

## A review on Wear Behaviour of clutch plate made of PEEK Composite Material

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**Abstract :** The conventional clutch plate made of carbon fiber and ceramic mixture of copper, iron, tin bronze, silicon dioxide, and/or graphite, typical alloy is a lamellar pearlitic gray iron like G11H20b of which, it can be replaced by developing of new materials for reducing the wear rate of the clutch plate the materials chosen is Poly Ether Ether Ketone (PEEK) based composites mixed with silicon carbide powder shows better results in which it can be manufactured by the injection moulding process and it is tested in Friction and wear experiment wear run under constant temperature in a pin-on-disc arrangement, PEEK and its composites used in this investigated the friction coefficient decreases with the increasing load on PEEK. The composite showed a very low friction coefficient and wear rate increase in the normal applied load sliding distance decreases wear rate. Further the wear and friction behaviour decreases with increases the gradually by addition of fillers.

**Keywords -** Wear, Friction, injection moulding, silicon carbide, PEEK Composite.

### I. INTRODUCTION

Composite materials are utilized as a part of vast volume in different designing structures including space creates, planes, vehicles, pontoons, games' hardware, extensions, structures and Industrial. Composite materials have effectively substituted the customary materials in a few light weight and high Strength applications. Least Wear of segment or part utilized as a part of car application is imperative variable for the Industry. The grasp plate allows a relative movement between the contact surfaces of the coals, Transmit the power with little loss of force because of rubbing, to decrease the frictional resistance and wear, by high loads, low sliding speeds and substantial contact range. Since glass filaments have low quality, high flexural modulus and low extension rate, they are the most widely recognized fiber fortifications of thermoplastics to lessen the development rate. Te tribological conduct of PEEK (Poly-ether-ether-ketone) composites fortified by 30% short glass fiber and phosphor bronze Polymers with such capacities ought to be assessed for exact tribological attributes, for example, erosion and wear rate, The rubbing and wear rates are regularly acquired from little scale stick on-plate mechanical tests are favored due there ease or time and simple treatment of the test examples. These strategies give essential data about grinding and wear instruments and are valuable for preparatory material arrangement..

### II. LITERATURE REVIEW

S. M. Muzakkir, Harish Hirani[1] Experimental examination has been completed to recognize the impact of pounding heading on the wear of the sliding surfaces subjected to overwhelming burden and low sliding speed with molybdenum disulphide MoS<sub>2</sub> as added substance in business ointment. The conformal piece and plate test setup has been utilized to lead probes conformal obstructs with two crushing headings: one along the course of sliding and different over the bearing of sliding. The wear of the piece is measured as its weight reduction after the test. David L. Burris, W. Gregory Sawyer [2] PEEK is a high quality designing thermoplastic that experiences a high contact coefficient and a grinding instigated wear mode. A compositional evaluating of PEEK and PTFE is executed in this review to make a mass composite with the utilitarian necessities of segment quality, firmness and wear resistance while giving strong oil at the sliding interface. The tribological exhibitions of three practically reviewed PEEK segments were assessed on direct reacting to, pivoting pin-on-plate. H. Unal, A. Mimaroglu [3] has considered and investigated the impact of test speed and load values on the rubbing and wear conduct of immaculate Poly tetra fluoro-ethylene (PTFE), glass fiber fortified (GFR) and bronze and carbon (C) filled PTFE polymers. Erosion and wear investigations were keep running under surrounding conditions in a stick on-circle game plan. Tests were completed at sliding velocity of 0.32-, 0.64-, 0.96-and 1.28-m s<sub>-1</sub> and under an ostensible heap of 5-, 10-, 20-and 30-N. The outcomes demonstrated that, for unadulterated PTFE and its composites utilized as a part of this explored, the grating coefficient diminish with the expansion in load. Jayashree Bijwe, Sukanta Sen [4] The ideal creation of PEEK-PTFE mixes for the most ideal blend of mechanical and tribological properties in the glue wear mode. Nothing is accounted for in this setting on low abundancy swaying/fussing wear mode. Also, the impact of expanding measures of PTFE in the

mix on grating wear conduct alongside a connection with quality properties is not revealed. Henceforth, in this work, five infusion formed mixes of PEEK with PTFE (in the scope of 0–30 wt.%) were assessed on a stick-on-plate design on a SRV Optimol Tester for their tribo-conduct in the low abundance swaying wear mode. Sung-Won Yoon, Yun-Hae Kim [5] The grating and wear conduct of carbon fiber and PEEK sheet composites, and the legitimacy of utilizing them as other options to the metal-based materials utilized for fake hip joints. In addition, this work assessed the grating coefficient as indicated by the fiber utilize introduction, alongside the cracked surfaces of the carbon/PEEK composites. The unidirectional composites had higher rubbing coefficients than those multidirectional composites. Sonam M. Gujrathi, Prof. L.S. Dhamande [6] The examination work is gone for building up another material for mechanical application. From writing audit and looking over sugar industrial facilities from close-by region, it is found that ordinary bearing material (Babbitt and bronze) prompts high wear rate and also high coefficient of contact. Presently a day's immaculate PTFE (poly tetrafluoroethylene) is broadly utilized as bearing material which is self greasing up and subjects to lower coefficient of grinding, yet issue with PTFE is that, it subjects to high wear rate, which can be diminished by including reasonable fillers. In this review, the impacts of differing burden, sliding separation, sliding speed and filler content in PTFE are tentatively inspected. A relative investigation of three composites (PTFE, PTFE + 25% C and PTFE + 35% C) is introduced indicating how properties of PTFE can be enhanced by expansion of filler substance. An arrangement of investigation in view of Taguchi system, was performed to procure information in controlled way. The aftereffects of trials are exhibited in table which demonstrate that the wear is firmly affected by the piece of filler substance. It was found that, by shifting the diverse parameter like Load, Velocity and Sliding separation the PTFE containing 35% carbon rate have the better wear execution. Peeyush Vats, B.C. Sharma [7] A diary bearing is intended for particular application. The bearing is outlined by the information accessible for the given bearing understudy. This examination should generally be possible with the progressed composed instrument like FEA. This papers manage the hypothetical warm investigation of a diary bearing by indicating temperature appropriation, warm created and warmth disseminated through the surfaces of the diary bearing. S. M. Muzakkir, Harish Hirani [8] Slow-speed diary heading subjected to overwhelming burdens work in a blended/limit grease administration. Leeway and oil assume vital parts in diminishing the wear and grating in these direction. In the present article, a trial consider on intensely stacked moderate speed diary course with different spiral clearances greased up with three unique ointments is exhibited. Ointments with changing viscosities and containing diverse rates of against wear added substances have been utilized. Bearing surface harshness and out-of-roundness are dealt with as clamor parameters. The aftereffects of contact coefficient and aggregate wear have been accounted for. The trial comes about recommend that a grease with high consistency and hostile to wear added substances essentially diminishes the coefficient of grinding and measure of wear under shifting bearing clearances, circularity, and cylindricity. The utilization of such a hearty grease may deter the impact of assembling vulnerabilities. This outcomes in lessening of assembling and estimation costs. M. Conte n, A. Igartua [9] A near examination of seven PTFE composites is exhibited indicating how properties of PTFE can be enhanced regardless of the possibility that the most alluring normal for low rubbing is lost because of the nearness of hard particles in the polymer framework. How the utilization of both delicate and hard stages in a polymer lattice upgrades the self-greasing up and the heap conveying properties of the framework enhancing the tribological properties of the PTFE is exhibited. Wojciech Wieleba [10] The condition of strain fluctuates in a polymer material amid sliding against steel. The purposes behind this are, in addition to other things, flaws of state of the surface of the reaching steel component and the oscillatory character of the rubbing power. The viscoelastic way of polymer materials (significant inward contact) implies that under such conditions a specific measure of grinding vitality is dispersed as warmth inside these materials, adding to their warming up. Consequently the inside rubbing for chose PTFE composites has been explored, and additionally the temperature dissemination on the surface of PTFE tests sliding against steel under dry grating conditions. It was watched (utilizing a thermo vision framework) that the most elevated temperature happened inside the polymer material, at some separation from the grinding surface. That vouches for the era of warmth amid grating, not just on the contact surface of the sliding materials additionally inside the polymer material. Sung-Won Yoon, Yun-Hae Kim [11] The rubbing and wear conduct of carbon fiber and PEEK sheet composites, and the legitimacy of utilizing them as other options to the metal-based materials utilized for simulated hip joints. In addition, this work assessed the erosion coefficient as indicated by the fiber handle introduction, alongside the cracked surfaces of the carbon/PEEK composites. The unidirectional composites had higher

rubbing coefficients than those multi-directional composites. This was brought about by the de holding between the carbon fiber and the PEEK sheet, which was corresponding to the contact territory between the sliding surface and the carbon fiber. The erosion test comes about demonstrated that there was no noteworthy contrasts in connection to the fiber utilize introduction. Notwithstanding, for a situation where the speed was 2.5 m/s, the rubbing coefficient was generally expansive for setup Géraldine Theiler, Thomas Gradt [12] The tribological tests completed with polyether ether ketone(PEEK), loaded with carbon strands and strong ointments (poly tetra fluoroethylene (PTFE), graphite or MoS<sub>2</sub>), against steel circles. Wavering sliding tests were performed in high vacuum condition in the temperature run between - 40°C and +160°C. Comes about demonstrate that MoS<sub>2</sub> filled PEEK demonstrate the best tribological execution in vacuum. Especially, in the lower temperature go and at higher burdens the grating conduct is enhanced by the MoS<sub>2</sub> content. Mr. Mankar N.A.Prof. Rijumon K [13] the improvement and portrayal of another class of half breed polymer composites comprising of Polyether-ether-keton (PEEK), polytetrafluoroethylene (PTFE), Bronze and MoS<sub>2</sub>. The impacts of different contact temperatures on the tribological properties of PTFE/PEEK composites were concentrated under dry and in addition wet grating conditions. In addition, the impact of different weights on the erosion and wear practices of the PTFE/PEEK composites was explored. Look is a semi-crystalline polymer utilized as uncommon building plastic because of its superb mechanical limit, great substance and warm strength. Look composites are regularly utilized as compressor cylinder rings or valve cuts for their exceptional mechanical and warm execution at high temperature conditions, where PTFE composites may neglect to benefit. In any case, high contact coefficient and wear rate of immaculate PEEK constrain its more extensive utilize numerous analysts found that PEEK is great in mechanical trademark yet less great exhibitions of tribological properties. However PTFE demonstrates better exhibitions of tribological properties. The impact on the erosion and wear practices of PEEK polymer composites has been enhanced, with expansion of PTFE at room temperature. There are different operation performed in industry by various machine parts, for example, high weight compre

### **III. METHODOLOGY AND MATERIAL**

#### ***Analytical methods***

The Taguchi procedure is an intense plan of analysis apparatus for obtaining the information controlledly and to examine the impact of process variable over some particular variable which is obscure capacity of these procedure factors and for the outline of brilliant frameworks. This strategy was been effectively utilized by numerous scientists in the investigation of wear conduct of PEEK composites materials. Taguchi makes a standard orthogonal cluster to oblige the impact of a few variables on the objective esteem and characterizes the arrangement of investigation. The trial results were examined utilizing ANOVA to concentrate the impact of parameters. Taguchi strategy is an effective device for the outline of amazing frameworks. It gives a straightforward proficient and precise way to deal with upgrade plans for execution, quality and cost. The system is profitable when plan parameters are subjective and discrete. Taguchi parameter configuration can upgrade the execution qualities through the setting of outline parameters and lessen the affectability of the framework execution to wellspring of variety. This procedure is multi-step prepare, which take after a specific grouping for the examinations to yield an enhanced comprehension of item or process execution.

#### ***Experimental Detail***

Materials used in this experiment for PEEK Composites material clutch plate design of diameter 96 mm and internal diameter of 56 mm it has been molded using solid work and it ortho -graphic views are shown in Fig. 1 which is taken for the consideration in experimental setup.

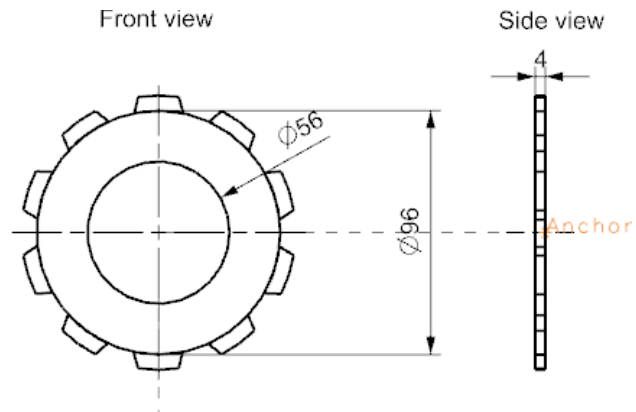


Fig.1. Orthographic view of clutch plate

Following Table.1 shows the different composition of the clutch plate is taken for the experimental reading the different materials are combined to form the wear characteristics of the composite.

Table 1.Composition of the material (Vol %)

Material	PEEK	PTFE	C.F.	Bronze	MoS2	G.F.
A	60	15	15	10	-	-
B	60	15	15	-	10	-
C	60	15	15	-	-	10

**Experimental setups**

Pin on Disc friction and wear monitor TR 20L is used to investigate wear characteristics of PEEK composites as per ASTM G 99 standards. The disc used is EN-31 stainless steel with hardness 60 HRC, 140mm Trac diameter and 8mm thick, with surface roughness of 0.3Ra. Complete arrangement of Experimental set up is shown in fig.2. Below



Fig.2: Pin on Disc test setup

**Results and discussions**

Before leading the test, the stick and the plate surfaces were cleaned with emery papers so that the contact will be smooth. All the destroy tests were conveyed according to ASTM G-99 standard under un greased up condition in an ordinary research facility environment at 50–60% relative moistness and a temperature of 28–30 °C. Each test was completed for 6 h run. Consistent heaps of 1 and 20 kg were connected amid the wear test for the examples; the weight reduction was measured for the predefined time interims. The weight reduction in the example after each test was assessed by measuring the heaviness of the example previously, then after the fact each test utilizing an electronic measuring machine having an exactness of up to 0.01 mg. Mind has been taken so that the examples under test are consistently cleaned with woolen material to stay away from the capture of wear flotsam and jetsam and to accomplish consistently in experiential strategy. The test pieces are cleaned with tetra-chloro-ethylene arrangement prior and then afterward each test. Scraped spot misfortune is found as 0.6 g for 1 kg connected load Abrasion misfortune is found as 0.8 g for 20 kg connected load. Load is connected through a dead weight stacking framework to press the stick against the circle. The frictional drive emerging at the contact can be perused out from the controller. The speed of the circle or engine (rev min<sup>-1</sup>) can be fluctuated through the controller. For Particular kind of composite, 27 sets of test pieces were tried. Each arrangement of test was done for a time of 6 h run. After every hour, the test pieces were expelled from the machine and weighted precisely to decide the misfortune in weight.

The outcome for each specimens has been stacked and it comes about has been shaped and enter in chart, the outcomes demonstrated that wear conduct regarding time in moment are appeared in the fig.3. Particular wear rate of PEEK/PTFE/MoS<sub>2</sub> blend of the grasp plate has been found with 20 kg stack observed to be  $4.70 \times 10^{-7} \text{mm}^3/\text{Nm}$  is less as analyzed different mixes. The Specific wear rate of PEEK/PTFE/Bronze for 40N stacking condition is  $4.30 \times 10^{-6} \text{mm}^3/\text{Nm}$  which is less when contrasted with different blends

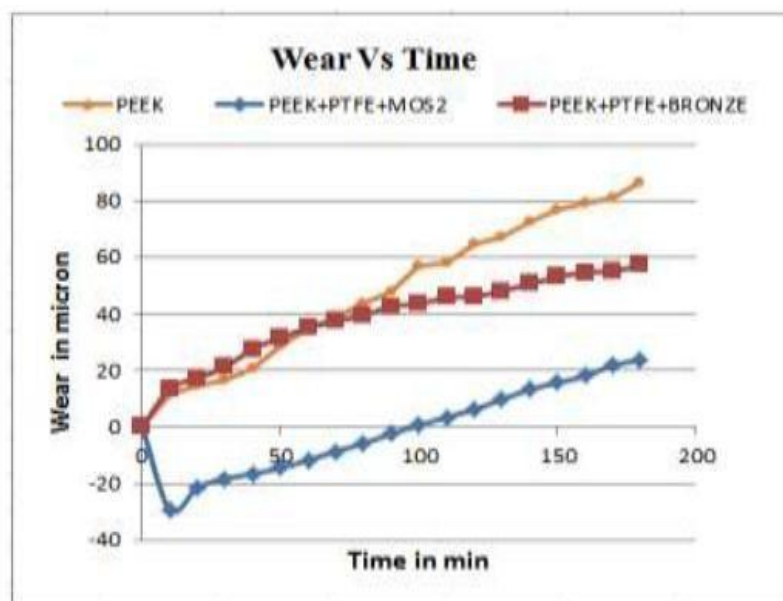


Fig.3. Wear rate of PEEK and PEEK composites at constant temperature and 20 kg load

The graph is shown in fig.4. gives the set of results for the coefficient of friction vs time in minute, from this graph it identified that the maximum wear occurs at the PEEK material when compared to other combined materials , the load is varied with that the constant temperature are calculated for the various combination of materials, the maximum time limit of 175 min, PEEK materials alone can able to sustained wear of 80 micron, PEEK with bronze combination shows wear up to 58 microns.

This type of behaviour exhibit the maximum wear occurs in the peek by addition of filler materials shows the wear gets reduced.



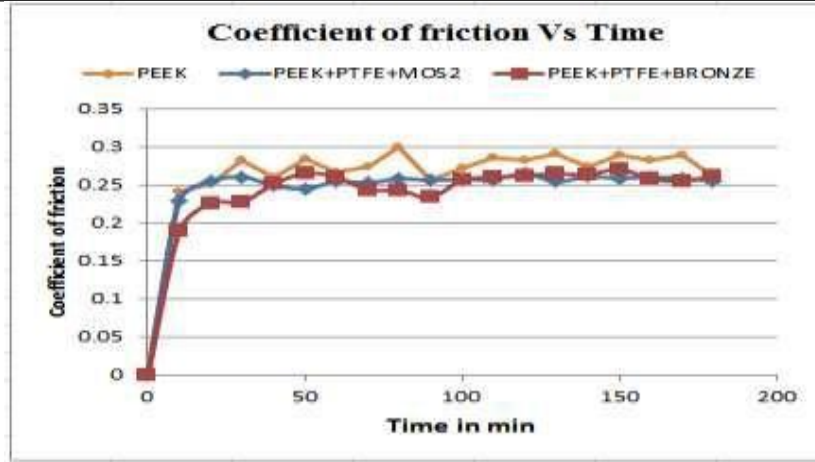


Fig.4. Coefficient of friction of PEEK and PEEK composites at constant temperature at 20 kg load

Load: - It is a common knowledge that the friction force is proportional to the normal applied load (the first law of friction). Load is applied through the lever and the pulley arrangement. Considering the pressure of 38.67 N/mm<sup>2</sup> to 49.21 N/mm<sup>2</sup> in the application between sugar mill journal & bearing in this particular experimental set up is applied by the weight of 20 kg

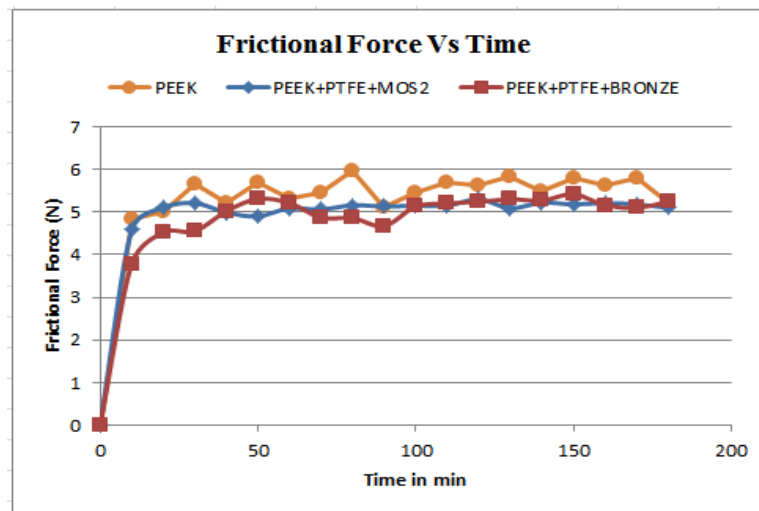


Fig.5. Frictional force of PEEK and PEEK composites at ambient temperature and 20N load

Particular wear rate of PEEK/PTFE/MoS2 at encompassing Temperature and 20N load observed to be  $4.70 \times 10^{-7}$  mm<sup>3</sup>/Nm is less as thought about different blends. The Specific wear rate of PEEK/PTFE/Bronze for 40N stacking condition is  $4.30 \times 10^{-6}$  mm<sup>3</sup>/Nm which is less as contrasted and different blends. It is additionally found that particular wear rate of PEEK/PTFE/Bronze at high stacking condition as 80 N is  $4.28 \times 10^{-6}$  mm<sup>3</sup>/Nm is less as thought about different blends. This demonstrates the particular wear rate of PEEK diminished with expansion 15% PTFE and 15% MoS2 at low stacking condition.

Speed: It is concurred that the rubbing power is free of the sliding speed. This proposition is substantial with a decent guess just for the situation where the contact temperature shifts inconsequential and, subsequently, the interface does not change its conduct. The unit is outfitted with a 1.5 HP, variable speed engine with a  $\pm 0.5\%$  exactness (full scale) designed for 220 V, single stage, 50 Hz..

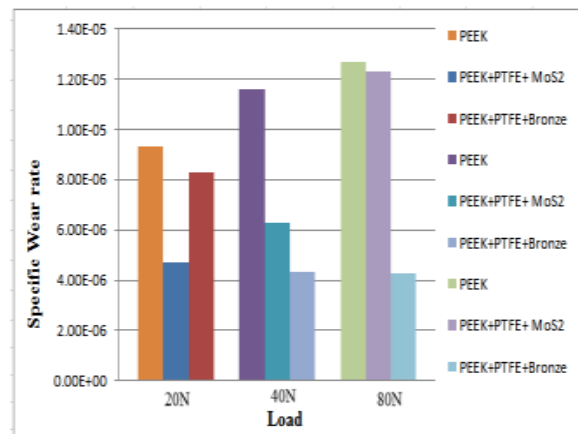


Fig.6. Effect on specific wear rate at constant temperature different loading Conditions

The engine drives the upper vertical shaft on which the base plate is set. The speed is controlled utilizing control potentiometer with speed ranges from 80 to 2000R.P.M. Considering the rotational speed of diary as 4.5 R.P.M. with 1000 mm distance across the straight speed is around of 0.235m/s. The same was accomplished in this specific test setup by fluctuating the separation of stick from the focal point of circle (sweep of revolution) and by shifting the R.P.M. Temperature: Polymers as viscoelastic materials are exceptionally touchy to frictional warming. It is outstanding that rubbing is a common dissipative process in which mechanical vitality is changed over into warmth. The warm condition of erosion contact is every now and again a definitive variable while assessing the execution of a rubbing unit. In this specific trial work no such offices were accessible for the test fix. The room temperature amid the test condition was kept around 27°C. During the test the ecological temperature can be recorded. Contact Area: Contact zone between the stick and plate Contact territory between the stick and circle is 58.265 mm<sup>2</sup>. (Breadth of stick is 10 mm.) Sliding Distance: Sliding separation was consistent all through the analysis for various mating surfaces for all conditions.

#### IV. CONCLUSION

The Tribological ideas have been effectively connected in building up another plan of the sugar process diary bearing which could work in blended grease of the bearing and in addition the diary from the investigation of the dry sliding wear of the PEEK composites.

1. Look composites have much good mechanical and Tribological properties as contrast with plain PEEK.
2. Wear rate is straightforwardly relative to stack connected.
3. Coefficient of rubbing is contrarily relative to the heap connected.
4. Wear increments as harshness of counter surface increments.
5. Change in rubbing power and temp. As wear parameter is change.
6. MoS2 and Bronze is broadly utilized as strong grease material. These materials effectively enter the harshness valley and steadily remain on circle. It gives important oil amid sliding. This is useful to lessen the wear and increment wear life of part.
7. It is presumed that inorganic materials like MoS2, bronze Power as fillers could successfully delay the wear life of Transfer film of PEEK based composites.

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