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Performance Assessment of Silicon Carbide Roller Bearings under Thermal Loads

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ABSTRACT

The overall objective of the present study is to evaluate and compare thermal analysis and performance of ceramic material that is silicon carbide for bearings and the conventional bearing material. Mostly bearings are rusting due to the high speed friction which causes the failure of bearings, which occurs due to high speed rotation of bearing at variable loads and operating condition. This provides the growing interest in the application of ceramics for bearing, as it is high corrosion resistance due to its unique properties. However, heat tolerance appears when they are in contact with other material at high speed and thus the experimental test are performed on the friction wear test machine that is Pin on Disc.

Keywords: - Rolling Contact Bearing, pin on disc, ceramic material, wear, Friction

1. INTRODUCTION

Silicon carbide ceramics have great properties such as low density, high rigidity, high temperature strength, corrosion resistance and corrosion resistance even at high temperature. They are attractive to various tribal applications such as bearings, mechanical seals, nozzles, turbine parts, heat exchangers, fusion reactor, cylinder liners, cutting tools, etc. [1] The load bearing capacity of the bearing is affected by bearing the design and applications of bearings and materials used for the bearing. Different types of bearings such as, ball bearing, roller bearing, linear bearing. selection depends on different applicationsof bearings Applications are of different types such as, high rotation speed, average load application, etc.[2] Materials of bearing cost also change with load and speed capabilities. In most cases bearing failure occurs due to vibration, shock loading and also rust. Design of bearing to different categories such as carrying radial load, axle bearing, orientation. Radial bearing is used to support radial loads. For the radial load the bearings used are angled and axial thrust bearings are used. [3]

The most common problem occurs in overload due to high speed and friction in pulleys and internal and external races. The bearings which bears the higher temperature than the material capacity leads to a change in shape and size of bearings[4] The large failure tolerance is the cause of wear and tear. The load often fails because of the high-speed heavy load, due to the high amount of friction caused by the high temperature, which makes the rolling element and the internal and external races of defects or rust. Several studies have been reported on wearing a cylindrical bearing in literature. In the beginning, the carrier bears no corrosion of the fixed load condition and constant velocity conditions, but with increased load speed and shocks increases the impact of the bearing. Ball bearings consist of three types, namely radial contact, angular contact and thrust bearings designed to support axle loads. Roller bearings bear high load capacity due to their size and are therefore used in heavy applications.[4] Periodic stresses developed on friction surfaces during the working condition of the bearing including the state of the three axis stress, where the load life is reduced due to the sliding contact.[3] There are many materials used to determine the bearings for the specific applications, Depend on some parameters such as life, load, and speed.

Bearings are also of different types based on applications and uses such as ball bearings, spherical bearings, cylindrical, etc. Bearings are special purpose applications are ceramic bearings used in high speed applications to generate minimum temperature applications Ceramic materials also contain a few types such as Sic, Si3N4, Al2O3. [5] Wear analysis on the silicon carbide coated HSS pin on SS disk substrate Wear plays an important role in reducing the life time of cutting tools. This investigation focuses on the impact of silicon carbide coated and non-coated on the HSS material. Silicon carbide powder was coated on a high speed steel pin using PVD technology. Stainless steel was chosen as a working piece material. Performance parameters such as volume loss, corrosion rate, improved stresses and high temperature between high speed coated steel pin and high speed non polished steel pin were compared when the stainless steel disc. [6] Performance and coefficients of friction were calculated values obtained from the pin test on the disc. Great resistance to wear of obtained with coated material has been achieved. Scanning Electronic microscopy analysis (SEM) and X-ray dispersion analysis (EDAX) were used in these techniques. [6] The PVD coating on the high speed steel tool has been successfully executed, and the stainless steel machining process has been carried out. The parameters carried out are given below. The pin loss size of the uncoated pin and coated pin is 27468.72 mm 3 and 19394.75 mm 3 . Similarly, the loss of disk size from the uncoated side and the coated nails are 392.6 mm 3 and 44.97 mm cube respectively. This indicates that the coated pin is less volume loss in the pin and disk. The wear rate of coated and uncoated pin is 3.289x10-14 mm / Nm and 2.192x10-14 mm / nm, respectively.[6] In the case of compressive pressure point, the non-coated pin has about 800 kPa and the coated pin is only 600 kPa. So that less compressive stress in the coated pin also the temperature is high in the coated pin (160 K) which is lower than that of the uncoated pin (250K). Due to high temperature, heat pressure will be urged. The maximum recorded recorder is 550MPa. But the non-coated pin has a maximum of 800 Mpa. From the coating process we can conclude that the metal powder coating on the tool enhances the properties of the tool with increasing productivity and increasing the shelf life of the tool. Working pieces can be made harder than the tool after the coating process. [6] Alumina and silicon carbide under lubricated sliding. L. C. Erickson et al. investigate the tribal characteristics of four different types of homogeneous alumina ceramics, alumina reinforced silicon carbide, mono crystalline silicon carbide and silicon carbide during slippery slide. Advanced techniques of electron microscopy and spectroscopy were used to characterize materials before and after testing. Tests were conducted where two level discs were rotated against each identified and discussed [7] what clearly emerges from these studies is the most The ability to maintain smooth surfaces and thus a high degree of hydrodynamic lubrication is largely due to the ability of the water to dissolve the debris of corrosion formed other under a closed connection in an oil and water environment. The rough fracture surfaces and the fact that the corrosion fragments form an intermittent surface layer will reduce the effect of lubrication, thus accelerating corrosion. Furthermore, a deformation layer is formed with small cracks in the contact which reduces corrosion resistance. [7] From this paper, it is clear that SiC and SiSiC have higher resistance to wear and more predictive corrosion behavior than AI2O3 and WRA under close sliding, water shattering. Al2O3 and WRA (Whiskers reinforced alumina) generate rugged wear surfaces including the formation of irregular ribbons. The dominant corrosion mechanism is surface fracture. On the other hand, SiC and SiSiC produce smooth sliding surfaces that effectively benefit from water lubricating films. The dominant corrosion mechanisms are the fine corrosion of the fine oxidizing silica layers and the small fracture. All the materials show a deformed sub surface layer and a finely cracked cleft of 200-300 nm in thickness. [7]

Table 1:- Properties of the ceramic materials investigated [7]

Materials	**Chemical Composition**	**Grain Size (μm)**	**Porosity (%)**	**Fracture Toughness**	**Hardness (HV)**
Al_2O_3	Al2O3>99%,SiO2<0.1%	10-20	3.0	4.5	1500
WRA	Al2O3,SiC-Whiskers 25%	2-5,0.7	< 0.5	8.0	2250
SiC	SiC 92%	3-7	< 1.0	4.6	3200

Sliding performance It is necessary to have smooth sliding surface in the case of fully hydrodynamic. The reason for giving silicon carbide better performance than alumina in slip sliding to its ability to generate and maintain smooth contact surfaces. This fact cannot be linked to mechanical properties because it is the same size as silicon carbide and alumina. On the other hand, their good thermal properties may reduce the risk of excessive heat accumulation and hence the tendency to thermal expansion and heat-induced surface breakage. High thermal conductivity and thermal shock resistance of silicon carbides are the most common properties The good performance of this material is attributed to sliding lubrication. However, we believe that tribal chemical reactions are more important for corrosion resistance than SiC and SiSiC. The reason why ribbons are not easily formed, as in dry slipping, is due to the above-mentioned water ability to dissolve the SiO2 corrosion and water / oil shale to transport it away from the contact area, thus relieving the surface of the terrain. In addition, thin silica layers are thought to promote low and uniform erosion and protect the surface from sudden breakage. Molecules are removed by the molecule or dissolved, leading to very smooth surfaces that maintain better performance of the lubricating membranes. Also, the fact that carbide forms ribo films with useful properties under dry conditions should be an advantage in situations with the risk of transition to extreme wear and tear. [7] Alumina (Al_20_3 and WRA), on the other hand, has no potential as lethal agents in border lubrication. High pressure and sliding Speeds lead to increased pressure concentrations in the surface which may lead to fracture and thus increase surface roughness. The main reason for the failure of alumina in the test at 80 ° C was probably the low viscosity and the corresponding loss of carrying capacity of oil / water lubricants, resulting in increased contact with asphalt and final breakage. The beneficial protection of alumina provided by water films competes with the deteriorating impact of water on the mechanical strength of surface materials due to pressure corrosion. [7] Friction properties Wear SiC SiC and Si3N4 against ZrO_2 ceramics under dry friction The friction and wear of SiC and Si3N4 against Zirconia (Y-TZP) were tested under dry friction conditions and room temperature by X. Tian, B. Lin and W.L. Zhang with a pin on the boat disk at a slope of 0.56 m.s-1 and normal load of 50 N, 80 N and 120 N, respectively. The friction coefficient and corrosion rate were found to depend on the duration of the test as well as the normal load. Through analysis and comparison, the friction rates of the frictional couple are both at 10-6 mm 3 (N.m) -1. Based on the varied organization of wear maps, the couple wear mechanisms have been analyzed. Between the couple, the friction characteristics and wearing the SiC / ZrO2 couple are better than the Si_3N_4 / ZrO_2 couple. [8]

Table 2: Mechanical and physical properties of ceramic samples [8]

Materials	Density [g/cm^3]	Hardness [Gpa]	Flexural Strength [Mpa]	Fracture toughness [Mpa.m$^{1/2}$]	Elastic modulus[Gpa]	Diameter[mm]
SiC	3.086	25	443	4.81	430	13.2
Si_3N_4	3.24	18	900	6.3	300	10.36
ZrO_2	-	12.9	419	8.98	216	-

Tribal tests were performed using a high speed MG-200 and a high temperature tribometer via the disk on the pin. The discs tested by ceramic (Y-TZP) of zirconia were tested. The nails are prepared by silicon carbide (SiC) and silicon nitride (Si3N4). The disks were all pins. Their physical characteristics and the size of materials used in the table are given. Dry slide experiments were conducted in room temperature and unubrication. Ceramic pins SiC and Si3N4 slide against the turntable on the pressure scale. The normal loads applied to the pins were 50 N, 80 N and 120 N, respectively. The sliding speed was fixed at 0.56 m / s. Before and after the test, all samples were cleaned by acetone. [8] Based on the silicon carbide pre-test, silicon nitride silicon slips against a zirconium disc under room temperature conditions and is not charged. The friction coefficient of the SiC / ZrO_2 pair changes slightly and one of the Si3N_4 / ZrO_2 pairs increases with increasing loads. It is considered as micro abrasion / micro ploughing. The overall wear loss of the pin to the SiC / ZrO_2 pair increases and the number of Si_3N_4 / ZrO_2 increases with increasing loads. But the total corrosion loss of the Si_3N_4 / ZrO_2 couple pin higher than the SiC / ZrO_2 couple in the same conditions. Increased total disc loss losses of two couples with increased loads. But the total corrosion loss of the Si3N4 / ZrO2 disk is the largest at 50 Newton. There is a slight decrease with increased loads at 80 Newton, 120 Newton. The result is that the friction characteristics and wear of SiC / ZrO_2 are better than the Si_3N_4 / ZrO_2 couple. [8] Thermal analysis, load characteristics and coefficient of friction for ball bearings Experimental and analytical analysis was performed by Jafar Taqiibi and M.M. Khonsari [9] Experimental analysis of spherical ball bearings contains internal and external ring balls and steel balls. This work studies that the balls expand because of the heat resulting from the friction between the inner ring and the outer ring and the balls. The test was performed at different speeds of 2500 rpm at 5600 rpm and variable load. It was found that the temperature of 70 c rises / 500 rpm.

This occurs because of uneven loading conditions in the machine. This is not the case with ceramic material because ceramic has high temperature ability and high resistance to friction. Zhao Chungyang [10] stated that the load characteristics and the friction coefficient of the spherical ball bearings of the high seed and the relationship between gyroscopic torque were shown by taking the diameter of the ball 22.2 mm, the contact angle α0 = 40 , the internal groove diameter 102.8 mm and the diameter of the outer ring grove 147.7 mm if the coefficient of friction About 0.06 and 0.07 increase in axial force with a decrease in the contact surface of the load bearing endurance gyroscope bearing with increased axial force and speed. The coefficient of friction needed to balance the load on the top of the rotor gyroscope increases rapidly with the increase of axial force at a low rotational speed and then decreases rapidly. The higher the speed of rotation, the greater the axial force, the greater the coefficient of friction and then the lower., which leads to heating of the bearing and at a certain speed the small contact forces, should be avoided. Therefore, the weight of the axial force must be determined against these two factors. Corrosion of pulleys occurs due to load applied to bearing and dimensional changes due to variable speed and variable loading effects on the loader. Alain Marian Puscasu, [11] ANSYS analysis of these fine elements showed no temperature effects and stresses on the bearings by the image model in the research paper. Ceramic Si_3N_4 and Silicon carbide for bearing Siriam Papperman, et al. [12] states that the bearings show stress uncertainty and the studies and parameters shown here reduce the maximum size of the cracks, reducing the crack size by 4.4% as well as decreasing the increased fracture area. Viability increases with the diameter of the ball decreasing to certain. This work presents a comprehensive method for determining the probability that hybrid silicon nitride bearings will remain under different uncertainties by using the substitution of scientific studies. Continuous fatigue contact in tips cracks on a spherical surface and generate 3D model using FEA. Allen Levy and others [13] argue that the engine holds the pistons in the engine because of high speed lifting, and their chromium-chromium splits are further hardened and powders of different sizes are obtained in 4 mm thick in engine overlays. For the 9000 hour list the Zirconium thermal coating can withstand the operating environment of the diesel engine at least medium speed. The more moderate operating conditions of the lower piston surfaces with respect to valve surfaces have resulted in satisfactory performance of coatings on pistons that failed on the surfaces of the Griffin and Rajesh Kumar valves. [14] This analysis is provided for gas turbine coated with ceramic (gas). By using ANSYS, the ceramic blade under the test conditions of the thermal state and pressure to test the effect of thermal conductivity to squeeze the material. The thermal conductivity of ceramic materials has been found to be very good and not affected by high temperatures, so heat dissipation is faster than other materials. Ravinder Reddy Pinninti [15] SiC-Al alloy piston covered with ceramic was analyzed by temperature and pressure analysis as the piston has a high speed of the reciprocal movement of the motor, so a large amount of heat is generated due to friction. In this study to reduce the temperature of the piston, the Sic Al layer and the thermal analysis we conducted are tested to verify the result under the variable coating thickness on the piston. The thickness of the coating material was tested from 0.4 mm to 1.6 mm and obtained better results in the thickness of 1.6 mm of material. The temperature in the crown compared to the temperature of the uncoated piston, 32.7%, 55.8%, 72.5% and 84.8% for 0.4 mm, 0.8 mm, 1.2 mm and 1.6 mm, Flavia Aparecida de Almeida et al. [16] states that under the sliding state as biodiesel, diesel and lubrication to withstand silicon nitride and analyze corrosion and friction behavior and therefore Flavia [16] finds corrosion coefficient as 10-8-10-9 mm 3 / nm, nitride based silicon nitride (Si_3N_4) Ceramic-based materials are known for high-performance ceramic due to high hardness, hardness, strength, chemically stable and corrosion resistance. In the internal combustion engine, the pressure can reach 200 Mpa, allowing for better fuel efficiency, with the use of the values of the yong and poisson ratio of SiN_4about 300 Gpa and 0.3, Si_3N_4 disk of 10 mm diameter and thickness of 3 mm due to inactivity and the absorption of particles on ceramic surfaces much smaller Compared to minerals. [16]

Experimental apparatus Details Experimental tests are placed on a test platform as described in figure 1. It consists of a pin with a spherical surface such as a tip and a rotating rotary disk placed on a perpendicular to the spherical surface. The pin diameter is 12 mm and the length is 30 mm. The disc consists of hardened steel that is pinned to it and rotation of the disc leading to wearing a pin on a fixed path on the disk. The pin is pressed against the surface of the disc with the load being applied with the arm extension provided to the device. The device is equipped with a data acquisition system and WINDUCOM 2010 program that gives values and charts.

Figure 1: Pin on Disc

Figure 2: Silicon carbide, EN 31 Pin and disc, Infrared thermometer

Table 3: Specification of Machine

Test Parameter	Values
Specimen	Pin size:- 10mm – 12mm diameter Length:- 32mm
Wear Disc size	Diameter:- 165mm Thickness:- 8mm
Wear Track Diameter	Min:- 50mm Max:- 500mm
Disc Material	EN 31
Disc Rotation	Min:- 200rpm Max:- 2000rpm
Normal Load	Min:- 5N Max:- 200N
Frictional Force	Min:- 0N Max:- 200N
Wear Rate	Min:- 0 µm

Figure 3: Pin Silicon Carbide

Table 3: Working Parameters

Parameter	Range
Wear trackradius	80mm
Load applied	50N,100N,150N,200 N
Rotation ofdisc	500rpm, 1000rpm, 1500rpm, 2000rpm
Time Duration	15min
Pin size	12mm diameter
Pin Material	SiC, EN 31
Disc Material	EN 31
Infrared thermometer	-32^{0}C - 550^{0}C

2. EXPERIMENTAL PROCEDURE

Dry sliding wear tests for different number of specimens was conducted by using a pin on disc Model wear and friction monitor TR-20 supplied by DUCOM is as shown in figure 4. The pin was held against the counter face of rotating disc EN 31 steel disc with wear track diameter 80 mm. the pin was loaded against the disc through a dead weight loading system. The wear test for all specimens was conducted under the normal loads of 50N, 100N, 150N, 200N and sliding velocity of 0.5 m/s. The pin samples were 30mm in length and 12mm in diameter. experiment was conducted on a set of samples for 15 minutes, at variable loading and variable speed condition. The setup is related to the data acquisition system that calculates the friction force and the friction coefficient of the material. By specifying any two parameters with one variable parameter experiment is performed. WINDUCOM 2010 gives a graphical representation of the corrosion rate with friction force and friction coefficient. The result will show the coefficient of friction for (time, speed and load) and the systematic comparison of one material with the other. Friction is the strength that resists sliding and is measured by a coefficient generally considered to be fixed and specific to various materials. First, the operating temperature is measured at the resulting temperature with the help of an infrared thermometer gun. Each sample is made up to 15 minutes and all readings are taken from 5 minutes, 10 minutes and 15 minutes in the case of variable load of 50 Newton, 100 Newton, 150 Newton, 200 Newton, with an 80 mm sliding distance and also with a variable speed of 500 rpm, 1000 rpm, 1500 rpm, 2000 rpm. For each load and variable velocity readings were taken as shown below in the observation tables. Separate observation is obtained for each and every readings of both EN31 materials which is 12 mm in diameter and 30 mm length were as the Silicon carbide is of 8 mm in diameter and 30 mm length. Here in these the experimentation the pin is not given any temperature whereas the temperature of the pin of both the EN31 and SiC is measured with the help of the infrared thermometer with laser pointer so that the pin temperature generated is measured accurately and the difference in both the temperature generated can be evaluated.

Figure 4: WINDUCOM 2010 with a data acquisition system

Graphical Representation

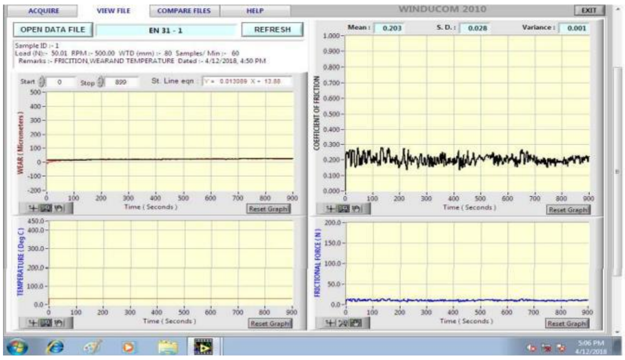

Figure 5: Result of EN 31 pin sample at 500 rpmand 50 N load.

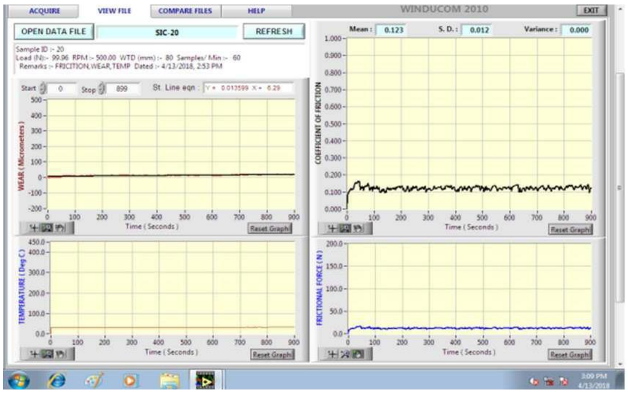

Figure 6: Result of SiC pin sample at 500 rpm and 50 N load.

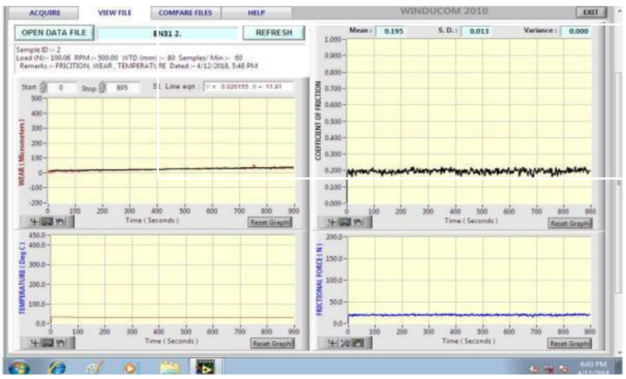

Figure 7: Result of EN 31 pin sample at 500 rpm and 100 N load.

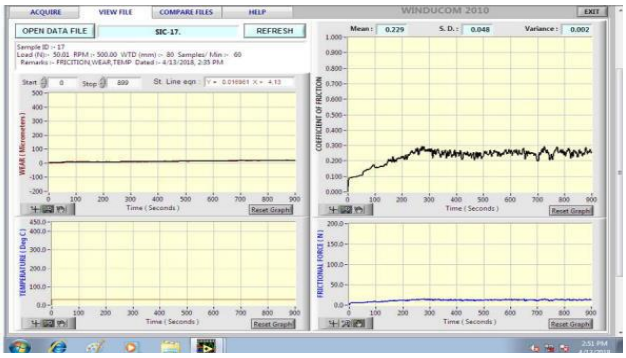

Figure 8: Result of SiC pin sampleat 500 rpm and 100 N load.

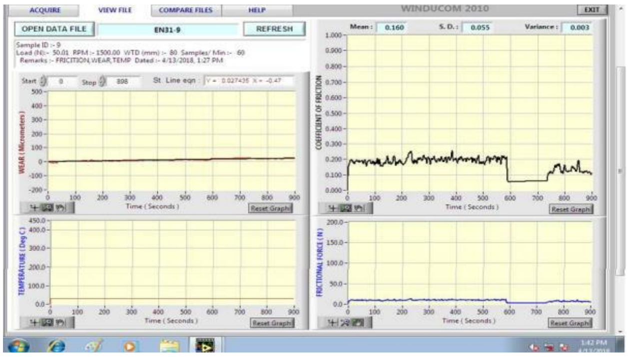

Figure 9: Result of EN 31 pin sample at 1500 rpm and 50 N load.

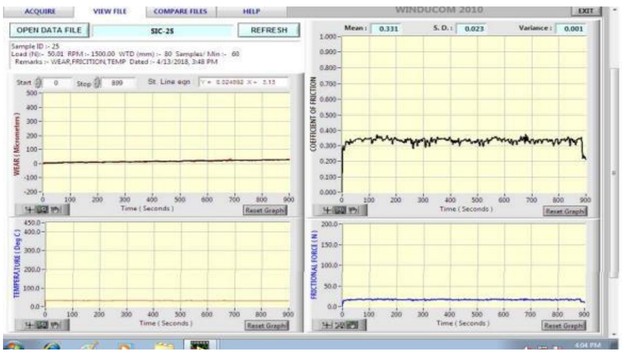

Figure 10: Result of SiC pin sample at 1500 rpm and 50 N load.

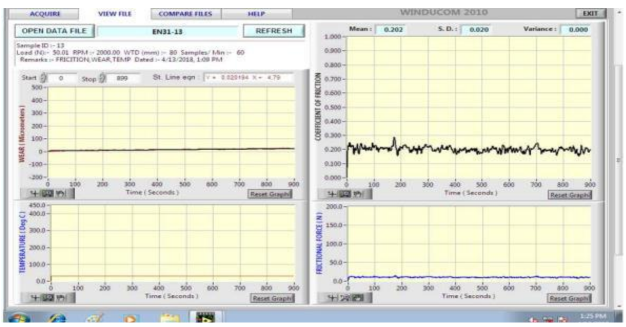

Figure 11: Result of EN 31 pin sample at 2000 rpm and 50 N load.

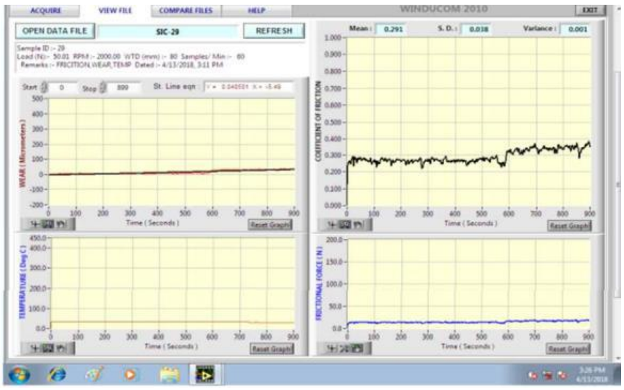

Figure 12: Result of SiC pin sample at 2000 rpmand 50 N load.

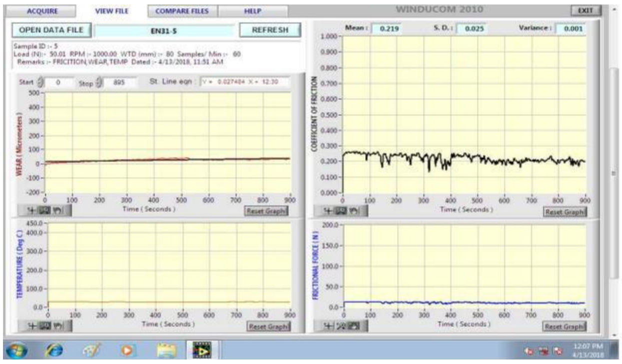

Figure 13: Result of EN31 pin sample at 2000 rpm and 100 N load.

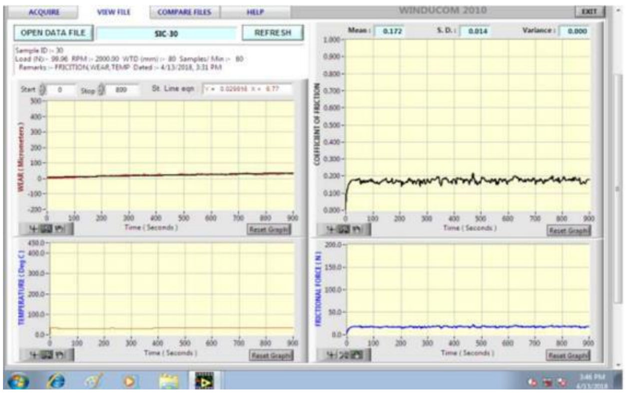

Figure14 : Result of SiC pin sample at 2000 rpm and100 N load

EN31 pin against EN31 disc.

The above Figures 5 to figure 14 show the wear and coefficient of friction and temperature of the pin material made up of silicon carbide and EN31 at different loading and speed conditions at minimum load that is 50 N load and at 500 rpm speed of the disc the pin perpendicular to the disc rotates on the disc and gives the wear 23 µm at 15 minutes of revolutions and coefficient of friction 0.203 and frictional force of 11.1N and thus the temperature generated by the pin is 45.70C and for the same speed that is 500 rpm then only the loading condition is changed which is 100 N thus the wear obtained is 31 µm and frictional force of 20.6 N and the coefficient of friction of 0.195 thus the temperature generated is little bit more than 50N load condition that is 52.30C. also at similar speed and thus the load is just increased of 150 N and wear got is 35 µm and frictional force of 22N and coefficient of friction 0.129 and temperature obtained 55.70C, and if load is increased by 200N thus the wear got is of 39 µm and frictional force of 16.3N and coefficient of friction of 0.084 and temperature is 50.20C. Thus, for a speed of 1000 rpm, load is similar to the speed of 500 rpm of 50 N, 100 N, 150 N and 200 N, so at load 50 and at 1000 rpm, the wear is obtained 32 µm, the friction force is generated 12.3 N and the friction coefficient is 0.219 and the obtained temperature is 49.10°C and for the maximum load of 200 N the wear obtained is 44 µm and the friction force generated is 18.8 N and the coefficient of friction is 0.060 and thus the temperature The resulting is 51.30C. However increase the load and speed as shown in Figure 8 And 9 got to wear 49 µm for 1500 rpm and 200 N load conditions and the friction force obtained is 21.2 N and the friction coefficient of 0.061 and the generated temperature is 55.20C and also the maximum loading speed is 2000 rpm wear obtained The maximum is 54 µm and the friction force is 23.6 Newton, and the friction coefficient is 0.058 thus the obtained temperature is maximum 58.20C. Ceramics are serious contenders for the use of bearings and sealants because of their high melting point, chemical detainees, and in some cases low density. A high melting point task in low diesel engine is heat rejection and turbine application. Silicon Carbide pin against EN31 Disc. From the above experimentation at 50 N load and 500 rpm the wear obtained 15 µm and frictional force of 13.2 N and coefficient of friction of 0.229 and temperature generated 41.80C at room temperature of 290C and as the load is increased 100 N the wear obtained is 17 µm and frictional force of 14.4 N and coefficient of friction obtained is 0.184 and temperature generated is 43.80C. And as the load is increased is up to 200 N thus wear obtained is 21 µm and frictional force 18.9 N and coefficient of friction is 0.123 and temperature generated is 47.10C. and if the speed is increased to 1000 rpm and also the load is kept at 50 N thus the wear obtained is 16 µm and coefficient of friction is 0.208 and temperature generated is 43.60C and for the 200 N load the wear obtained is 25 µm and coefficient of friction is 0.083 for the 15 minutes of disc rotation and as the speed is further is increased at 1500 rpm the wear obtained at 50 N load is 18 µm and frictional force 15.2 N and coefficient of friction is 0.331 and temperature generated by the pin is 42.70C and for the 200 N load the wear obtained is 31 µm and frictional force is 18.8 N and coefficient of friction is 0.114 and temperature generated by the pin is 52.40C and for the 2000 rpm speed and for the 50 N load the wear the obtained is 23 µm and coefficient of friction is 0.291 and the temperature generated is 43.70C and thus for the maximum load and maximum speed condition the wear obtained is 36 µm as shown in figure 13 and frictional force of 21.5 N and coefficient of friction obtained is 0.098 and thus temperature generated by the pin is 55.30C.

3. RESULTS AND DISCUSSION

Friction coefficient

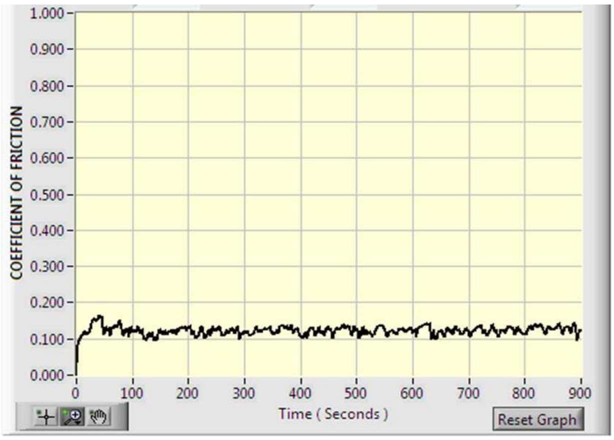

Figure 15: Friction of coefficient of SiC at 2000 rpm 200 N load.

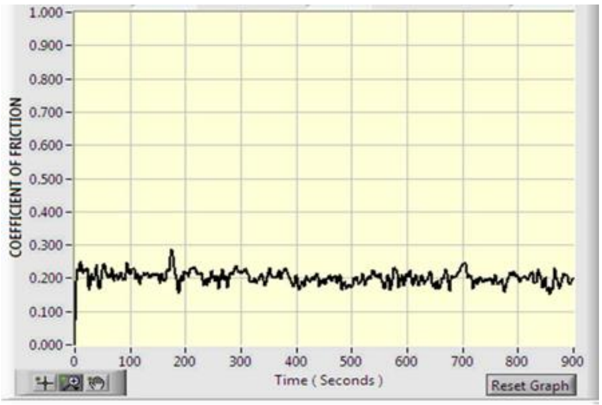

Figure 16:-Friction of coefficient of EN 31 at 2000rpm200 N load

Figure 15 and 16 Describes the friction coefficient of SiC and EN 31 under the loading condition of 200 N and the disc rotation of 2000 rpm and the sliding distance 80 mm the on comparing both the graphs it is seen that coefficient of friction of both varies much the coefficient of friction of SiC is between 0.100 to 0.200 and whereas the coefficient of friction of EN 31 is 0.200 and gives much variation as compared to the SiC. However similar loading and rotating condition is provided although when the load is increased the friction and wear rate is increased and with the simultaneous increased the speed then it also affects the wear rate of the SiC and EN 31

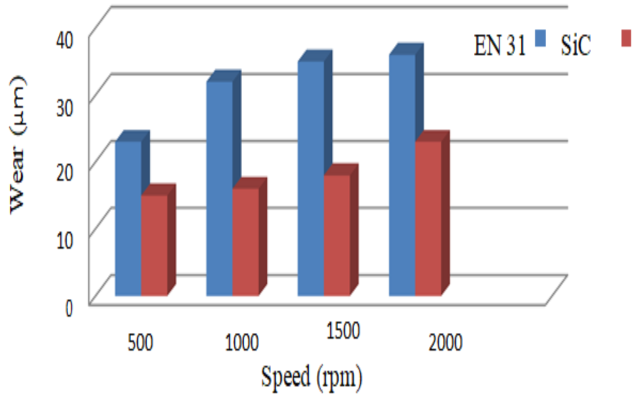

Figure 17: Wear of EN31 and Silicon carbide at variable speed condition at minimum load of 50 N

Wear Rate

The wear rate of SiC and EN 31 as shown in figure 18 under the similar load and speed condition obviously the wear rate of SiC was far lower than the EN31 under much higher test load, therefore it may be used in sliding bearings. As the pin of material EN31 the load is kept at lower and also the speed at lower that is 500 rpm speed and 50N load then the figure 5 shows the lower rate wear formation and as if we increased the load gradually the and also the speed then the formation of wear also increased the maximum loading is 200 N load is provided and also the maximum Speed is provided that is 2000 rpm. Similarly the testing was also done on SiC material the wear rate came lower than EN31 because of the Silicon Carbide properties of high hardness and so it lower wear rate as compared to the EN31 the wear track of the pin on disc machine the color changes to black these his because of the constant revolution of the pin on that track. The figure 14 shows the overall performance of the SiC and EN31 material at the maximum loading that is 200 N and it shows as the speed increases the wear also increases and also the temperature increase.

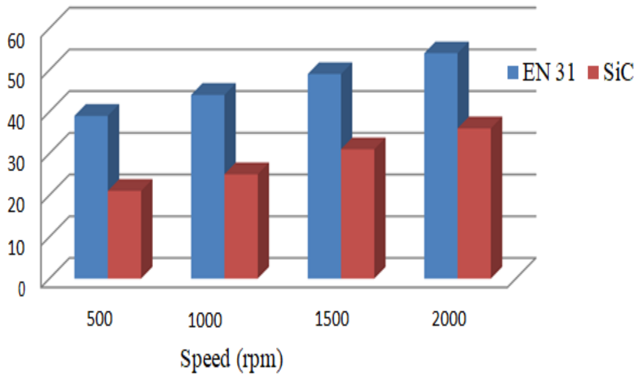

Figure 18: Wear of EN31 and Silicon carbide at variable speed condition at maximum load of 200 N

Temperature Generation

From figure 19 the temperature generation of the pin at the minimum load 50 N and the temperature generation is measured with the help of infrared thermometer from the figure it is clear that the temperature of the pin made up of EN 31 generates maximum temperature of round 45.7^0 C at 50 N load and at 500 rpm the room temperature measured by the pin on disc is around 29^{0}C the temperature also increased as the load and the speed is increased thus for EN31 pin at 2000 rpm and at 200 N load the temperature generated is around 58.2 ^{0}C thus from these it is cleared that the temperature also increased as the load and speed is increased

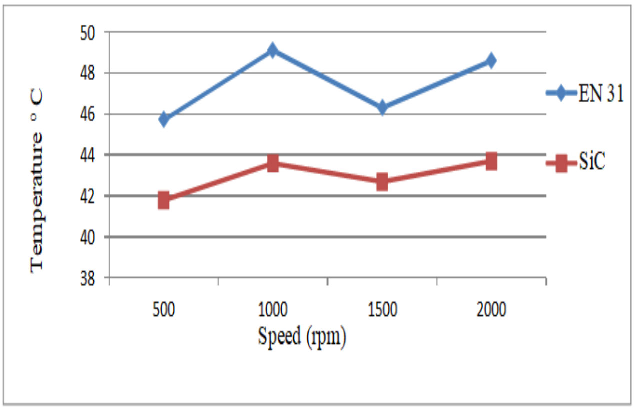

Figure 19: Temperature generation at variable speed condition of EN 31 and SiC at minimum load condition i.e. 50 N.

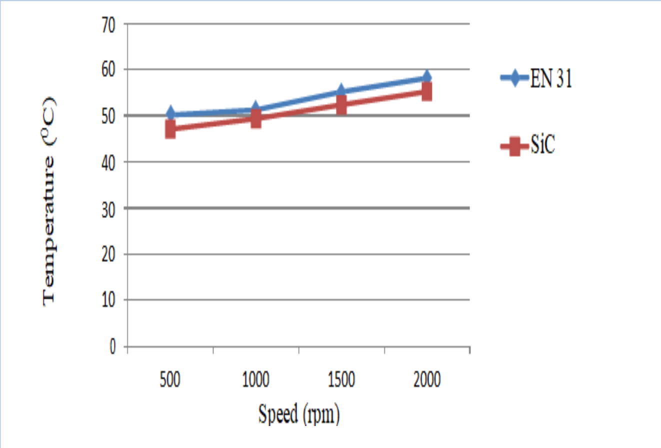

Figure 20: Temperature generation at variable speed condition of EN 31 and SiC at maximum load condition i.e. 200 N.

Figure 20 shows the temperature of the EN 31 and SiC at maximum load and speed condition for SiC at 50 N load the temperature came around 41.8^{0}C and the wear came around 15 µm the frictional force is around 13.3 N and also the SiC at 2000 rpm and 200 N load the temperature came around 36^{0}C and wear came 36 µm and 21.5 N friction force.

4. CONCLUSIONS

Silicon Carbide ceramics for sliding behavior against conventional material EN31 for rolled cylindrical material were examined for variable load and speed conditions with room temperature conditions the following result can be drawn. The overall minimum damage of the SiC pin is much lower compared to EN31 and with increased load and decrease in wear as well as the temperature is in moderate condition. Also in the same case the EN31 pin has an increase in the wear rate and coefficient of friction and also the temperature is increases with increasing load and increasing speed. For EN31 at load of 200 N at 2000 rpm and 54 µm and the resulting temperature is 58.20° C as well as for the SiC compound at 200 N and at 2000 rpm the 36 µm is generated and the pin temperature is 55.30C and therefore the result is That friction and wear characteristics SiC is better than EN31 So therefore the silicon carbide is very much useful in bearings as it can sustain high temperature and have good wear resistance and coefficient of friction and thus the silicon carbide roller bearing material can be used in high speed and medium load applications.

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