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Tribological Investigation of PTFE Filled Composite with Varying Percentage of MOS2 in Bearing Application

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Abstract: *Polytetrafluoroethylene (PTFE) is now a day's finding increasing utility because of it has properties like high chemical resistivity, low coefficient of friction and high temperature stability. However, its application has been greatly limited due to its poor mechanical properties like poor wear and abrasion resistance. The wear resistance of PTFE can be significantly improved by addition of suitable filler materials. Among the most common filler materials are glass fibers, graphite, carbon and bronze. In this work attention is given to suggest self-lubricating PTFE composite bearings in place of the existing hydrostatically lubricated gun metal or brass bearing used for sugar mills and also replace conventional lubricant i.e. IPOL used in sugar mills as a lubricant by using varying % of MoS2 (3%, 5%, 7% and 10%) in distilled water as a lubricant. Bronze filled PTFE composites produces very thick, uniform and adherent transfer films of both PTFE and bronze. Therefore the investigation of friction and wear behaviour of PTFE composites filled with bronze particles considering the parameters like varying loads of sugar mill was carried out as a work. Experimental work is carried out by varying loads of 100.91N, 109.049 N, 113.07 N and 117.189 N at sliding velocity 0.12 m/s, keeping rest of the parameters constant. Rubbing the test pins of PTFE composites against AISI SS 304 stainless steel disc surface in wet condition using a pin-on-disc Tribometer (TR-20LE-PHM 400) at NTP. Composites of PTFE + 40 % bronze particles filled are taken as bearing materials to investigate its friction and wear behaviour.The results are tabulated and graphs are plotted for evaluation of current thesiswork. From these graphs effect of selected loads with varying % of MoS2 (3%, 5%, 7%and 10%) in distilled water as a lubricant on wear and coefficient of friction are studied.*

Keywords: Tribological, composite, Experimental, Optimization.

I. Introduction

Tribology is the science of rubbing surfaces in relative motion. It is the study of the friction, wear and lubrication of engineering surfaces with a view of understanding surface interactions in detail and then prescribing improvements in given applications. One of the important objectives in tribology is the regulation of the magnitude of frictional force according to whether we require a minimum or a maximum. This objective can be understand only after a fundamental understanding of the frictional process for all conditions like load, sliding velocity, lubrication, surface finish, temperature and material properties.

Now a day there has been a significant growth in the large-scale production of polymers and polymer matrix composites. Polymer composites mostly used as structural components that are very often subjected to friction and wear loadings under use. In some situations, the coefficient of friction is of the highest importance, but mostly the mechanical load-carrying capacity and the wear life of components that determine their acceptability in industrial applications under different operating conditions.

Variables in friction and wear testing are load, velocity, contact area, surface finish, sliding distance, environment, material of counter face, type of lubricant used, hardness of counter face and temperature. Usually wear is undesirable, because it makes necessary frequent inspection and replacements of parts and also it will lead to deterioration of accuracy of machine parts. It can produce vibrations, fatigue and consequently failure of the parts. For the particular practical application the kind of wear loading can be different, and therefore the structure of the composite material used for these applications can also be different in order to achieve the particular requirements.

For over sixty years, our world and the quality of its inhabitant's lives have been improved by a resin known as polytetrafluoroethylene or PTFE. It is discovered in 1938 by a DuPont chemist, Mr. Roy J. Plunkett. Upon examination, DuPont learned that PTFE provided a combination of friction, temperature, chemical, mechanical and electrical resisting properties. PTFE ([C2F4]n) is recorded in The Guinness Book of World Records for the lowest coefficient of static and dynamic friction as 0.02 - equivalent to wet ice on wet ice. PTFE is a kind of self-lubricating material having super low coefficient of friction, outstanding corrosion resistance, chemical inertness and wide service temperature range. PTFE is a frequently used as a solid lubricant both as a filler and matrix. PTFE is currently finding increasing utility in high performance mechanical seals due to its unique properties like high chemical resistivity, low coefficient of friction and high temperature stability. However, its application has been greatly limited due to its poor mechanical properties, high linear expansion coefficient, bad thermal conductivity and poor wear and abrasion resistance. Adding glass fibers, carbon, Mos2 fillers to PTFE were found effective in reducing the wear rate of PTFE composite. In addition for the range of loads and speeds used in this investigation, wear rate showed very little sensitivity to test speed and more sensitivity to the applied load, particularly at high load value.PTFE is extensively used for a wide variety of structural applications as in aerospace, automotive, earth moving, medical, electrical, electronics, and computer and chemical industries. On account of its good combination of properties, these are used for producing a number of mechanical components such as gears, cams, wheels, brakes, clutches, bearings, gaskets, seals as well as wires, cables, textile fibers, electronic components, medical implants, surgical instruments etc.India is the largest sugar producing country in the world & sugar industry in India is the second largest manufacturing industry. Presently Indian sugar industries are operating at different cane crushing capacity ranging from 1000 to 10,000 tons per day. In sugar industry juice from sugar cane is extracted in milling section. The sugar mills use number of running components fabricated with ferrous and non-ferrous alloys which requires frequent or continuous lubrication. These mills often suffer from corrosion related problems which in turn results in the need for large maintenance, thereby increasing the production cost. Now there is a scope to reduce the cost of sugar production and increase the efficiency of the sugar mills by replacing some of the conventional material components with those of newly developed light weight composites. In this work attention is given to suggest the replacement of the existing hydrostatically lubricated gun metal or brass bearing used for sugar mills by self-lubricating PTFE composite bearings. Because of this, In this paper tribological behaviors of PTFE+ glass fiber against MOS2 filled distilled water were comparatively investigated by considering the parameters like loads and sliding velocity of existing bearing of sugar mills. Wear tests are carried out by rubbing the test pin of PTFE composites against stainless steel disc surface in wet condition using a pin-on-disc Tribometer.The influence of normal load, % of Mos2 in distilled water and percentage of bronze is discussed in results and discussion.

II. COMPOSITES

Composite materials (or composites) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties and which remain separate and distinct on a macroscopic level within the finished structure. Composites are widely used because overall properties of the composites are superior to those of the individual components.

There are two constituent materials of composite; matrix and reinforcement. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.

A variety of molding methods can be used according to the end-item design requirements and natures of the chosen matrix and reinforcement materials. Most commercially produced composites use a polymer matrix material often called as a resin solution. There are many different polymers like polyester, vinyl ester, epoxy, phenolic, polyimide, polyamide, polypropylene, PEEK, etc. are available. The reinforcement materials are often in the form of fibers but also commonly ground minerals. The strength of the product is greatly dependent on the percentage of fiber content.

A number of material-processing strategies have been used to improve the wear performance of polymers. This has prompted many researchers to cast the polymers with fibers/fillers. Considerable efforts are being made to extend the range of applications. Various researchers have studied the tribological behavior of FRPCs. Studies have been conducted with various shapes, sizes, types and compositions of fibers in a number of matrices. In general these materials exhibit lower wear and friction when compared to pure polymers. An understanding of the friction and wear mechanisms of FRPC's would promote the development of a new class of materials .Use of inorganic fillers dispersed in polymeric composites is increasing. Fillers not only reduce the cost of the composites, but also meet performance requirements, which could not have been achieved by using reinforcement and resin ingredients alone. In order to obtain perfect friction and wear properties many researchers modified polymers using different fillers like Al_2O_3, ZnO, CuO, Pb_3O_4, ZrO_2, TiO_2, CuS, MoS_2, Bronze, Brass, Glass fiber, Carbon, Rubber, Graphite, Oxide Particles, Carbide particles, etc. and even other polymer materials also.

Fiber reinforced polymers or FRPs include wood (comprising cellulose fibers in a lignin and hemicelluloses matrix), carbon-fiber reinforced plastic or CFRP, and glass reinforced plastic or GRP. If classified by matrix then there are thermoplastic composites, short fiber thermoplastics, long fiber thermoplastics or long fiber reinforced thermoplastics. There are numerous thermoset composites, but advanced systems usually incorporate aramid fiber and carbon fiber in an epoxy resin matrix.

Composites can also use metal fibers reinforcing other metals, called as metal matrix composites (MMC). Magnesium is often used in MMCs because it has similar mechanical properties as epoxy. Ceramic matrix composites include bone (hydroxyapatite reinforced with collagen fibers), Cermets (ceramic and metal) and concrete. Ceramic matrix composites are built primarily for toughness, not for strength. Chobhamarmor is a special composite used in military applications.

The thermoplastic composite materials can also be formulated with specific metal powders resulting in materials with a density range from 2 g/cc to 11 g/cc. These materials can be used in place of traditional materials such as aluminum, stainless steel, and brass, bronze, copper, lead, and even tungsten in weighing, balancing, vibration damping, and radiation shielding applications. Composite materials are popular in high-performance products that need to be lightweight, yet strong enough to take harsh loading conditions such as aerospace components (tails, wings, fuselages, propellers), boat, bicycle frames and racing car bodies. Other uses include fishing rods and storage tanks. The new Boeing787 structure including the wings is composed of over 50 percent composites. Carbon composite is a key material in today's launch vehicles and spacecrafts. It is widely used in solar panel substrates, antenna reflectors and yokes of spacecraft. PTFE, phenolic, nylon, acetal polyimide, polysulfide, polyphenylene sulfide, ultrahigh molecular weight polyethylene, lubron etc. and their composites can be used as bearing materials.

III. Bearing Lubrication

Most of the bearings operate with a fluid film of oil, liquid, or gas. The largest numbers of bearings are oil lubricated. The oil film can be maintained through pumping by a pressurization system in which case the lubrication is termed as hydrostatic. Or it can be maintained by a squeezing or wedging of lubricant produced by the rolling action of the bearing itself termed hydrodynamic lubrication. If loads are too high or speeds are too slow, the hydrodynamic action begins to break down a condition referred to as boundary lubrication.

A. Lubrication of Sugar Cane Mill Bearings

In cane crushing sugar mills the highly smooth and polished split type journal bearing shown in fig. 1 is commonly used because mills runs at very low speed, rollers exert very high pressure on bearing which need substantial area to support the load. The material used for these bearings are brass or gunmetal.

The hydrostatic type of lubrication is provided through the lubricator driven by sprocket filled on pintle end of top roller shaft as shown in fig. 2. The hydraulic pressure of 775 psi to 900 psi is acting on the bearing side of hydraulic piston of 300 mm diameter in the cylindrical chamber. At the start of the mill and when sudden heavy load exerted by roller on the bearing the condition of lubrication is boundary lubrication.

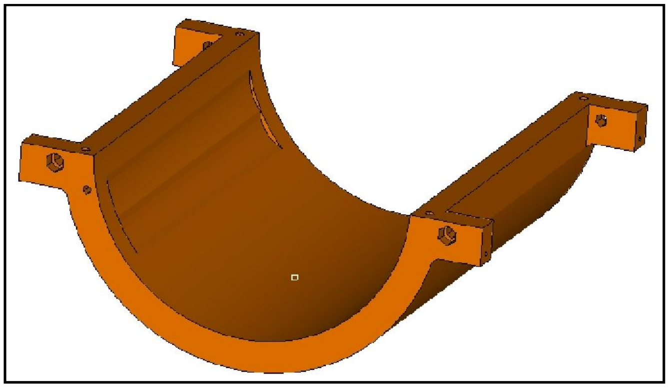

Figure 1: one halve of split type journal bearing.

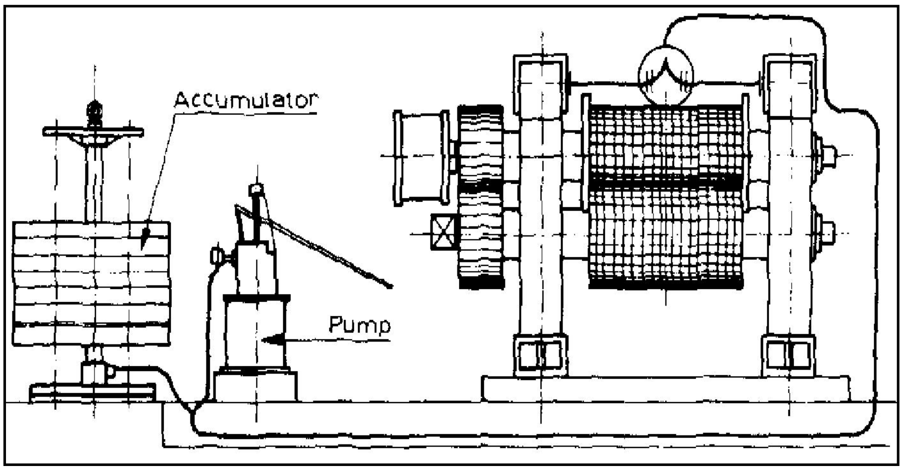

Figure 2: Hydraulic pressure system.

Average oil consumption is 30 liters / hour for the sugar factory of 2500 tonnes of crushing capacity per day. This oil should have a viscosity of 3000 – 3200 centipoises at 400c and contain the additives: 4.5% of a mixture of sulphur and phosphorus 0.5 % of an anti-foaming agent, 0.01% of a lubricant agent. Cooling water for the six bearings of a slowly rotating three roller mills required is 700 to 1000 liters/hour.

IV. Brief Review of Literature

From study of literature it is observed that pure PTFE has poor sliding and wear properties and to enhance the friction and wear behavior of PTFE composites tremendous work had been carried out regarding filler material and its %, size of the particles, surface treatment to fillers, shape and orientation of the fillers, sliding time (distance), counter face material and its roughness, external lubrication, normal load between two surfaces, sliding speed between two surfaces and mechanism of wear and concluded that the strength and adherence of a transfer films produced during friction is responsible for the friction and wear behavior of polymer composites. Also it is determined that the bronze filled PTFE composites were produce very thick, uniform and adherent transfer films of both PTFE and bronze as compared to carbon, copper and glass fiber, which itself is a source of high friction and heat generation, reinforced PTFE composites. Also, from the study of literature it is found that no work had been carried out on effect of distilled water + % variation of Mos2 as a lubricant on friction and sliding wear behavior of PTFE composites for low speed and high load applications. Many of the researcher works to improve the performance of journal bearing with different bearing material & lubricants. It is observed that very less work had been done as a polymer bearing for sugar mill. Here the more practical option for improving existing bearing material & lubrication system, polymer is the best alternative. So the study of effect of varying percentage of Mos2 in distilled water as a lubricant on friction and sliding

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wear behavior of bronze filled PTFE composites for low speed and high load application of sugar mill bearing is carried out as a project work.

V. Problem Definition

India is the largest sugar producing country in the world & sugar industry in India is the second largest manufacturing industry. Presently Indian sugar industries are operating at different cane crushing capacity ranging from 1000 to 10,000 tons per day. In sugar industry juice from sugar cane is extracted in milling section. The sugar mills use number of running components fabricated with ferrous and non-ferrous alloys which requires frequent or continuous lubrication. These mills often suffer from corrosion related problems which in turn results in the need for large maintenance, thereby increasing the production cost. Now there is a scope to reduce the cost of sugar production and increase the efficiency of the sugar mills by replacing some of the conventional material components by those of newly developed light weight composites.

Sugar plant having crushing capacity of 5000 tonnes per day, that in milling section number of mills are there to extract juice from sugar cane by passing and compressing fiberized sugar cane through slowly rotating (4.5 rpm to 6 rpm) heavy metal mills as shown in fig. 5.1. These mills are supported on gunmetal or brass journal bearings shown in fig. 3

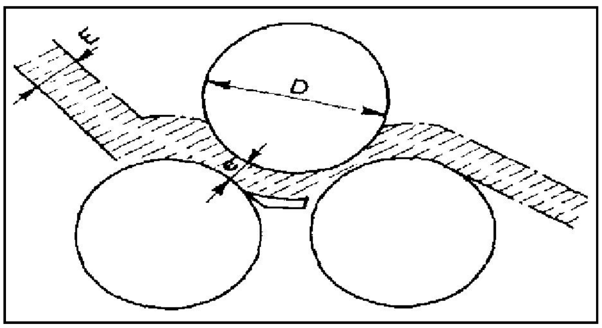

Figure 3: Three roller mills with fiberized sugar cane.

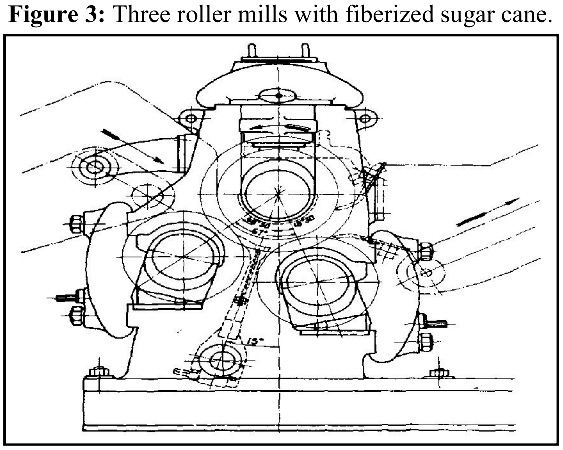

Figure 4: Hydrostatically lubricated sugar cane bearings of mills.

The lubrication used for these bearings is hydrostatic lubrication. The thick oil used for this hydrostatic lubrication is IPOL-3 mineral oil under oil pressures ranging from 775 psi to 900 psi.

From the discussion with deputy chief engineer to know the problems faced in the past & the problems arises during the season for the mill bearings of milling section of this sugar factory, it comes to know that:

- Sometimes the lubricating oil may get mixed with sugar cane juice due to leakage and may change the juice properties slightly.
- Juice which contains bagasse particles may enters in the bearing when the top roll moves up & down during milling, degrading the lubricant properties.

- The life of a bottom roller bearing is one to five seasons longer than that of top roller bearings.
- High and non-uniform wear of journal bearing surface (1 to 5 mm) over its length along with the corrosion, pitting scoring and 'v' grooving.

So the suggestion of self-lubricating PTFE composite bearings in place of the existing hydrostatically lubricated gun metal or brass bearing used for sugar mills is tried to give. Therefore, a test program was initiated to determine the tribological properties of few self-lubricating materials. As the bronze filled PTFE composites were produce very thick, uniform and adherent transfer films of both PTFE and bronze, the investigation of friction and wear behavior of PTFE composites filled with bronze particles considering the parameters like varying loads and constant sliding velocity of sugar mill bearings by using a pin-on-disc type wear tester at NTP is taken as a project work. Hence PTFE + 40 % bronze particles filled composite is taken as bearing materials to investigate its friction and wear behavior. Experimental work has been carried out considering the sliding velocity 0.12 m/s and normal loads of 100.91N, 109.049N, 113.07N, 117.189N under wet condition. In this work AISI SS 304 stainless steel disc is used as a counterpart surface as a roller mill material and tests are carried out at ambient conditions using a pin-on-disc Tribometer (TR-20LE). The influence of % of bronze particles and distilled water +% Mos2 as a lubricant, on the friction and wear of the PTFE composites under wet sliding conditions against the AISI SS 304 stainless steel discus tried to investigate and suggest the best suitable self-lubricating PTFE composites material for the mill bearings.
Similar applications could be found in other units of sugar industries and many units of process industries, chemical industries, pharmaceutical industries, paint industries, food and beverage industries etc.

VI. Objectives of the Project

The purpose of this work is to study the friction and wear behavior of PTFE composites reinforced with varying percentage of Bronze particles with respect to varying high loads and varying low sliding velocities, under dry condition at normal temperature and pressure when tested against AISI SS 304 stainless steel. It is expected that, this research will be useful in promoting the applications of PTFE composites for high load and low speed applications under dry condition.

Following are the objectives of the project work, To suggest the best suitable self-lubricating PTFE composite material for the journal bearing applications from the tested PTFE composite materials for the existing hydrostatically lubricated gun metal or brass journal bearing used for sugar mills. To find out the behavior of the new composite material from wear & friction point of view and the effect of various sliding speeds and loads on it.To verify the basic laws of friction. To develop relationship of total wear with the applied normal load, sliding velocity and percentage of bronze by mathematical modelling using regression analysis.

VII. Experimental Methodology

A. Preparation of Specimen

For the testing PTFE composite materials are purchased from SH hitchsoluation, MIDC, Bhosari, Pune. This material is in the form of cylindrical rod with dimentions 20 mm diameter and 155 mm length. The testspecimens (pins) of 8mm diameter and 30mm length are cut from Sai enginering wirks Ahemdngar,Workshop.The disc of materialAISI SS 304 stainless steel plate is finished by sai enginering works,Pune.

B. Experimental Setup

Experimental set up which is available in Reliable laborites thane, is as shown in following fig. 5. Using a pin-on-disc Tribometer (TR-20LE) reading of wear and frictional force are taken.

C. Construction

The TR-20LE Pin on disc wear testing is advanced regarding the simplicity and convenience of operation, ease of specimen clamping and accuracy of measurements, both of wear and frictional force along with lubrication and environmental facility.

Figure 5: Photograph of experimental set up (Tribometer TR-20LE).

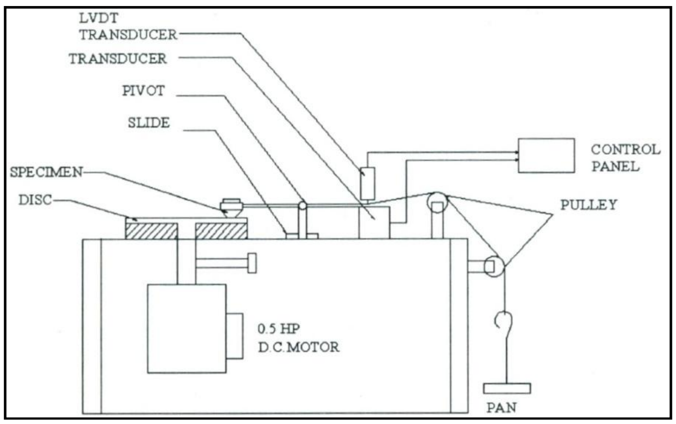

Figure 6: Experimental setup of Pin on Disc Tribometer.

The machine is designed to apply loads up to 20 kg and is intended both for dry and lubricated test conditions. It facilitates study of friction and wear characteristics in sliding contacts under desired test conditions within machine specifications. Sliding occurs between the stationary pin and a rotating disc. Normal load, rotational speed and 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 a function of load and speed.

The machine consists of spindle assembly, loading lever assembly, sliding plate assembly and environmental chamber, all mounted on base plate over structure made up of welded steel tubes which absorbs entire force and load acting during testing. To minimize the vibration during testing, it is fitted with four numbers of adjustable anti-vibration pads at base. Some items like AC motor, variable frequency drive and all electrical items are fitted inside the structure and sides of it are covered with panels.

The wear disc is mounted on the spindle top and is driven by an AC motor through a timer belt, which provides high torque drive with low vibration. The loading lever with specimen holder fixed at one end and at other end, it carries a wire rope for suspending dead weights to apply normal load on specimen. The frictional force produced between specimen pin and disc is directly measured by the load cell at other end. The specimen pin is placed inside a hardened split jaw and clamped to specimen holder. To clamp different sizes of specimens, individual jaws are provided for different sizes of pin specimens. The oil for test is supplied by a lubrication unit fixed at base of machine.

The wear between specimen pin and disc is measured by LVDT and is sensed by a sensor mounted on lever. The friction between specimen pin and rotating disc is measured by a strain gauge type load cell mounted on a bracket. The spindle speed is measured by proximity sensor through a rpm sensor disc. The machine operation is controlled by a electronic controller which is connected to machine through a set of cables, control cable and signal input cable. The signals passes from machine to controller and then controller processed signals to connected PC. The signals from wear

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and frictional force sensor are sent to instrumentation card, the output from which is sent to data acquisition card and the output from it is sent to display on controller and to PC.

D. Working Procedure

- Connect the power input cable to 230 V, 50 Hz, and 15 Amps supply. Switch ON controller. Allow 5 minutes for normalizing all electrical items.
- Using dial indicator, clamp disc within 10 µm run out.
- Thoroughly clean specimens, remove burs from the circumference using a 2000 grit fine silicon carbide abrasive paper. Clean the wear disc thoroughly with petrol.
- Insert specimen pin inside the hardened jaws and clamp to specimen holder. Set the height of specimen pin above the wear disc using height adjustment block, ensuring the loading arm always horizontal. Tighten clamping screws on jaws to clamp specimen pin firmly. Swivel off the height adjustment block away from loading arm.
- Set the required wear track diameter (18 mm to 32 mm) according to sliding speed by moving the sliding plate over graduated scale on base plate. Tighten both the clamping screws to ensure assembly is clamped firmly.
- Wear display: Loosen LVDT lock screw; rotate thumbscrew to bring LVDT plunger visually to mid position, the wear reading display on controller should be as near to zero. Initialize wear display to ‘0’ by pressing ‘ZERO’ push button on controller.
- Frictional force display: Move loading arm away from frictional force load cell and set frictional force display ‘0’ by pressing relative ‘ZERO’ button on controller.
- Place required weights on loading pan to apply normal load.
- Setting disc speed: Set 10 minute time on controller, press test, start push button and rotate. Set by rotating rpm knob on controller till required test speed is displayed. Continually run for the remaining time to observe any fluctuation. Press STOP button.
- Setting test duration on controller: Test duration is set either in time mode (set in hr, min, sec) or counter mode (set in no. of cycles, max. is 100000 cycles). Mode selection is by the toggle switch below timer display, the switch position indicates selection as either time or counter. Test duration of 90 minutes is selected.
- Setting of computer for testing and data acquisition:
- Connect the data acquisition cable from controller to PC.
- Open the software Winducom 2008 on PC.
- Click on mode run continuously icon on software screen to activate screen.
- Click on ACQUIRE tool bar at screen top to open acquiring screen.
- Enter a name on file name window.
- In the cell for Sample ID, enter the material of the specimen and its dimensions.
- Fill the remaining empty cells for speed, load, wear track and data sampling rate.
- In the Remark cell, enter dry test, duration of test, speed etc.
- Click START button in PC window.
- Press START push button on the controller front panel to commence the test and send data to PC.
- Set the required rpm by rotating slowly the rpm knob in clockwise direction.
- Measured rpm is displayed on the SPEED window of the controller front panel. .
- Click zero button on PC screen and initialize all sensor values to zero.
- Click SAVE button on PC screen to save data.
- On controller the acquired test parameters like wear, frictional force, speed and temperature are displayed, the same values are displayed on PC screen with graph

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E. Post Test Evaluation

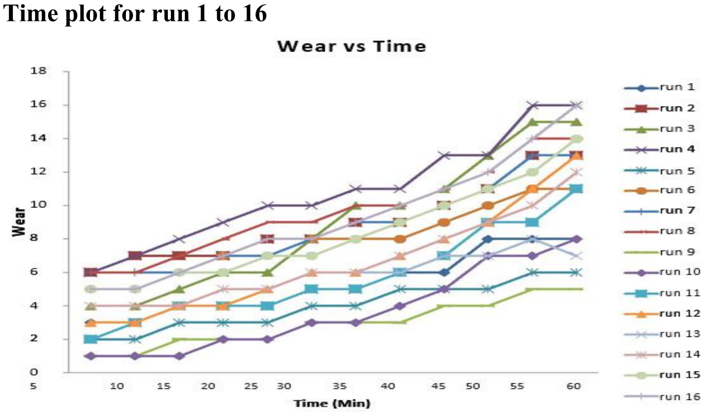
The online wear of specimen is always not taken as actual wear. When actual wear is required the mass has to be adopted. To measure wear using mass loss the specimen is weighed before and after test on highly Precise weighing balance having least count of 0.0001 mg.

VIII. Results and Discussions

From the observation tables in Chapter 6 the meaningful graphs of variation of Wear and COF with respect to test duration and effect of load, % variation of MoS2 in distilled water as a lubricant and on wear and COF are generated in the chapter 7.

A. Graphs

a. Variation of wear v/s Time plot for run 1 to 16

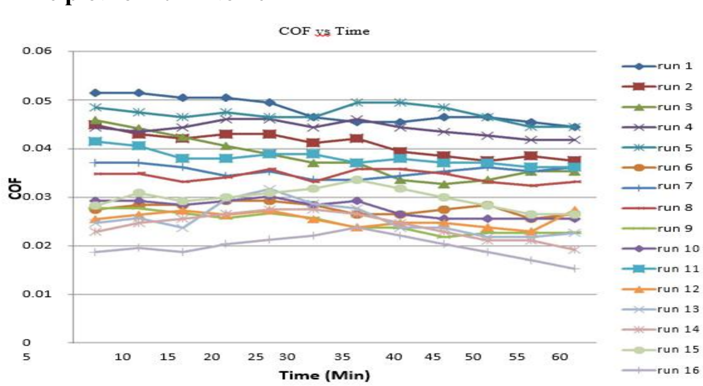


Graph No.7.1 Wear v/s Time plot for run 1 to 16

Graph 7.1 shows the variation of wear with time. It shows that wear increases with increasing load for all runs. By observing graph, run 9 i.e. at load of 100.91N and sliding velocity of 0.12 m/s and of Distilled Water + 7% MoS2 as a lubricant gives minimum wear.

From this for all test samples it is observed that, for all the combination of normal loads and Distilled water + % MoS2 as lubricant shows that initially material wear increases with time due to the formation of poor transfer film between the surfaces. After certain time the transfer film is relocated and is uniform and strong enough to retain itself, stabilizing the wear rate. In between the slight decrement in wear is observed and it may be due to formation of additional layer on transfer film between the sliding surfaces. Stability in wear depends on how strongly the transfer film adhered and maintained till its breakage.

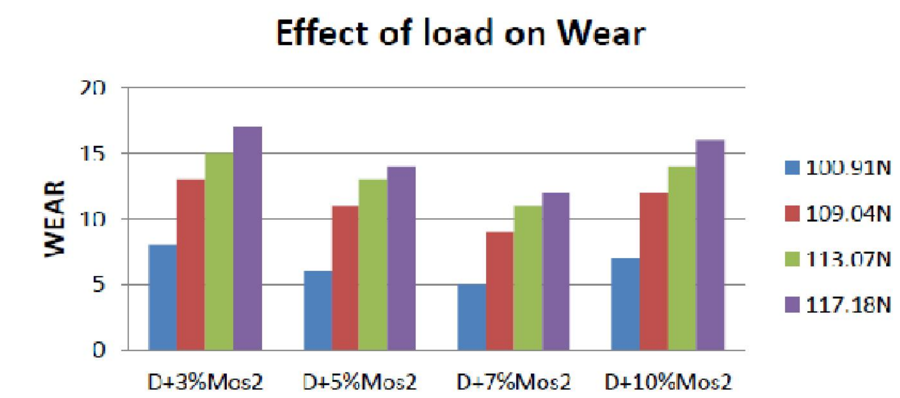
b. Variation of COF v/s Time plot for run 1 to 16



Graph No.7.2 COF vs Time plot for run 1 to 16

Graph 7.2 shows the variation of coefficient of friction with experimental time for run 1 to 16. At run 16 COF is minimum compared to other runs. At first COF increases with time after that it will decrease and take constant values. Hence at run 16 i.e. load of 117.189 N and sliding velocity of 0.12 m/s coefficient of friction has minimum value Than other runs. Hence at this condition PTFE + 40% Fiber material shows better performance at wet lubrication condition.

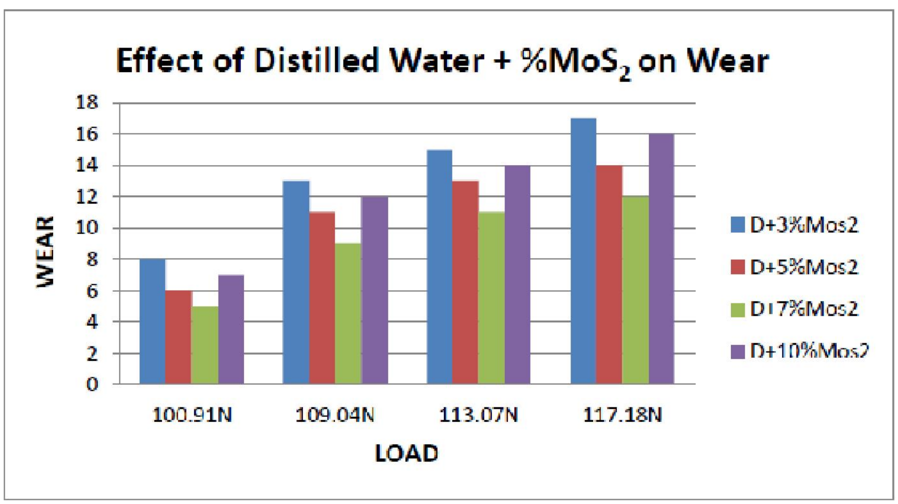
c. Effect of load with % MoS2 on Wear



Graph No.7.3 Effect of load on wear with Distilled water + % MoS2

Graph 7.3 shows that, the effect of load with Distilled water + varying % MoS2on the values of wear. In case of D+7% MoS2 wear is minimum as compared to othercombinations and also less wear value is observed in all D+%MoS2 combinations at lowload i.e.100.91 N from this we can conclude that as load increases wear value is also getincrease.

d. Effect of Distilled Water + %MoS2 on Wear



Graph 7.4 Effect of varying % MoS2 in distilled water as a lubricant on wear

Graph 7.4 shows that Effect of Varying % MoS2 in Distilled Water as aLubricant on values of wear. Wear versus load at D+3% MoS2, D+5% MoS2,and D+ 7%MoS2. D+10% MoS2 is plotted in the Graph. In this graph it is observed that as loadincreases wear value is also increase. And also from graph it is clearly seen that as %MoS2 in Distilled water increases wear value decrease upto D+ 7% and for D+10% wearvalue get increases.so from this graph we can easily conclude that as % MoS2 in distilledwater increases wear decreases. So we can easily use distilled water + % MoS2 as alubricant over IPOL.

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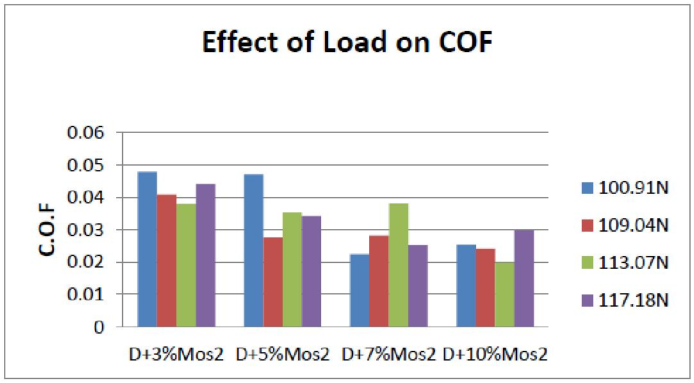
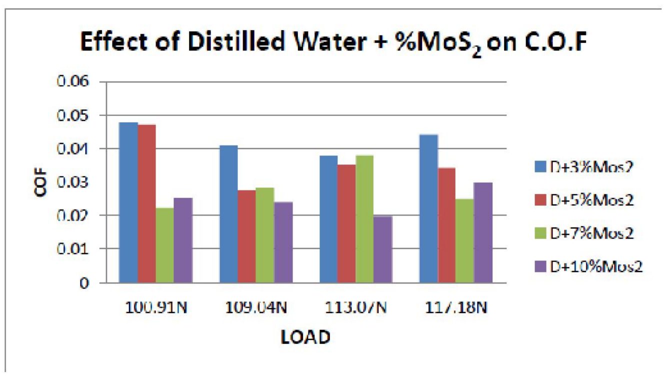
e. Effect of load with % MoS2 on COF



Graph No.7.5 Effect of load on COF with Distilled water + % MoS2

Graph 7.5 shows that the effect of load with Distilled water + % MoS2 as alubricant on coefficient of friction. Coefficient of friction is more depending on frictionalforce and normal load. As normal load increases frictional force is also get increased anditseffects on coefficient of friction. In the graph we can see that at minimum loadcoefficient of friction has maximum value but for average load coefficient of friction ismore minimum.

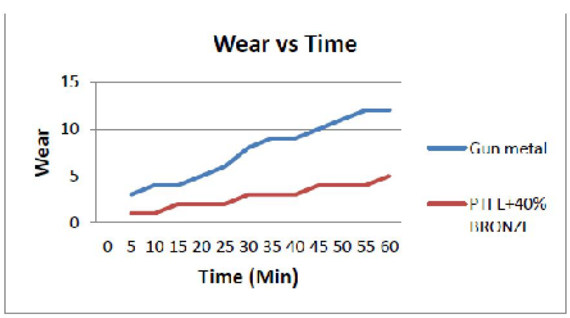
f. Effect of Distilled Water + %MoS2 on C.O.F



Graph No.7.6 Effect of varying % MoS2 in distilled water as a lubricant on wear %

MoS2 on COFFrom graph 7.6 we can observe that as % MoS2 increases in distilled water as alubricant increases C.O.F value get decrease. As seen in above graph less COF Observedin D+7% MoS2 and D+ 10% MoS2 as compared to D+ 3% MoS2 and D+ 3% MoS2.

B. Comparison between PTFE + 40% Bronze composite and GunMetal with Distilled Water+ 7%MoS2 as a lubricant for run 9



Graph 7.7 Plot of wear variation with time between PTFE + 40% Bronze and GunMetalthe Graph 7.7 is a plot of wear variation with time between PTFE + 40% Bronzeand Gun Metal. The graph shows that as time passes wear of both material increases.After some interval wear of both the material remains constant. For both materials we getbetter results at load 100.91N with distilled water+ 7% MoS2 as a lubricant. Hence bycomparing PTFE + 40% Bronze with actual material which is used in Sugar industry RollMill i.e. Gun Metal it is concluded that PTFE + 40% Bronze gives better performancethan Gun Metal.Hence we can use PTFE + 40% Bronze as bearing material with Distilled water+7% MoS2 as a lubricant.

IX. SEM ANALYSIS

Discussions

It is now fully recognized that Tribological behavior of polymer sliding against metal is strongly influenced by its transfer film forming ability on the counter face.Therefore, the transfer film is a very important researching point of polymericTribological material.Surfaces of tested pins of PTFE + 40% Bronze are examined under FieldEmission Scanning Electron Microscope. It gives microstructure of the surface so that wecan examine the wear losses. Some images are obtained by SEM are as follows

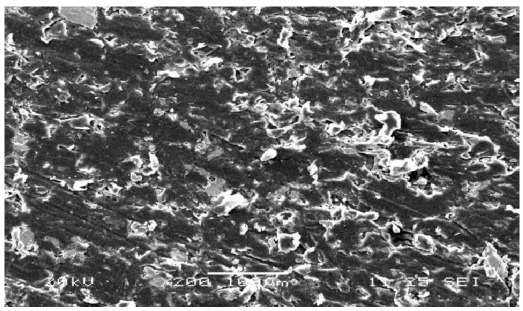


Figure 8: SEM structure of PTFE + 40% Bronze pin atWet lubrication before wear test

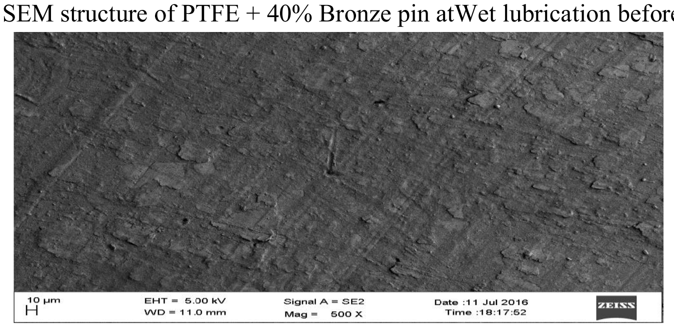


Figure 9: SEM structure of PTFE + 40% Bronze pin at Wet lubrication after wear test (Run 9)

Figure 8 shows the SEM photographic picture of surface of 40% bronze particles filled PTFE composite, before wear test showing the polishing marks on the bronze particles and plowing off on the PTFE matrix due to wearing of surface during polishing with 2000 grit silicon carbide abrasive paper before friction wear test. Figure 9 demonstrates the SEM photograph of worn surface of 40 % bronze particles filled PTFE composite, after wear test, at 100.91 N normal load, 0.12 m/s sliding velocity and Distilled Water + 7 % MoS2 Clearly it is distinguished that the polishing marks on bronze particles and plowing tracks on PTFE matrix are smoothened due to friction forming a transfer film of both PTFE and bronze. Transfer film formed isgood, thick and uniform covered the most of the area of the surface showing the less

Further wear of composite. No cracking on the surface perpendicular to the sliding direction is observed. From these SEM images, it is also examined that with distilled water + 7% MoS2as a lubricant at run 9 with minimum load ,sliding velocity 0.12 m/s and at speed 91.67RPM, PTFE+ 40% Bronze gives minimum wear. These figure shows that the transfer

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Film of PTFE and Bronze is created on the pin surface it interprets that in wet lubrication. Transfer film formed is good, thick and uniform.

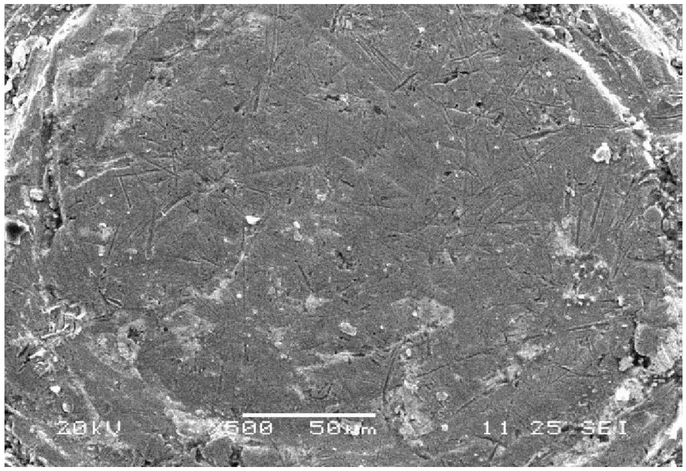

Figure 10: SEM structure of Gun Metal Pin atWet lubrication before experimentation

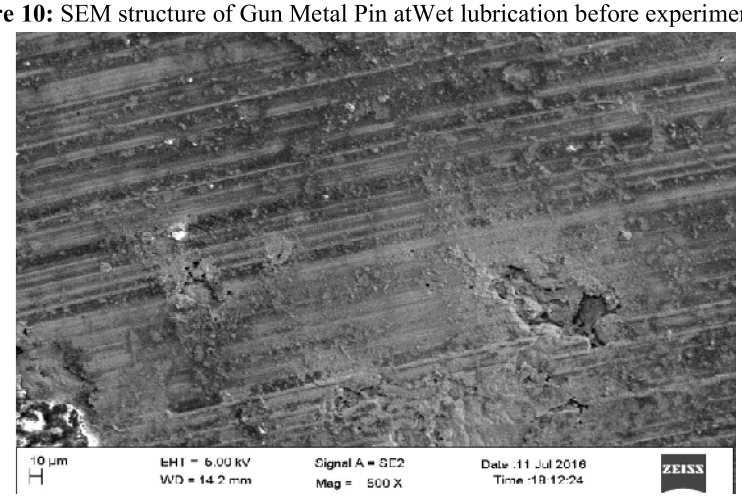

Figure 11: SEM structure of Gun Metal Pin atWet lubrication after experimentation (Run 9)

In wet lubricating condition Strong boundary layer is formed in between twomating parts it gives lift to the pin arm so wear indicator indicates the wear reading up to5µm & due to reduction in the frictional force indicator indicates the Small COF.

X. Conclusion

The following conclusions, from the experiential investigation can be made about the friction and sliding wear behavior of PTFE composites filled with bronze particles under the selected ranges of normal loads and sliding velocities.

- For the PTFE + 40% bronze composites, initially wear is more & after certain sliding time wear curve shows very small wear with time or it gets stabilized. This may be due to formation of more & more uniform transfer film on the counter face.
- Frictional coefficient initially increases with sliding time & later it remains almost constant due to more compact and uniform transfer film.
- Wear increases with increase in applied load.
- Depending upon selected load, and lubrication used in this study can be ranked as Distilled Water+ 7 % MoS2 > Distilled Water + 5% MoS2 >> Distilled Water + 3%

- MoS2 for their wear resistance Performance. However Distilled Water + 10% MoS2shows increase in wear.
- Bronze filled PTFE composites under experimental investigation register the stability in wear loss with time after the rapid initial wear.
- The variation in normal load is more responsible for decrement in coefficient of friction.
- From the investigation carried out, 40 % bronze particles filled PTFE composite material can be suggested as the best suitable self-lubricating material for sugarcane milling roller journal bearings to enhance the wear life of bearing

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REFERENCES

[1]. Alaister Cameron, 'Basic Lubrication Theory', Wiley Eastern Publications Limited, Third Edition, 215-221.
[2]. http://www.dupont.com/teflon/newsroom/history.html
[3]. Xian-Hua Cheng, Yu-Jun Xue, Chao-Ying Xie, 2003, 'Tribological investigation of PTFE composite filled with lead and rare earths-modified glass fiber', Materials Letters 57 (2003) 2553–2557.
[4]. David L. Burris, W. Gregory Sawyer, 2006, 'Improved wear resistance in alumina-PTFE nanocomposites with irregular shaped nanoparticles', Wear 260 (2006) 915–918.
[5]. H. Unal, U.sen, A Mimaroglu, 2006, 'An approach to friction and wear properties of polytetrafluoroethylene composite', Materials and Design 27 (2006) 694–699.
[6]. JaydeepKhedkar, IoanNegulescu, Efstathios I. Meletis, 2002, 'Sliding wear behavior of PTFE composites', Wear 252 (2002) 361–369.
[7]. Kyuichiro Tanaka, Santoshi Kawakami, 1982, 'Effect of various fillers on the friction and wear of polytetrafluoroethylene based composites', Wear 79 (1982) 221–234.
[8]. Donald R. Askeland, Pradeep P. Phule, 2003, 'The Science and Engineering of Materials', Fourth Edition, Thomsons Book/Cole Publication.
[9]. B. Suresha, G. Chandramohan, J. N. Prakash, V. Balusamy and K. Sankaranarayanasamy, 2006, 'The Role of Fillers on Friction and Slide Wear Characteristics in Glass-Epoxy Composite Systems.' Journal of Minerals & Materials Characterization & Engineering, Vol. 5, No.1, 87-101.
[10]. E. Hugot, 'Handbook of cane sugar engineering', Third, completely revised edition, 1986, chapter 11–13.
[11]. B. C. Majumdar, 'Introduction to Tribology of bearings', Wheeler Publishing, First Edition, 282–283.
[12]. T. S. Ingle, 'Gear Lubrication for mill roller journal', Proceeding of 67th Annual Convection of STAI 2006, Pg. 30–35
[13]. M. A. Lokannavar& C. G. Mane, 'Mill journal lubrication with grease new direction to Indian sugar industry', Proceeding of 67th Annual Convention of STAI (2006) 88–93.
[14]. H. Unal, A Mimaroglu, U. Kadioglu, H. Ekiz, 2004, 'Sliding friction and wear behaviour of polytetrafluoroethylene and its composites under dry conditions', Materials and Design 25 (2004) 239–245.
[15]. T. R. Jett and R. L. Thom, Marshall Space Flight Center, Marshall Space Flight Center, Alabama,1998, 'Database for the Tribological Properties of Self-Lubricating Materials', NASA/TM (1998), 1–12.
[16]. Y. R. Kharde and K. V. Saisrinadh, 2009, 'Effect of various fibers on tribological properties of polytetrafluoroethylene (PTFE) composites in dry conditions', International Journal of Maths., Science & Engineering Applications (IJMSEA) ISSN 0973-9424, Vol. 3. No. II (2009) 311–328.
[17]. N. V. Klaasa, K. Marcusa, C. Kellock, 'The tribological behavior of glass filled Polytetrafluoroethylene', Teratology International 38 (2005) 824–833.

[18]. Klaus Friedrich, Zhong Zhang, Alois K. Schlarb, 'Effects of various fillers on the sliding wear of polymer composites', Composites Science and Technology 65 (2005) 2329–2343.

[19]. G. Theiler , W.Hubner , T. Gradt , P. Klein , K. Friedrich, 'Friction and wear of PTFE composites at cryogenic temperatures', Tribology International 35 (2002) 449–458.

[20]. Yunxia Wang, Fengyuan Yan, 'Tribological properties of transfer films of PTFE-based composites', Wear 261 (2006) 1359–1366.

[21]. Bin-Bin Jia, Tong-Sheng Li, Xu-Jun Liu, Pei-Hong Cong, 'Tribological behaviors of several polymer–polymer sliding combinations under dry friction and oil-lubricated conditions', Wear 262 (2007) 1353–1359.

[22]. M. H. Choa, S. Bahadura, & J.W. Andereggb, 'Design of experiments approach to the study of tribological performance of Cu-concentrate-filled PPS composites', Tribology International 39 (2006) 1436–1446.