EXPERIMENTAL INVESTIGATION OF WEAR RATE OF PTFE COMPOSITES FILLED WITH CARBON FIBER, MOS2, BRONZE REINFORCEMENT

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Abstract – Ptfe that is polytetrafluroethylene has extensive increasing call for because of its precise homes like low coefficient of friction, excessive chemical resistivity, and high temperature balance. But, ptfe well-known shows negative put on resistance, specially abrasion. The wear resistance of ptfe can be considerably stepped forward with the aid of addition of appropriate reinforcement (filler) substances. Many of the maximum commonplace filler substances are carbon fibers, mos2 and bronze. On this paper, it is supplied a assessment of tribological residences of composite substances with ptfe matrix and above referred to filler materials.

***Key Words*: *Index Terms*— PTFE, composites, carbon fibers, MoS_2, bronze, friction, wear**

1. INTRODUCTION:

1.1 Overview

These days, there's very in depth increase within the massive scale manufacturing of the fiber bolstered polymer composites since they own sure benefits over the metals. The blessings include lower density, less want for protection and decrease value. Polymers and polymers bolstered with fibers are used for generating of various mechanical additives, together with gears, cams, wheels, brakes, clutches, bush bearing and seals. Considerable efforts are being made to increase the range of applications. Such use might offer the comparatively cheap and functional benefits to each manufacturers and consumers. Many researchers have studied the tribological conduct of polytetrafluroethylene (ptfe). Research have been performed with numerous shapes, sizes, sorts and compositions of fibers. In popular those composites showcase decrease put on and friction whilst as compared to pure ptfe.

The maximum normally used reinforcements (fillers) for tribological applications are mos2, b and carbon fiber. Typically the fillers enhance the wear and tear resistance from 10 to 500 times, relying at the filler type and shape and problem of this paper are composites with ptfe matrix. Filler materials investigated in this paper are carbon fiber, mos2 and bronze. The paper analyzes tribological characteristics like coefficient of friction and put on at dry sliding situations. Maximum in all likelihood instances, friction and put on assessments have been performed on pin-on-disc tribometer at ambient conditions (temperature and humidity). Counterpart material used in the experiments become always harder than composite. In most cases, counterpart material was steel. All exams had been completed at dry sliding situations. Overall outcomes from all analyzed papers are summarized and supplied in desk.

1.2 Factors Affecting Polymer Composite Wear and Friction:

There are numerous factors that have an effect on cloth tribological properties. For polymer composites the most influential are:

Regular load: the polymer composite must be able to paintings as strong lubricant, to reap that is must be capable of assist the burden, in addition to the tangential stresses prompted by means of sliding. At excessive masses extreme wear occur, characterized by using brittle fracture or excessive plastic deformation. At low loads normally slight wear occur possessed by the neighborhood plastic float of the skinny switch film and floor layers (decreasing friction), together with delamination put on. Touch area: the contact region will decide the projected touch stresses. If the weight can not be reduced, one way of reducing pressure is to increase the projected contact place. The massive area of touch rather than the cloth flowing throughout the counterpart surface, it'll will be predisposed to build up, forming ridges, which can purpose high localized stresses and better adhesion, for that reason better friction and wear. It's far vital to layout a element with correct healthy up of load and get in touch with area. Sliding pace: increasing sliding velocity causes friction heating and subsequently excessive temperature.

This may purpose the polymer or the polymer composite additives to degrade. However in some cases higher temperature might be useful to the lubricating process. For you to develop a floor shear movie and/or a switch film, the molecular chain should have time to reorient. If one slides too speedy over those un-orientated chains, in preference to reorienting, they'll fracture, leading to the production of huge wear particles and high wear. Selection of sliding velocity is essential for each unique polymer to make sure the preferred choicest performance. Counterpart topography: If the counterpart material is too rough it can abrade the composite and not allow a shear film or transfer film to form.

Consequently, it can be normally conventional that, the smoother the counterpart the decrease the wear. This has positive limits, since it's also found that over-polishing have a tendency to put off the counterpart softer matrix material, leaving the more difficult phases and/or particles protruded above the surface.

1.3 Problem Statement:-

India is the largest sugar producing country in the global & sugar enterprise in india is the second one largest manufacturing enterprise. Currently indian sugar industries are running at exclusive cane crushing ability ranging from 1000 to ten,000 tons in keeping with day. In sugar enterprise juice from sugar cane is extracted in milling section. The sugar generators use range of going for walks components fabricated with ferrous and nonferrous alloys which requires frequent or non-stop lubrication. These turbines frequently suffer from corrosion associated issues which in turn effects within the want for big renovation, there through growing the production fee. Now there may be a scope to reduce the cost of sugar manufacturing and increase the performance of the sugar generators by way of replacing a number of the conventional cloth additives by way of the ones of newly evolved mild weight composites.

From the dialogue with deputy chief engineer to know the problems faced within the past & the issues arises all through the season for the mill bearings of milling segment of this sugar factory, it comes to recognize that

1) Sometimes the lubricating oil may additionally get combined with sugar cane juice because of leakage and may alternate the juice properties barely.

2) Juice which incorporates bagasse debris can also enters inside the bearing while the top roll moves up & down for the duration of milling, degrading the lubricant houses.

3) The existence of a backside curler bearing is one to 5 seasons longer than that of pinnacle curler bearings.

4) Excessive and non-uniform wear of magazine bearing surface (1 to five mm) over its length in conjunction with the corrosion, pitting scoring and „v‟ grooving.

Similar applications could be found in different gadgets of sugar industries and plenty of devices of method industries, chemical industries, pharmaceutical industries, paint industries, food and beverage industries and so forth.

1.4 Objectives:-

The purpose of this paintings is to observe the friction and wear behavior of ptfe composites bolstered with varying percentage of, carbon fiber bronze particles with admire to varying high masses and varying low sliding velocities, underneath dry circumstance at ordinary temperature and strain while examined against aisi ss 304 stainless steel. It's far anticipated that, this research will be beneficial in selling the programs of ptfe composites for high load and low speed programs below dry condition. Following are the goals of the project paintings,

1) To indicate the high-quality suitable self-lubricating ptfe composite material for the journal bearing packages from the examined ptfe composite substances for the existing hydrostatically lubricated gun steel or brass magazine bearing used for sugar turbines.

2) To signify great appropriate lubrication instead of traditional lubricant like ipol and so on. Used in roll generators.

3) To find out the behavior of bronze crammed ptfe composite material from wear &friction point of view and the effect of diverse sliding speeds and loads on it.

4) To confirm the fundamental laws of friction.

5) To increase relationship of total put on with the carried out regular load, sliding velocity and percentage of bronze by way of using regression evaluation

2 Literature Review

2.1 Review of Book, Journal & International Paper

From have a look at of literature it's miles discovered that pure ptfe has terrible sliding and put on houses and to beautify the friction and wear behavior of ptfe composites great work were carried out regarding filler cloth and its %, size of the debris, surface treatment to fillers, form and orientation of the fillers, sliding time (distance), counter face cloth and its roughness, outside lubrication, ordinary load between surfaces, sliding speed between surfaces and mechanism of wear and tear and concluded that thestrength and adherence of a transfer movies produced in the course of friction is chargeable for thefriction and put on conduct of polymer composites. Additionally it's far determined that the bronze filled ptfe composites have been produce very thick, uniform and adherent switch films of both ptfe and bronze in comparison to carbon, copper and carbon fiber, which itself is a supply of high friction and warmth technology, reinforced ptfe composites. Additionally, from the take a look at of literature it's far determined that no paintings have been completed on impact of distilled water+ % variant of mos2 as a lubricant on friction and sliding put on behavior of ptfe composites for low speed and high load packages. Many of the researcher works to enhance the overall performance of magazine bearing with extraordinary bearing fabric & lubricants. It's miles discovered that very less paintings were done as a polymer bearing for sugar mill. Right here the extra practical alternative for enhancing current bearing fabric & lubrication gadget, polymer is the exceptional opportunity. So the study of effect of varying percentage of mos2 indistilled water as a lubricant on friction and sliding put on behavior of bronze crammed ptfe composites for low velocity and high load application of sugar mill bearing is completed as a task work.

3 Experimental Methodology

3.1 Preparation of Specimen

For the trying out ptfe composite substances are purchased from mahavir sales ahmednagar, midc, this material is in the shape of powder from and the use of metal compaction method with assist of ball make trying out specimen with dimension's 30mm diameter and 50 mm duration. The take a look at specimens (pins) of 8mm diameter and 30 mm duration are cut from sai engg works ahmednagar using lathe machine. The disc of cloth aisi ss 304 stainless steel plate is finished via pdvvp coe ahmednagar

Table No 3.1 sample pin composition

Sr.no	Composite pin
1.	Ptfe+30% carbon fiber+5% mos2+5%Bz
2.	Ptfe+25%carbon fiber+5%mos2+5%Bz
3.	Ptfe+20%carbon fiber +5%mos2+5%Bz
4.	Ptfe+15%carbon fiber+5% mos2+5%Bz

3.2 Experimental Setup

Experimental set up that is available in pdvvp college of engineering, ahmednagar isas shown in following fig. 3. 2. The use of a pin on disc tribometer (tr20le) reading of wearand frictional force are taken

Fig. 3.2 Photograph of experimental set up (Tribometer TR20LE-PHM-400).

Table 3.2 Specifications of PIN and Disc Tribometer (TR20LE)

Specifications of pin on disc Tribometer (TR-20)	MAKe: Ducom Ltd, Bangalore.
Pin Size	3 to 12 mm diagonal
Disc Size	165 mm dia. X 8 mm thick
Wear Track Diameter (Mean)	10 mm to 160 mm
Sliding Speed Range	0.26 m/sec. to 10 m/sec.
Disc Rotation Speed	100-2000 RPM
Normal Load	200 N Maximum
Friction Force	0-200 N, digital readout, recorder output
Wear Measurement Range	4 mm, digital readout, and recorder output
Power	230V,15A,1 Phase,50 Hz

4 Result and discussion

Pin1:-Effect of Time on Ptfe+30% carbon fiber+5% mos2+5%Bz

The wear and tear test has been done for the duration of 3hr, to analysis the wear and tear ordinary performance of ptfe

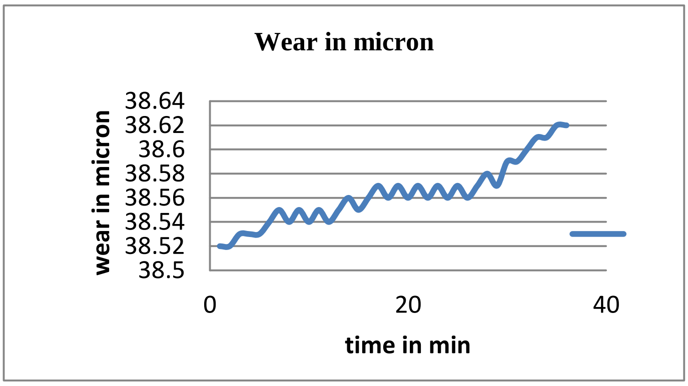
All readings of wear test recorded for every 10 minutes of lap timing.

All readings were recorded in above table.

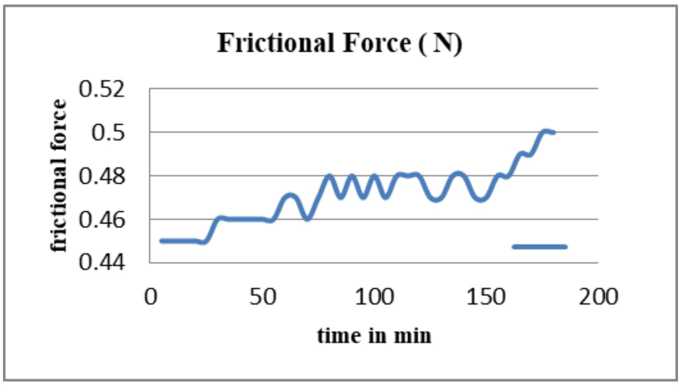
Table 4.1.1: Observations Table for PIN-P1

Time (min)	Wear in micron	Frictional Force (N)
5	37.51	0.41
10	37.52	0.41
15	37.53	0.42

20	37.53	0.41
25	37.54	0.42
30	37.54	0.43
35	37.55	0.43
40	37.51	0.43
45	37.54	0.44
50	37.53	0.44
55	37.52	0.43
60	37.53	0.44
65	37.53	0.43
70	37.55	0.45
75	37.55	0.45
80	37.56	0.44
85	37.55	0.45
90	37.52	0.46
95	37.57	0.46
100	37.56	0.45
105	37.57	0.46
110	37.56	0.46
115	37.56	0.48
120	37.56	0.48



4.1.1.: Effect of time on wear of PIN-1



4.1.1. b :Effect of time on frictional force of PIN-1

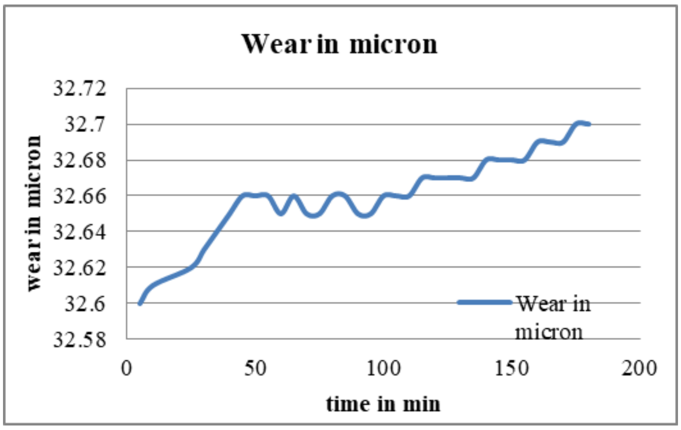
Pin 2:-Effect of Time on Ptfe+25%carbon fiber+5%mos2+5%Bz

The fig 4. 1. 2: a impact of time on wear price of ptfe composite at fashionable operating situations. It has been located that precise wear for pin-2 was to start with particularly high due to unexpected ordinary and tangential pressure acted on the pin for the duration of the starting of check rigTable

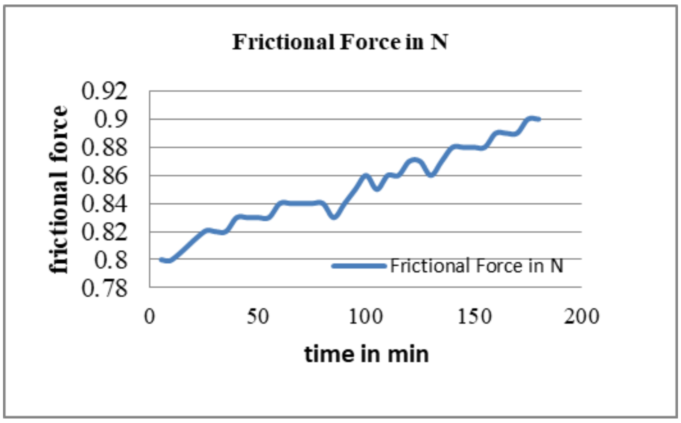
4.1.2: Observations Table for PIN-2

Time in min	Time in min	Frictional Force in N
5	31.60	0.81
10	31.61	0.81
25	31.62	0.82
30	31.63	0.81
35	31.64	0.81
40	31.65	0.82
45	31.66	0.82
50	31.66	0.81
55	31.64	0.82
60	31.65	0.82
65	31.66	0.83
70	31.65	0.83
75	31.65	0.82
80	31.66	0.83

85	31.66	0.83
90	31.65	0.82
95	31.65	0.84
100	31.66	0.84
105	31.66	0.85
110	31.66	0.84
115	31.67	0.85
120	31.67	0.85



4.1.2.: Effect of time on wear of PIN-2



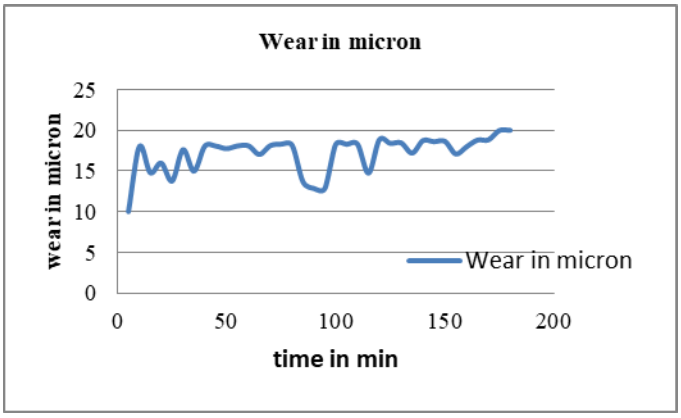
4.1.2.b :Effect of time on frictional force of PIN-2

Pin 3:- Effect of Time Ptfe+20%carbon fiber +5%mos2+5%Bz

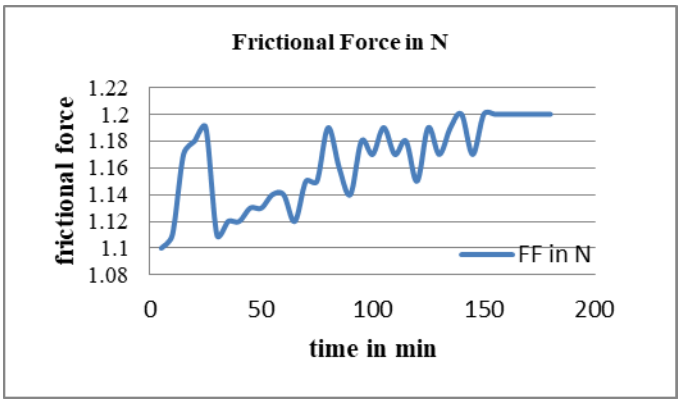
The fig four. 1. 3. A indicates the impact of time on precise put on fee of ptfe at standard operating situations. To begin with the wear fee turned into bad that is because of unexpected thermal expansion between disc and pin. The growth detoriates mechanical homes due to which base cloth to start with lose some pin cloth in a area of counter components and adhere on the floor of pin. This switch film creates resistance in opposition to put on properties. The addition of mos2 with carbon fiber act as self-lubricating agent assist to form a thin black gray color switch film on disk along side thermal expansion of pin material. Addition of 5%mos2 in carbon fiber reduces the abrasion

Table 4.1.3: Observations Table for PIN-P3

Time in min	Wear in micron	FF in N
5	14.66	1.22
10	16.99	1.22
15	15.78	1.25
20	15.98	1.26
25	14.77	1.29
30	16.62	1.21
35	16.98	1.22
40	17.05	1.22
45	17.06	1.23
50	18.75	1.23
55	17.08	1.24
60	17.09	1.24
65	18.04	1.22
70	18.11	1.25
75	18.3	1.25
80	18.15	1.29
85	14.65	1.26
90	13.85	1.24
95	13.84	1.28
100	17.27	1.27
105	17.28	1.29
110	17.29	1.17
115	15.74	1.18
120	16.85	1.15



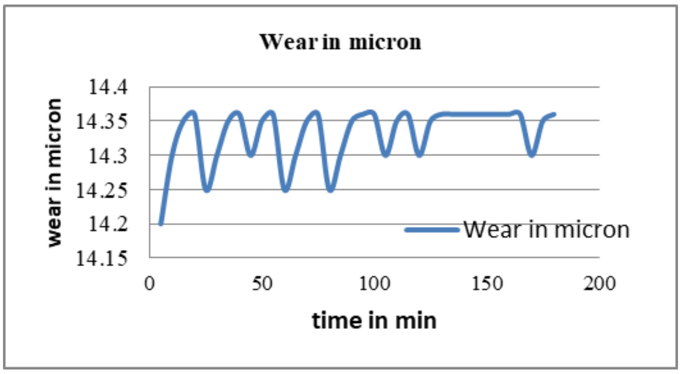
4.1.3. a :Effect of time on wear of PIN-3



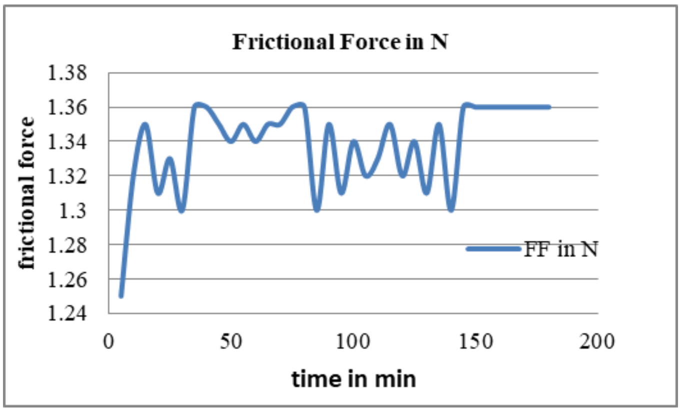
4.1.3. b :Effect of time on frictional force of PIN-3

Pin 4 :-Ptfe+15%carbon fiber+5% mos2+5% The fig 7. 4. 1 suggests the impact of time on put on fee or unique put on rate of ptfe at popular operating situations. The fig shows initially much less put on, and growth constantly with respective time. For the duration of the check the skinny brown shade transfers movie shape on disc. The specific wear charge has been located three. 79x 10-6 mm3/nm after crowning glory of check. The fig 7. 1. 4. Table 7.1.4.: Observations Table for PIN-P4 Time in min Wear in micron FF in N

Time in min	Wear in micron	FF in N
5	11.96	1.25
10	12.60	1.22
15	12.1	1.35
20	12.15	1.32
25	12.2	1.31
30	12.25	1.32
35	12.3	1.3
40	12.35	1.36
45	12.4	1.35
50	12.45	1.34
55	12.5	1.35
60	12.55	1.34
65	12.6	1.35
70	12.65	1.35
75	12.55	1.36
80	12.5	1.36
85	12.5	1.33
90	12.45	1.34
95	12.5	1.32
100	12.55	1.32
105	12.6	1.33
110	12.65	1.32
115	12.7	1.32
120	12.75	1.33



4.1.4. a :Effect of time on wear of PTFE+PTFE+GF+MOS2+Bronze



4.1.4. b :Effect of time on frictional force PIN-4

5 Result and discussion

5.1. Comparative study of wear, frictional force and coefficient of friction of pure PTFE with PTFE composites:

Table 5.1:

Specimen	Specific wear rate mm3/Nm(x10^-6)	Coefficient of friction (μ)
At ambient temperature :(23°C)		
PIN-4	1.265x10^-5	0.138
PIN-3	1.6145x10^-5	0.133
PIN-2	3.0846 x10^-5	0.15
PIN-1	3.752 x10^-5	0.182

Table 5.2: Comparative study of frictional force and coefficient of friction

Specimen	Frictional Force (N)	Coefficient of friction (μ)
At ambient temperature :(23°C)		
PIN-4	1.338	0.138
PIN-3	1.164	0.133
PIN-2	0.805	0.15
PIN-1	0.470	0.182

6. Conclusions

The ptfe primarily based composite shows two levels, i) transfer phase and ii) stabilized wear section. From the experimental study the subsequent conclusions are drawn.

1. Pure ptfe indicates excessive wear fee, k0= 2. 65 x 10-6mm3/nm.

2. The addition of carbon fibers to ptfe/ptfe improves its wear resistance homes.

3. It changed into also observed that the 15% carbon fiber reinforced with ptfe/ptfe improving the friction and wear conduct of polymer composite. Also fiber fillers improve the creep resistance and composite energy of the ptfe composite and end result enhance wear résistance, it's far ko= 2. 1345x 10-6 mm3/nm

4. It was also located that the composite pin-3 composition five% mos2 with 15% carbon fibers in ptfe/ptfe exhibited low coefficient of friction and excessive wear resistance. It shows very much less put on charge than that of ptfe/ptfe strengthened with carbon fibers. It's miles 7. 963x 10-8 mm3/nm. That is due to percentage of stable lubricant.

5. Mos2 and bronze is used as strong lubricant cloth. These materials easily enter the roughness valley and stably live on disk. It provides necessary lubrication throughout sliding. This is beneficial to reduce the damage and increase put on life of component.

6. Also conclude that at the same time as increasing the share of bronze this is 20% in ptfe composite suggests excessive wear resistance than pin 4. It improves from 3. 79x10-6 mm3/nm to 7. 80257x 10-7 mm3/nm.

7. By including diverse filler materials in polymer composite enhance the tribological properties. Pin -three shown extra put on resistances at variable load circumstance than natural ptfe

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