PTFE AS A JOURNAL BEARING MATERIAL

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Abstract— This study investigates the comparative analysis of polytetrafluoroethylene composites that how properties of PTFE can be improved and it is logical to expect that its load- carrying ability and its wear resistance can be improved by the addition of suitable fillers. How the use of both soft and hard phases in a polymer matrix improving the tribological properties of the PTFE is presented. Friction and wear tests of PTFE composite against AISI SS 304 stainless steel are carried out under dry conditions using a pin-on-disc arrangement. PTFE composites includes graphite filled PTFE, bronze filled, carbon filled pure PTFE are tested under tribo-meter steel counter-surface for various load conditions. Bronze filled, carbon filled, and PTFE are found to be superior properties and less variation over the course of testing and very well suitable as a polymer journal bearing material.

Keywords— Polytetrafluoroethylene; Friction; Wear; Polymer matrix; Tribo -meter.

I. INTRODUCTION

Formation and property of transfer film are wear reduction factors for many tribological engineering materials, especially those used under dry friction situation. Increasing tribological use of polymer has made the study on transfer film of polymer very important and in urgent need. To many polymers, it has been found introduction of filler could greatly change their tribological behaviour. Such change on tribological behaviour of the bulk composite material is directly related to the change of tribological properties of the corresponding transfer film formed during the friction process [1].

Nowadays, reduction of lubricants is considered of great importance being their regeneration and disposal governed by harsh acts which entail high added costs. In fact, they are estimated to be used by 46% in the automotive and factory farm industry, by 47% in general production industry and by 7% in the marine and aeronautical industry. One of the most used material taken for the purpose of pollution free and non-lubricated in dry running movement is Polytetrafluoroethylene (PTFE). It is well known for its relevant tribological characteristics, in particular low friction and quasi-absence of sticking effect, high resistance to temperature and good compatibility. Furthermore, PTFE fibrils broke along their length, leaving fragment running along the surface as well as transferred to the counterface, oriented along the sliding direction. Such fragments fractionally cover the counterface filling in the roughness valleys to form a transfer film The most commonly used fillers for tribological applications are carbon, bronze, glass fibers, graphite in different percentages and sometimes combined between them for improving the wear resistance and the coefficient of friction. [3].

Since its invention in the 1930s, countless studies have found PTFE to provide low friction in dry sliding. However, PTFE is also associated with some of the highest wear rates among crystalline polymers in dry contacts. This deficiency has led to the use of fillers to improve the mechanical and wear properties of the PTFE matrix and has been widely documented by Arash et al. [4].

A comparative study between different kinds of filled PTFEs is proposed to have a map of PTFE materials to be used depending by thetribological application. In particular, bronze, carbon, graphite, PEEK fillers effects on tribological properties are compared and referred to pure PTFE.

II EXPERIMENTAL

Preparation of PTFE based composite

These fillers are chosen because of the following two considerations. Firstly, they have simple components and broad applications. Secondly, these fillers are so different in physical–chemical properties that we can get a comprehensive understanding of the effect of fillers on properties of composite, especially, the wear behaviour of the composite and corresponding transfer film and to developed upon the earlier study of PTFE based composites. The proportions of fillers in the composite are shown in Table 1.

According to the provider's communications, the PTFE samples come from a process of compression moulding of the PTFE and filler powder mixtures, and subsequently sinterization and cooling. The PTFE dispersion has a median particle size of 0.25 μm; average carbon particle diameter is about 10–25 μm; average bronze particle size is about 25 μm; graphite 25–50 μm diameter. Density of PTFE composites is in the range of 2.15–2.20 g/cm3.

TABLE I
PTFE COMPOSITES

Sr. No.	Sample
1	PTFE
2	PTFE+25% Carbon
3	PTFE+40% Bronze
4	PTFE+25% Graphite
5	PEEK

Friction and Wear Testing

Unidirectional sliding friction and wear tests are carried out in laboratory air (36% humidity) using a computer controlled pin-on-disc type tribometer. All the samples mentioned in the Table 1 are used as a pin material having pin diameter 8mm. All the tests are conducted at various load conditions 0.5 Kg, 1Kg and 2Kg with a sliding velocity 1.2566 m/sec. Sliding distance and coefficient of friction (f) is monitored with the aid of a linear variable displacement transducer and continuously recorded throughout the tests. Sliding wear and friction studies are carried out by sliding all the specimens against AISI 440C stainless steel as disk under dry condition.

III RESULTS AND DISCUSSION

More commonly known PTFE material exhibits a unique combination of heat resistance and low friction together with outstanding chemical and good electrical properties. Continuous use temperatures range -400F to +500F, no moisture absorption, high arc resistance, and is self lubricating with a low coefficient of friction. Typical carbon filler is high-purity coke powder, which may be combined with graphite in concentrations. Compounds of Teflon and carbon have excellent wear resistance, both dry and in water, chemical resistant, and carry heavy loads under rubbing contact.

All the PTFE composite samples are influenced by the parameters: sliding distance and time.

Wear Behaviour

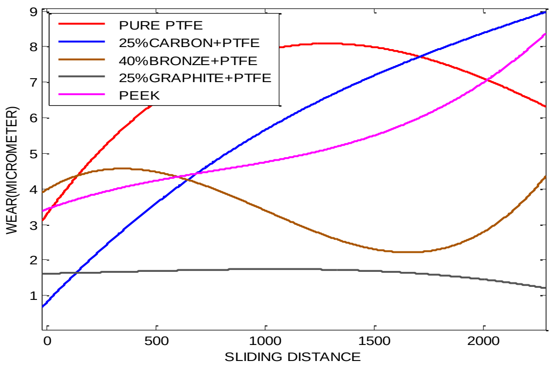

Fig.1 Comparison of wear rate against sliding distance for 0.5kg loading condition.

Fig. 1 shows a comparison between various test samples for wear rate under 0.5kg loading condition against the sliding distance which gives that the pure PTFE have maximum wear rate (8μm) and 25%Graphite+PTFE have minimum wear rate (1.8μm).

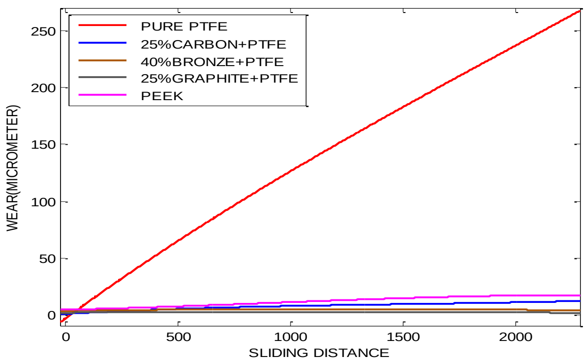

Fig.2. Comparison of wear rate against sliding distance for 1kg loading condition.

Fig.2 shows comparison of wear against sliding distance for 1kg loading condition. From the graph it is clearly seen that pure PTFE have maximum wear rate (250μm) & all other materials have below (18μm). Out of all the materials 25%Graphite+PTFE have minimum wear rate (2.5μm).

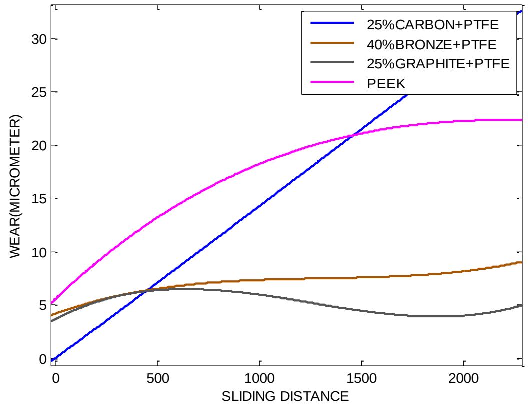

Fig.3 Comparison of wear vs sliding distance for 2kg loading condition by eliminating pure PTFE.

Fig. 3 shows comparison of wear vs sliding distance for 2kg loading condition by eliminating pure PTFE and it is clearly seen that 25%Graphite+PTFE have minimum wear rate (5μm) along with this 40% bronze+ PTFE also exhibit low wear rate as compare to other materials.

Friction Behaviour

The trends of the friction coefficients along the distance are shown in fig 4. At regime, there is relatively steady friction coefficient in the sliding process even with the presence of fillers. Under 0.5 Kg loading condition plain PEEK exhibits more coefficient of friction and 40%Bronze+PTFE have minimum COF.

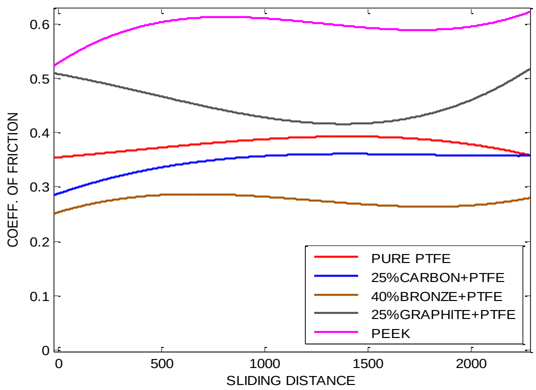

Fig.4 Comparison of coefficient of friction vs sliding distance for 0.5 kg loading condition

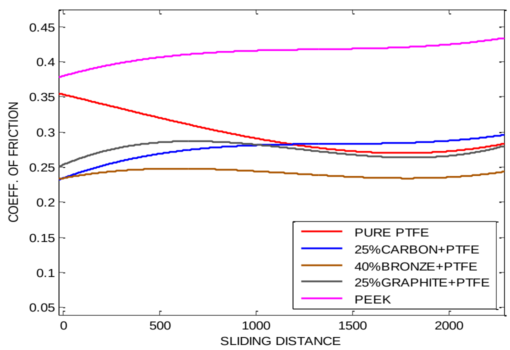

Fig.5. Comparison of coefficient of friction vs sliding distance for 1 kg loading condition.

Fig.5. shows comparison of coefficient of friction vs sliding distance for 1 kg loading condition and under 1 Kg loading condition plain PEEK exhibits more coefficient of friction and 40%Bronze+PTFE have minimum COF (0.23). For 2Kg load Pure PTFE exhibits minimum COF (0.2). Relation of COF is nearly constant with time for all the materials as shown in fig. 6.

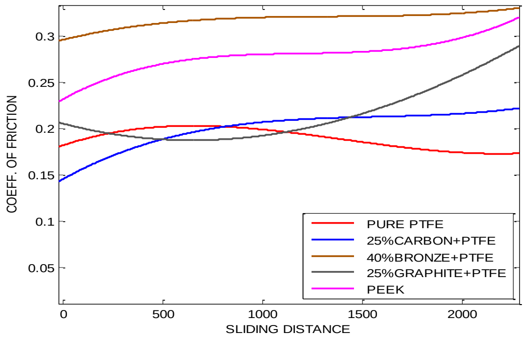

Fig.6. Comparison of coefficient of friction vs sliding distance for 2 kg loading condition.

IV Conclusions

It can be concluded from observations and graphs that:

1) Coefficient of friction is inversely proportional to the Load applied.
2) Wear rate is directly proportional to load applied.
3) 25%Graphite+PTFE gives best result of wear rate compared to others materials when tested under similar working conditions (1.8-5µm).
4) 40%Bronze+PTFE gives minimum coefficient of friction compared to others materials when tested under similar working conditions (0.21-0.31).
5) Composite PTFE has much good mechanical and tribological properties as compared to Plain PTFE.
6) Wear increases as roughness of counter surface increases.

Hence, 25%Graphite+PTFE and 40%Bronze+PTFE are best suited for bearing applications because of its low wear rate, low cost, better mechanical properties than other materials.

Acknowledgment

With a firm belief that a guide in a project is one who holds the candle in the maze of darkness. We take this opportunity to express our profound gratitude to SCSM COE, Nepti, Ahmednagar who as guider, have enacted the role of a torch in their endeavor.

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