0
M13	2	4	1.09	40%Bronze+5%MoS_2	18.2
M14	2	4	2.199	15%Bronze+5%MoS_2	15.1
M15	2	4	3.29	25%Bronze+5%MoS_2	16.1
M16	2	6	1.09	15%Bronze+5%MoS_2	13.7
M17	2	6	2.199	25%Bronze+5%MoS_2	18.1
M18	2	6	3.29	40%Bronze+5%MoS_2	10.8
M19	3	2	1.09	40%Bronze+5%MoS_2	14.4
M20	3	2	2.199	15%Bronze+5%MoS_2	15.1
M21	3	2	3.29	25%Bronze+5%MoS_2	13.9
M22	3	4	1.09	15%Bronze+5%MoS_2	16.7
M23	3	4	2.199	25%Bronze+5%MoS_2	22.0
M24	3	4	3.29	40%Bronze+5%MoS_2	12.0
M25	3	6	1.09	25%Bronze+5%MoS_2	19.0
M26	3	6	2.199	40%Bronze+5%MoS_2	18.4
M27	3	6	3.29	15%Bronze+5%MoS_2	12.2

Table 5.Result for Group IV PTFE Composites

Trial No.	Load (Kg)	SD (Km)	Velocity (m/s)	Material	Wear (µm)
M28	1	2	1.09	15%Bronze+10%MoS_2	19.2
M29	1	2	2.199	25%Bronze+10%MoS_2	20.5
M30	1	2	3.29	40%Bronze+10%MoS_2	16.6
M31	1	4	1.09	25%Bronze+10%MoS_2	20.5
M32	1	4	2.199	40%Bronze+10%MoS_2	15.1
M33	1	4	3.29	15%Bronze+10%MoS_2	14.4
M34	1	6	1.09	40%Bronze+10%MoS_2	18.2
M35	1	6	2.199	15%Bronze+10%MoS_2	14.4
M36	1	6	3.29	25%Bronze+10%MoS_2	18.5
M37	2	2	1.09	25%Bronze+10%MoS_2	21.4
M38	2	2	2.199	40%Bronze+10%MoS_2	13.5
M39	2	2	3.29	15%Bronze+10%MoS_2	14.5
M40	2	4	1.09	40%Bronze+10%MoS_2	15.8
M41	2	4	2.199	15%Bronze+10%MoS_2	11.9
M42	2	4	3.29	25%Bronze+10%MoS_2	16.7
M43	2	6	1.09	15%Bronze+10%MoS_2	15.8
M44	2	6	2.199	25%Bronze+10%MoS_2	16.9
M45	2	6	3.29	40%Bronze+10%MoS_2	13.1
M46	3	2	1.09	40%Bronze+10%MoS_2	18.0

M47	3	2	2.199	15%Bronze+10%MoS_2	14.0
M48	3	2	3.29	25%Bronze+10%MoS_2	16.1
M49	3	4	1.09	15%Bronze+10%MoS_2	14.8
M50	3	4	2.199	25%Bronze+10%MoS_2	13.8
M51	3	4	3.29	40%Bronze+10%MoS_2	12.8
M52	3	6	1.09	25%Bronze+10%MoS_2	18.3
M53	3	6	2.199	40%Bronze+10%MoS_2	12.7
M54	3	6	3.29	15%Bronze+10%MoS_2	12.9

CONCLUSIONS

From the analysis on the results of dry sliding wear of the PTFE Filled with Bronze, Mos2 composites, the following conclusions can be drawn from the study.

1. Sliding distance is the wear factor that has the highest physical properties as well as statistical influence on the dry sliding wear and of the composites. The load, sliding speed and reinforcement, and the interaction sliding speed and sliding distance will contribute more and other interactions will influence very less.
2. Pure PTFE gives very high wear rate as compared to composite PTFE.
3. Composite PTFE has much good mechanical and tribological properties as compared to Plain PTFE.
4. Wear rate is directly proportional to load applied.
5. Coefficient of friction is inversely proportional to the Load applied.
6. Composite with less percentage of Bronze in PTFE gives less wear rate as compared to other with high percentage of Bronze when tested under similar working condition.
7. As percentage of Bronze in PTFE increases, coefficient of friction also increases.
8. Composite PTFE has much good mechanical and tribological properties as compared to Plain PTFE.
9. Wear increases as roughness of counter surface increases.
10. Hence, 10%, 20%, 30% Bronze filled PTFE are best suited for applications requiring less coefficient of friction, less cost of material and where moderate wear rate is tolerable.
11. 40%, 50%, 60% Bronze filled PTFE are best suited for bearing applications because of its low wear rate, low coefficient of friction, low cost & better mechanical properties than other materials.

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