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Analysis of Tribological Properties of Ptfe and its Composites for Sliding Bearing Applications

Prashant Vishwas Parab	Dept. Mechanical Engineering, J.T.Mahajan College of Engineering Faizpur, Jalgaon
Prof.V. L. Firke	Dept. Mechanical Engineering, J.T.Mahajan College of Engineering Faizpur, Jalgaon

ABSTRACT

The use of polymers and its composites specially the Polytetrafluroethylene or Teflon is increasing in engineering applications in tribology over the conventional tribological materials. The PTFE is self-lubricating material and exhibit lower coefficient of friction but high wear rate. The wear resistivity of pure PTFE can be considerably improved by addition of suitable fillers in appropriate form with it. In present work we studied and analyzed the friction and wear performance of Pure PTFE and its composites as PTFE+25%Carbon,PTFE+15% Graphite,PTFE+40% Bronze, PTFE+60% Bronze and PTFE+55% Bronze+5% MoS2.The friction and wear test is performed on Pin-On-Disc machine at ambient dry conditions. The tests are carried out at sliding velocities 0.96m/s, 1.98m/s and 3.01m/s with loads as 39.24N, 58.86N and 78.48N.We studied the effect of variation in loads, variation in sliding velocities and variation in sliding distances on tribological properties of selected materials. The results shows that the coefficient of friction values are decreasing as load increases for all specimens. Addition of

reinforcing elements significantly enhances the wear resistivity of pure PTFE. The wear rate of pure PTFE is higher than other composites which in the order of 10^{-3} and 10^{-4} mm^3/N-m. The wear rate of composites are in order of $10^{5}mm^3$/N-m.The maximum wear resistance is exhibited by PTFE+60% Bronze.The wear rate is less sensetive for change in sliding velocities but it is more sensitive to change in load.

KEYWORDS : Friction, Wear, PTFE, PTFE composites

1.Introduction: The use of polymers and polymeric composites specially the PTFE and its composites are day by day increasing rapidly in bearing applications because of its advantages over conventional bearing materials as chemically inherent, light in weight, low coefficient of friction, good corrosion resistivity, self-lubricating and can withstand higher tempretures. Some applications in processing industries requires clean environment at machine shop floor. But its use as bearing material restricted due to its poor load carrying capacity, bad thermal conductivity and poor wear resistance. The mechanical and tribological properties of pure PTFE can be enhanced by reinforcing the suitable metallic or in-organic fillers in correct quantity and in proper size , shape and its orientation to optimise a bearing material to suit the designed application. Addition of fillers causes slight change in coefficient of friction and improvement in wear resistivity. The hardness of pure PTFE is increasing while the tensile strength is decreasing[8] . To understand the tribological behaviour of PTFE and its composites under operating conditions and environmental conditions the wear test is carried in laboratory on pin-on-disc machine. The friction and wear of materials is affected by normal load, sliding velocity, sliding distance, surface finish and hardness and material of counter surface, environmental conditions and bearing pressure etc.

The PTFE and its composites are widely used in engineering industries such as automotive, electrical, electronics, mechanical, computer ,chemical and also in medical field, defence, marine engineering. The use of PTFE and its composites as dry bearing material in food processing and pharmaceutical plants is growing as it requires oil free and clean environment.The conventional bearing materials are very costly naturally it affects on final product cost .So there is scope to develop a composite PTFE bearing material to meet the designed requirements.

In a food processing industry like dairy, sugar, chocolate the thick liquid or pulp is forwarded with centrifugal pumps , gear pumps. The bearings used for these mechanical units are of conventional brass bearings. It requires lubrication and due to wear problem replacement rate is higher which increases the maintenance cost. In this study we tried to optimise a bearing material from PTFE composites to suit our requirements. For that we have selected six specimens (pure PTFE and five composites) and testing is carried out at different loads, sliding velocities and sliding distances. The variable values are based on existing pumps bearings.The shaft materials are stainless steel, EN8 or EN31. The test is taken against hardened EN31 steel disc by rubbing the specimen pins in dry conditions with pin-on-disc tribometer at room tempreture.

2.Experimentation:

2.1preparation of sample pins and counter surface: The pin samples are available at Jayhind polymers , Sangli (Maharashtra) in size as 12mm diameter and 100mm length. After getting the same we prepared them into required size as 10mm diameter and 30mm length in our college workshop. The discs of EN31 hardened steel are manufactured by Chaudhari Engineering works, Aambad, M.I.D.C, Nashik (Maharashtra).

2.2 Specimen Materials:

Sample	Matrix	Filler	%Wt	Colour	Density (g/cm^3)
I	PTFE	----	100	White	2.16
II	PTFE	Carbon	25	Black	2.00
III	PTFE	Graphite	15	Black	2.22
IV	PTFE	Bronze	40	Brown	3.12
V	PTFE	Bronze	60	Brown	3.98
VI	PTFE	Bronze+MoS_2	55+5	Gray	3.77

2.3 Setup for Experimentation:

Fig.1 Pin-On-Disc Machine Setup

2.4 Friction and wear testing:

2.4.1 Testing Procedure:

All testing specimens are prepared with suitable size as 10 mm diameter and 30 mm length in my college. Then we have manufactured the discs with required size and material according to application at M/s. Chaudhari Engineering Works, Nashik.

According to our application and studied papers the variables in wear testing are as follows

Normal loads(F_N)

Here for experimentation we have selected the loads as 4 kg, 6 kg and 8 kg or 39.24 N, 58.86 N and 78.48 N.

Sliding velocity ($v = \pi$ d N/60)

In case of centrifugal pumps for thick liquids specially gear pumps shaft rotates with approximate speeds as 300 rpm, 460 rpm, 750 rpm, 1440 rpm and3000rpm.Here we have considered 460 rpm,750 rpm and 1440 rpm hence the relative sliding velocities 0.962m/s, 1.98m/s and 3.01m/s respectively.(Maximum bearing pressure for sliding contact bearing for

Centrifugal pump= 0.7 to 1.4 N/mm^2, shaft dia. d= 40 mm, L/d=1to2) Firstly we have taken a pure PTFE specimen (I) and firmly holded in a pin holder and one of the disc is fixed with screw in a machines rotating unit.

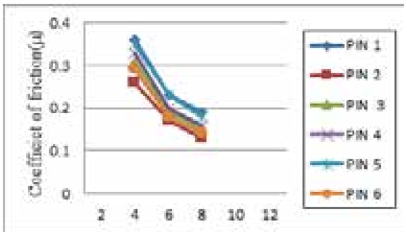
After loading specimen I we started the machine and also switch on the computer which is connected to the control panel. Then desired speed, track diameter, load and time is set. Then we set the frictional force and wear readings to zero. Then we press the button START of control panel and also click on START icon of computer. Thus the test for first sample is started. Test is stopped automatically as the time is preset. The results are directly saved in computer . we are getting directly the results for frictional force in Newton , wear in micrometers and for temperature .

The same procedure is used for all remaining samples for decided loads and sliding speeds and time.

3. Result and discussions:

The tests are carried out by rubbing all specimens against EN31 hardened steel disc for a selected range of sliding velocity and load on Pin-On-Disc type tribometer .The results are plotted for tribological properties of PTFE and its composites are as follows. Load (Kg)

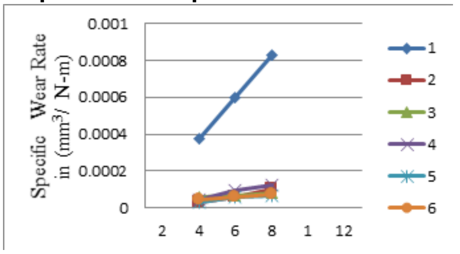
Graph. 1 Load Vs Coefficient of friction



Load (Kg)

There is decrease in value of coefficient of friction as the load increases for a given range of load. The pure PTFE shows higher coefficient of friction and after addition of fillers the value of it slightly decreases. The value of coefficient of friction remains in the range of 0.1 to 0.3. Load (Kg)

Graph .2 Load Vs Specific wear Rate



Load (Kg)

From graph it is seen that the pure PTFE shows higher wear rate for a given range of load while the composites shows considerable decrease in wear rate. The specimen V and VI exhibits close values but for higher load the specimen V is better.

4. Conclusion:

1. The value of coefficient of friction of pure PTFE and its composites increases with increase in load.In starting it remains low then reaches a peak value then decreases slowly and for further long term running remains stationary. It is slightly decreased with the addition of fillers. In present study the sample II shows lowest value.

2. The volume loss and specific wear rate increases with increase in load. The specific wear rate decreases with increase in sliding velocity. In present study the sample V shows better wear resistivity as well as load carrying capacity to suit our requirement.

3. In this study it is concluded that for considered range of load and sliding velocity the wear is more sensitive for load and less sensitive for sliding velocity.

4. In present work the wear resistivity of materials can be ranked as PTFE+60% bronze >PTFE+55%bronze+5%MoS_2>PTFE+15% graphite> PTFE+25% carbon>PTFE+40% bronze>pure PTFE

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