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A Review on Effects of Filler materials on the Tribological Behaviour of PTFE Composites

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Abstract: In this work an review and recent progress of PTFE and various fillers. PTFE is a thermoplastic polymer, which is a white solid at room temperature, with a density of about 2200 kg/m3. Its melting point is 600 K .Owing to its low co-efficient of friction. it is used for applications where sliding action of parts is needed: plain bearings, gears, slide plates, etc. The wear behaviour of polytetrafluroethylene filled with filler particles was studied on a pin on disc test rig. Solid lubricant composite materials were prepared by compression moulding technique. The parameters considered for the study were applied load, sliding speed and sliding distance and weight percentage of fillers. The experimental results indicate that the weight loss increases with increasing load, sliding speed and sliding distance, as expected. Sliding distance has more effect on weight loss followed by applied load. The dominant interactive wear mechanisms during sliding and its composites are discussed in this paper. The above four factors are selected on the basis of Effect–Cause analysis and literature survey.

Keywords: polytetrafluroethylene (PTFE), Friction, Pin on Disc,

I. INTRODUCTION

Nowadays, there is very intensive growth in the large scale production of the fibre reinforced polymer composites since they posses certain advantages over the metals. The advantages include lower density, less need for maintenance and lower cost [1]..Polytetrafluoroethylene (PTFE) is an important polymer based engineering material. When rubbed against a hard surface, PTFE exhibits a low coefficient of friction but a high rate of wear . It is white or gray in color. It is an ideal bearing material for heavy and light load pressures with medium and low surface speeds. PTFE has all qualities of bearing alloy like compatibility, conformability, embedability, load capacity, fatigue strength, corrosion resistance and hardness . The low-friction characteristics of PTFE are largely responsible for the inception of this paper. PTFE is a popular polymer solid lubricant because of its resistance to chemical attack in a wide variety of solvents and solutions, high melting point, low coefficient of friction, and biocompatibility. It is commonly used in bearing and seals applications. The low-friction characteristics of PTFE were largely responsible for the inception of this project. This resin is waxy in appearance, and white or gray in color, except that thin sheets are transparent. It is a crystalline solid with good stability from -320° to +500° F, and is chemically inert to known reagents and solvents except molten alkaline metals and gaseous fluorine under pressure. Its relative softness and poor heat conductivity limit its suitability as a bearing material to applications involving low speeds and low unit pressures. In present investigation various types of composite polymer materials such as PTFE filled with 40%Glass, 40%Carbon, 40% Bronze. PTFE composites are technically superior and economically cheaper friction material as compared to conventional bearing materials. A plan of experiments, based on techniques of Taguchi, was performed to acquire data in controlled way. An orthogonal array and the analysis of variance were employed to investigate the influence of process parameters on the wear of composites. An understanding of the friction and wear mechanisms would aid in the development of a new class of materials so as to counter the challenges faced by industries.

II. LITERATURE REVIEW

Prasad M.Patare[1], et.,al.have explained in the paper entitled " Effect of glass fiber on tribological properties of PTFE composites" in IJERT [2014]The effects of filler on the friction and wear properties of 15% glass fibre and 25% glass fibre filled PTFE (Polytetrafluoroethylene) composites under dry friction conditions were studied. Meanwhile the influence of filler content, sliding duration, test speed and load were also investigated. Experimental results shows that wear rate of PTFE reduced by addition of glass fiber and tribological properties also improved. The friction and wear tests were conducted on pin-on-disc apparatus. Prashant B.Patil[2],et.,al. have explained in the paper entitled "friction and wear behaviour of PTFE & its composites in dry conditions"in IJERT [2015] The effects of velocity of sliding, load and sliding distance on friction and wear of polymer material made of PTFE composites with filler materials such as glass bronze and carbon are studied. The experimental work is performed on pin-on-disc apparatus and analysed

with the help of Design- Expert software. Parameters are set for three different levels and in optimum possible combination by Taguchi experimentation design array. Wear rate is obtained as a response of experimentation and then further analysed in design expert software. Parametric relation is developed in the form of equation for each material composition. At the end all three materials are compared on the basis of wear rate and coefficient of friction.

H. Unal et al [3] "Sliding friction and wear behaviour of polytetrafluoroethylene and its composites under dry conditions" in Materials and Design 25 (2004) 239–245 presented the influence of test speed and load values on the friction and wear behaviour of pure polytetrafluoroethylene (PTFE), glass fibre reinforced (GFR) and bronze and carbon (C) filled PTFE polymers under ambient conditions in a pin-on-disc arrangement concluded that The friction coefficient of pure PTFE and its composites decreases when applied load increases also pure PTFE is characterised by high wear because of its small mechanical properties. Therefore, the reinforcement PTFE with glass fibres improves the load carrying capability that lowers the wear rate of the PTFE.

Jaydeep Khedkar et. al.,[4] have explained in the paper entitled 'Sliding wear behavior of PTFE composites',[2002]that the tribological behavior of polytetrafluoroethylene (PTFE) and PTFE composites with filler materials such as carbon, graphite, E glass fibers, MoS2 and poly-p- phenyleneterephthalamide (PPDT) fibers, was studied. The present filler additions found to increase hardness and wear resistance in all composites studied. The highest wear resistance was found for composites containing (i) 18% carbon + 7%graphite, (ii) 20% glass fibers + 5%
MoS2 and (iii) 10% PPDT fibers. Scanning electron microscopy (SEM) was utilized to exam in ecomposite microstructures and study modes of failure. Wear testing and SEM analysis showed that three-body abrasion was probably the dominant mode of failure for PTFE + 18% carbon + 7% graphite composite, while fiber pull out and fragmentation caused failure of PTFE + 20% glass fiber + 5% MoS2 composite. The composite with 10% PPDT fibers caused wear reduction due to the ability of the fibers to remain embedded in the matrix and preferentially support the load. Differential scanning calorimetry (DSC) analysis was also performed to study the relative heat absorbing capacity and thermal stability of the various composites in an effort to correlate these properties to the tribological performance. The results indicated that composites with higher heat absorption capacity exhibited improved wear resistance. The dominant interactive wear mechanisms during sliding of PTFE and its composites are discussed in view of the present findings.

S.M. Yadav et al [5] "Studies on wear resistance of PTFE filled with glass & bronze particle based on Taguchi techniques" in [2013]An attempt has been made to study the influence of wear parameters like applied load, sliding speed, sliding distance on the dry sliding wear of PTFE, PTFE+25% Glass and PTFE+40% Bronze composites. A plan of experiments, based on techniques of Taguchi, was performed to acquire data in controlled way. An orthogonal array and the analysis of variance were employed to investigate the influence of process parameters on the wear of composites. The experimental results shows that sliding distance and applied load were found to be the more significant factors among the other control factors on wear. The objective is to establish a correlation between dry sliding wear of composites and wear parameters. These correlations were obtained by multiple regressions. A good agreement between the predicted and actual wear resistance was seen.

P.D. Pansare et al [6] "Tribological behaviour of PTFE composie material for Journal bearing"in IJIERT[2015]In this study, the effect of load and sliding velocity on friction and wear of materials made of PTFE and PTFE composites with filler materials such as 25% carbon, 35% carbon, 40% bronze, 15% glass fiber, 15% glass fiber + 5% MoS2 have studied. The experimental work has performed on pin-on-disc friction and wear test rig and analyzed with the help of Design Expert software. The results of experiments are presented in tables and graphs which shows that the addition of carbon, bronze, glass filler to the pure PTFE decreases wear rate significantly and there is slight increase in coefficient of friction. The highest wear resistance was found for 15% glass fiber + 5% MoS2 filled PTFE followed by 35% carbon, 25% carbon, 15% glass fiber, 40% bronze and pure PTFE. Through this study, we can suggests the best suitable self lubricating material for sugarcane milling roller journal bearings to enhance the wear life.

Sonam M.Gujrathi et al [7] "wear studies on polytetrafluroetylene (PTFE) composites –Taguchi Approach"in IJIEM[2015]The present research work is aimed at developing a new material for industrial application. From literature review and surveying sugar factories from nearby area, it is found that conventional bearing material (Babbitt and bronze) leads to high wear rate as well as high coefficient of friction. Now a day's pure PTFE (polytetrafluoroethylene) is widely used as bearing material which is self lubricating and subjects to lower coefficient of friction, but problem with PTFE is that, it subjects to high wear rate, which can be reduced by adding suitable fillers. In this study, the effects of varying load, sliding distance, sliding velocity and filler content in PTFE are experimentally examined. A comparative analysis of three composites (PTFE, PTFE + 25% C and PTFE + 35% C) is presented showing how properties of PTFE can be improved by addition of filler content. A plan of experiment based on Taguchi technique,

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was performed to acquire data in controlled way. The results of experiments are presented in table which prove that the wear is strongly influenced by the composition of filler content. It was found that, by varying the different parameter like Load, Velocity and Sliding distance the PTFE containing 35% carbon percentage have the better wear performance.

B.A. Mudasar Pasha et al [8] "Dry sliding behaviour of PTFE filled with glass & bronze particles"[2015]

The wear behaviour of polytetrafluroethylene (PTFE) filled with 25% glass and 40% bronze particles was studied on a pin on disc test rig. Solid lubricant composite materials were prepared by compression moulding technique. The wear parameters considered for the study were applied load, sliding speed and sliding distance. The experimental results indicate that the weight loss increases with increasing load, sliding speed and sliding distance, as expected. Sliding distance has more effect on weight loss followed by applied load. The 40% bronzePTFE composite exhibits better wear resistance compared to other types. The dominant interactive wear mechanisms during sliding of PTFE and its composites are discussed in this paper.

III. CONCLUSION

History of Polytetrafluoroethylene and its evolution as a bearing material is discussed in above information. Literature survey gives a brief idea about how much work on this topic has already done. It also indicates future scope for PTFE composites. Plastics and composites involving polymers compounded with a wide variety of solid filler materials have found wide use, gaining their greatest impetus with the invention of nylon and PTFE. It can be observed that bronze in the transfer film effectively partaken in shear force applied onthe transfer film and its good ductility helped to improve tribological properties of PTFE.

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