ISSN No:-2456-2165

Viscosity Index and the Rate of Conduction Due to Variation in Convective Heat Transfer Coefficient by Water to Grease Velocity in Proportion with Sand Contaminant

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Abstract:- Viscosity index it is a dimensionless quantity measurement of fluid change in viscosity which is relative to temperature change .In this research an evaluation is carried out on design of ball bearing the effect of thermal expansion, variation in convective heat transfer coefficient, linear elasticity partitions, geometry, internal clearance defects, rate of speed ,rotary shaft circular motion, lack of timing of grease volume, refilling and mounting measurement systematic error due to climatic variation during design consideration with temperature fluctuation within material and it outer boundary system that actuate the sliding force with shear thickening process in grease and it solubility rate alongside contacting surfaces within the strain determination for the hub connecting the shaft to aid transmission of energy to the gearing system and it acceleration. As the heating temperature increases the volume of the thermal linear expansion of ball bearing groove with cage affecting the shield increases uniformly while the grease lubricity of chemical binding concentration decrease this is a critical problem needed to be solved using various field of engineering principles such as chemistry, physic, metallurgy and engineering. This research also focuses on shield or seals improper molding design and configuration within the pattern entry unit of sand contaminant into the hub which slows the speed rate by causing surface defects as a result of excitation of the atom within the ball bearing and scattering of the balls.

Keywords:- *Viscosity Index, Conduction, Convective Heat Coefficient, Water , Grease Contaminant, Ball Bearing,*

I. INTRODUCTION

Ball bearing as a rolling mechanism it separate and allows the motion of bearing races. Ball bearing reduces friction in a linear or rotary path of a mechanical load either in axial load, radial load at times both combination in a given ball rolling element to the shaft assembly system. There are different types of bearing namely ,ball bearing, Roller bearing, Ball thrust bearing, Roller thrust [12] bearing. Tapered roller bearing. Heat flows normally from a hotter body to a cooler body by transient motion. The ball rolling element is in a spherical shape, the heat spread not evenly due to colder mixing with hotter air by density variation because of cold shuts and misrun defect during casting by heat forming and forging processes alongside the mold used and addictives, alloys, hardening and normalizing limit [13] at critical point either by hot working or cold working phase before solidification. Grease has a thickening reagent like sodium hydroxide, calcium hydroxide both are basic salts this makes the system to be affected as non Newtonian fluid since viscosity rate is independent to the stress and negligible with the young modulus constant. From a practical and theoretical perspective the centripetal and centrifugal knowledge of ball bearing should be put into critical design consideration whereby Balancing friction and wear. Such constraint in affecting floatation and capillary action which is a great problem when designing ball bearing since the inner rings or inner raceways moves the relief stresses to produce kinetic energy in a compressive stress analysis by thrusting [14] orientation. while the outer raceways is stationary. The solidus temperature and precipitation temperature is needed to regulate it thermal state of an equilibrium .Since the heat moves and not uniformly within the end of the microstructure in it crystallization temperature which can not be easily predicted at the solidus temperature at the transformation phase. The linear expansivity of the area is twice the superficial expansivity. while the cubic expansion is twice the linear expansivity. That is the system will liberate [1] more heat to the hub which could bend the shaft by $1/4^{th}$ due to molecular vibration and excessive loading on the shaft extended to the ball bearing while climbing hills . Unstable rotational speed occur along the shield should be protected against water contaminant such as dust, toxic waste which can directly increase heating process and non uniform contraction by fatigue stress on raceways and the ball bearing rolling element which makes the material to violate the Hooks law principle because the degree of thermal conductivity of materials are differ and the atomic masses within the system. Most shaft designer prefer using fit diameter of clearance three c3 and the smaller it shaft to accommodate compressive stress with an improved shot peening process. The nature of the of the lubricant plays an important role in specific heat capacity rate between the ball and cage in motion by creating increasing entropy in the system. For instance if two system are each in thermal equilibrium with a third system then they are in thermal equilibrium with each other. The **heat transfer coefficient** or **film coefficient**, or **film effectiveness**,

ISSN No:-2456-2165

in thermodynamics and in mechanics is the proportionality constant between the heat flux and the thermodynamic [2] driving force for the flow of heat. In this process the system has to be checked if the heat flows into the system or out of the system. Regardless of the flow route of the heat, the sum of total heat should be the same that is heat law of Hess's.

II. GROUND STATE OF GREASE AND HEAT FLOWS

When formulating thickener in grease and it rate of flow the macroscopic value such as volume ,pressure, and temperature should be consider first .For instance the collision rate at microstate varies due to the fact that degree and measurement of hotness and coldness is not fixed at a given point which disagree with the heat between hub that is inner and outer ball bearings transmission. The heat is higher at the outer diameter of the ball bearing rings than the inside diameter ball bearing rings which speed the connecting rims toward the wheel then the volumetric reduction [3] of grease will indirectly increases the torque effect. Considering Gibbs free energy the greatest amount of mechanical work which can be obtained from a given quantity of a certain substance in a given initial state, without increasing its total volume or allowing heat to pass to or from external bodies, except such as at the close of the processes are left in their initial condition.

The initial state of the body, according to Gibbs, is supposed to be such that "the body can be made to pass from it to states of dissipated energy by reversible processes heat resistance to delay by atomicity .Lithium stearate is mostly used as a high temperature lubricant .Hence when lithium combine with halogen family like chloride it form lithium chloride which forms lithium bromide which act as a reducing agent simply hydroscopic in nature. During ball [15] bearing installation, the ball rolling element should be properly mounted with oil rubbed all round the inner and outer raceways then avoid water mixture with the grease .Such condition affect the ball bearing service life .Because the surface of the lithium has a silvery coloration which reflect heat and reduces the reagent of the fatty acid when it comes in contact with grease it get reduced and this will generate defects which slow the sliding frictional contact alongside mixture with sand contaminate with different granular sizes in refractory nature which directly alter relief stress at motion inducing vibration of the molecular coexistence in forming metallic soap using sodium hydroxide at saponification process.

III. LITERATURE SURVEY

Most researchers have made some findings for the empirical possibility of initiating parameters for radial stiffness of the bearing under an axial load. But fail to under understand the torsion and principal strength. Those researchers think of uniform formulation principle due to change in volume at the constant pressure with variation in temperature that the load can be attain with a loading capacity when it is increased by deformation constant which may be reduced. Also we can increase the lifespan of the bearing, binders [16-17] dimensional accuracy ,high temperature, strength and designing of casting metals with tooling mechanism process which produces accurate and reproducibility in castings approach using computer integrated manufacturing and computer aided engineering. it is difficult to establish a real dynamic model with ball faults like creep and cracks because of the unpredictability of ball rotation path. In this paper, to simplify the model, it is assumed that the center of the rolling defect is always farther away from center of the raceway region which can be an environmental industrial attack by corrosion films and precipitation state with a relative humidity greater than 67 percent.

The radial runout of the inner ring does not always decrease with the increase of number of rollers. The radial runout of inner ring significantly reduces when the order of the roundness error and number of rollers satisfies a certain relationship These increase in the radial runout of inner ring is proportional with the increase of the radial clearance. The major components of rolling element are inner ring, outer and cage. But in our research we find out that balls expand more through the raceways [4] lining due to grease viscous flow at temperature higher than 180 degree. Synthetic oil prefer stability with an increasing temperature which directly affect the viscosity when grease mix with water forms hydrolysis by le chateliers principle while considering factors like pressure, concentration and temperature which shift the equilibrium of the system Grease are derived from castor oil in which it temperature is at 313 degree Celsius in this experimented research with a density of 0.961 g/cm3 while density of water is 1000kg/m3 this causes forced convection within the hydrophilic and hydrophobic alteration within radical irons. Contaminant accelerate temperature in material and directly affects viscoelasticity in a molecular crest amplitude of grease with the additive stoichiometric rate. This conduction causes osmotic pressure to actuate the surface to shrinkage by 39 kg/m3 marginal suction with polymer surface across the thin membrane of the rings and synthetic rubber and fluid. As result of this if it is a motorcycle the back wheel causes misalignment, water separating the thickener in grease affecting the viscosity due to dryness then unpredictable crystal bond weakening of a ball structural and molecular [5-6] disintegration formation with grease denser than water by refractive index. To solve the incoming flow of water through the synthetic rubber seals, there should be a proper stiochiometric rate of atom to molecule composition using a thinning reversible membrane surface when the flow is above 35 degree Celsius the seal rubber should be varied in their factice phase by certain percentage. Sulphur is used to yield the rubbery property in synthetic formation of rubber but it has six valence election at the energy level three and it unstable while fatty acid has a long chain needed to be saturated in a solution in grade acceptable on a given environment. Seals of ball bearing should be designed with catalytic copolymer which will only expand under critical temperature and pressure by introducing silicones methyl hydride siloxane at opening lining of seal [18] to the outer raceways of the ball rolling element molecular rearrangement using substance that repels that is reducing the contact angle of water to slow suction of

ISSN No:-2456-2165

adhesive forces forming a solution. **Chrome steel** these are one of the classes of non stainless steels such as AISI 52100, En31, SUJ2, 100Cr6, 100C6, DIN 5401 which are used for application mechanisms and design of rotary spare parts such bearings, tools, drills and utensils.

IV. EXPERIMENTAL WORK

A qualitative experiment was conducted using ball bearing rolling element and its complete components, the mercury in glass thermometer ,stop watch, 15ml, 20ml, spatula, grease ,cold water, ,gas cylinder and basin burner.

Initially, the temperature of the thermometer was at 40 degree Celsius. When the mercury in glass was inserted into cold water to 0 degree Celsius this is to the determine climatic change in tropical region like Edo state, Nigeria. The flow of the mercury is theoretically explained by the contraction and expansion due to capillary action and collision analysis internally on the ball bearing. The essence of using media system and flow to determine the viscosity is due to the practical experimental analysis and lack of visual computational fluid dynamic software, tachometer, oscilloscope ,accelerometer due to closure of border as a result of Covid 19 pandemic. Most businesses were crippled down which affects the 85.5 percent efficacy of this research procedures. The specific heat of vaporization was at 110 degree, the temperature tend to drop due to partitions within the material alongside the heat flux of grain growth and its transformation phase flow within the solid crystal in the nucleus. When grease lubricant flow mixed with sand contaminant the temperature from 110 degree Celsius increases to 260 degree Celsius with surface integrity defects. Sand contaminant has different category namely as: rounded sand, sub angular sand ,angular and compound sand. Whereas rounded shape silica has a higher bond strength in comparison to angular silica.

However, the normal room temperature of the mercury is at 40 degree Celsius. While the ice water temperature is at 0 degree Celsius condition mercury into 15ml test tube before inserting the mercury into the test tube at 100 degree celsius. Since the base oil and additives has some significant role in determining the viscosity index, the temperature will not be uniform. some of the reasons are some additive are anti wear (AW) and others are Extreme pressure (EP) in nature. In an extreme pressure the temperature and the oil work on metal to metal action whereas in anti wear condition the base oil or lubricant works within lubricant surface not in contact to the metal which might cause sacrificial corrosion attack, during boundary conditions. The anti wear [7] are ductile in nature within ash like film within the range of high to moderate temperature of 150 to 230 degree farenheit which shears under specific condition. Some anti wear were added to the surface of the ball rolling element to prevent risk of metal to metal oxidation which can affect the tensile strength and sand blasting. While zinc dialkydithiophosphate (ZDDP) increase the heat generated by the chemical content on the metal surface When the ball rolling element were heated continuously it was discovered that the rate of shot peening were affected by the surface scratch which depends on the long polymer chain existing in the fatty acid. Surface attack and drag by corrosive reaction was seen in fig 2.0 with different coloration .At the apex the green color was seen as an indication of metal wetting which affect mostly the bearings. The reason ball bearing disengages is due to polar material oxidation by half cell reaction like dirt, water, dust and chips by grease mixture due to yellow coloration which forms on a metal surface. But some doctored addictive [8] are produce and been imported to the market through borders by smugglers without giving the proper compositional chemical mixture verification. When sand particles enter the shield or seals it create solute ,solvent and solution that is an emulsifier is needed[19-20] to dissociate extreme heat or fire within the raceways wall in other to facilitate stable glue binding energies between the water and oil or grease normally this is not possible for the mixture to repel each other simply they are immiscible in nature as a result of difference in specific gravity and interfacial tension. Some of the emulsifiers have greater molar contraction when the temperature falls below the grease thinning shear effects

VI. FACTORS MITIGATING THE BALL BEARING RESEARCH AT WORKING OPERATION

i. Ball bearing rotate at given speed by different operation stage
ii. Grease fluidity and percentage composition of fatty acid ratio to additives are to be considered
iii. Geography location due to effect of climate change(Amount of rainfall) is an issue
iv. Nature of sand size
However, some of these additive are affected during motion by the following reaction namely
(i) Decomposition reaction
(ii) Adsorption reaction
(iii) Separation due to filtration

V. RESULTS AND DISCUSSION

The results of the research below from the given experiment were conducted on two conditions and phases such as Cold and Hot Temperature phases : In the hot condition phase contaminant such as sand affects the lubricity of the grease. Naturally the following criteria is needed for the refractoriness which depends on silicon dioxide {sio_2} like grain size of the particles, homogeneous or heterogeneous transformation of the solid nucleus, grain and volumetric composition .The material thickness of the cage and the ball are having different tensile strength within the bearing bore and corresponding relief fatigue when there is increasing viscosity index due to varying molecular difference on water it means the residual stress tend to fail .Because as the temperature decreases by partly increment of life ratio and bearing bore which increases the driving nucleus of the inner raceways for grease within the shields or cages from table 1.0 . It was found that when the grease cohesive and viscous ability diminishes at a given level the energy which looses it resistance is to keep the mechanical advantage of rims into stable equilibrium. Because the fatty acid has long polymer chain which is needed to effectively speed up [9] the adaptability of the working temperature in

ISSN No:-2456-2165

normal condition with the bond of speed or usage. For instance Le chateliers principles which states that in a system of an equilibrium where is a concentration, pressure and temperature the equilibrium will shift to change or annual the effect of heat change. The misalignment in the chain is accompany by the drying grease on the ball rolling element and improper mounting of the ball bearing with the clearance angle geometry from clearance one to clearance five in table 1.10 when the forces increases to 80N the displacement was at 0260 m/s due to dirt and water attraction at the jacket covering. That is water interface reduces the residual stress of the sliding friction by 0.307kn/m. The slacking chain at force 20N the displacement was 0.040m at the initial flow of sand into the shields or seals. When water enters the the ball bearing to form films with an increasing corrosion rate. There is an increasing shot life and decreasing shot peening rate which affects the walls of inner and outer raceways. When water drops on a surface it creates two point phase reaction such as anodic and cathodic points phase. Where as in table 1.11 at the range of 237 to 273k that is 0 degree celsius water freezes but can be super cooled known as anomaly -0.1 to – 0 degree Celsius . At standard pressure of 1bar when grease was in a homogenous phase with a temperature with a surplus escape velocity, If the coating and sacrificial anodic effect is not considered the material will form fissures, crack at the cage or ball separators and sudden design [21] failure due to frictional forces ,tensile and compressive forces below it young modulus constant of a specified code of standardization. The ball rolling element will pull out from the rings while in motion .During the experiment we were able to notice that the thermal conductivity of water is within 0.55 to 0.7 k.w/mk due to adhesion the molecular nature is difference in temperature which slow the kinetic energy to be in transient motion until the films get separated at each layer of the walls with bubbles attached to the glass surface at higher temperature .But at higher temperature the molecules diffuses more 260 degree Celsius. The reasons are thermal conductivity is affected by the following criteria during the condition namely

i Moist content
ii. Density of the material (grease : water
iii Pressure and temperature (operating conditions)
iv Material structure

As heat flow some of the grease content reduces by volume due to increasing temperature except aluminum and uranium element as a result of an unequal equilibrium by their specific heat capacity. At certain point the penetration of water into the raceways decreases the thermal conductivity by contraction of the crystal surface in mixture with sand except water with purity due to decrease in densities and air increment [22-23] at higher temperature range .But rate of speed is regulated by resistance by change in crystal lattice from table 1.12 by molecular collision by rotary path of the heat circulated inside the hub. Heisler–Gröber charts are a faster and simpler alternative to the exact solutions of these problems, there are some limitations. First, the body must be at uniform temperature initially. Additionally, the temperature of the surroundings and the convective heat transfer coefficient must remain constant and uniform. Also, there must be no heat generation from the body itself. It was observed that at a certain point when the cold water was poured on the surface of the ball bearing table 1.10 the temperature read 273K by kinematic viscosity rate of 1.25cSt.But within 7.5 to 10.00 centi stokes {cSt } the temperature was 453K and later drops by 433K with an increasing cooling rate which changes temperature of the crystal structure.

i. **Bearing internal clearance**

Bearing internal clearance is defining as the total distance through which one bearing ring is moved by angular speed.

Table 1.0 Expansion of inner raceways by water and grease from Relative humidity interference

Life Ratio Le/Li	Bearing Bore
0.15	25
0.20	50
0.25	75
0.30	100
0.35	125
0.40	150

Table 1.11 Force on chain drive with Ball bearing displacement misalignment

Force N	Displacement m
20	0.040
40	0.018
60	0.016
80	0.260
100	0.080

Table 1.10 Kinematic viscosity Experiment at 23cSt in a given temperature of 40 degree Celsius at constant force of gravity

Kinematic viscosity cSt	Temperature k
1.25	237
2.50	293
5.00	313
7.50	453
10.00	433

Table 1.12 Convective heat transfer coefficient at a given temperature variation

Time sec	Temperature k
140	453
145	533
20	353
60	303
33	413

ISSN No:-2456-2165

Figure 2.0 Flow rate between inner, outer raceways and bearing bores by water and water with contaminant

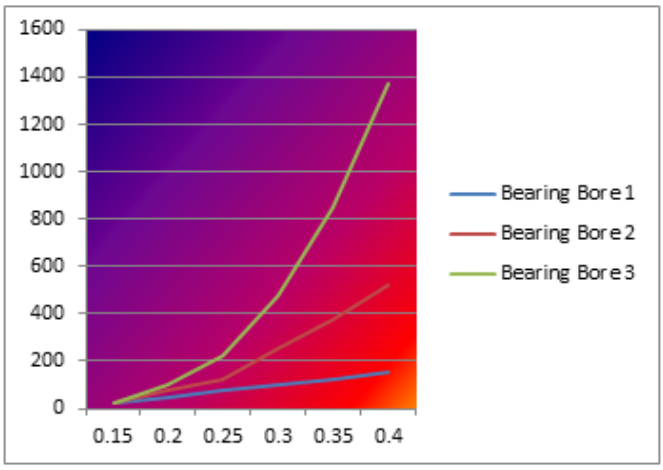


Fig 2.10 Hooke's Law By experimenting Force on chain ratio Ball bearing displacement in a separation.

Table 1.14 SURFACE PROTECTIVE ADDITIVES LUBRICANTS BY MASSES

water	0.10g	0.75g
air	0.37g	0.84g
sand	0.30g	0.67g
grease	0.02g	0.54g
Ice water	0.20g	0.14g
Mean value	0.198g	0.588g

Fig 2.11 Hooke's Law By experimenting Force on chain ratio Ball bearing displacement in a separator

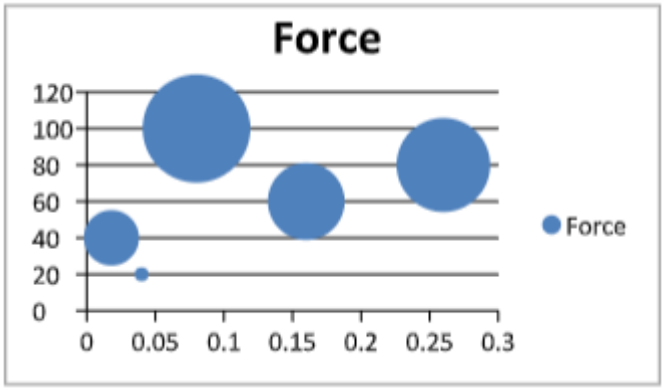
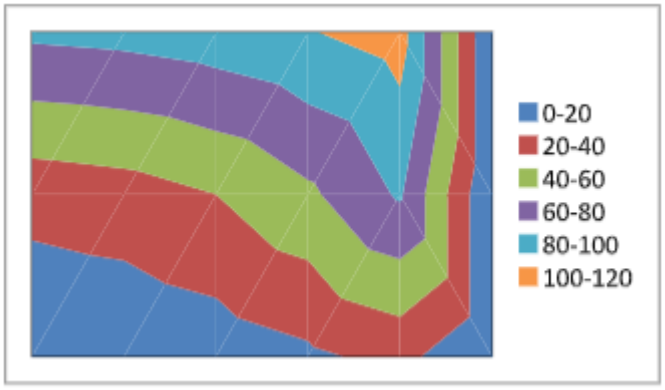


Fig 2.12 flow of grease and water suspension by adsorption



2.Bearing internal clearance and geometry

Bearing internal clearance and it geometry which can be examined by the rake angle and clearance angle within the threading and milling processes.Heat treatment is needed at the critical point of the eutectic phase of preliminary design and finish machining.

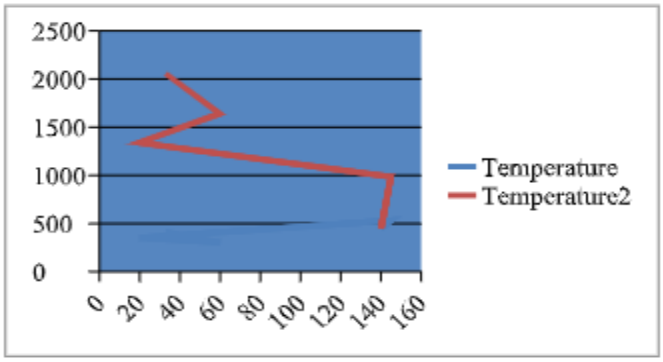
Bearing with enlarged radial clearance are often used.This will enhance the steady film concentration within the axial and radial surface to compensate for heat loss to the outer raceways lining that is work output is less when retardation is needed at a given condition of the ball bearing rolling. It was observed that in table 1.10 using under cooling temperature to examine the temperature of the alloys which forms the constituent of ball rolling thermal equilibrium with freezing temperature and the real fussion point within the lubrication phase while in motion. It was observed that temperature of the grease will be increasing at a steady state when the heat is absorbed when the substance making up the additive is homogenous without affecting the viscous flow at the regular predictive maintenance. But the stoichiometric rate of atomic rearrangement would be needed to the transformation of the grease to the contact surfaces into a stable constant coefficient of stable friction with the grease repose angle. Because the heat surface produce heat then the temperature of the dried balls decrease regressively from 2300 degree Celsius back to 500 degree Celsius with a meeting at 163 degree Celsius. Where as in table 1.11 the molecules gains energy at the initial phase which made the ball rolling element to expand by one tenth into two tenth.

The reason is that it takes the crystal ball in fig 1.12 to self organize it structure because the surface of the raceways has impurities of sand proportion mixed with water so the balls tend to take a long time to form a new [24] thermodynamic phase within 40 degree Celsius temperature from initial freezing temperature of the ice when measured at the initial phase. The rolling ball size increases and decrease as new phase emerges from the fig 2.11 and farther away from the pair initial ball with a negative value of negative elastic value of – 0.1(Heterogeneous nucleation) which modifies the ball rolling element ductility when carrying a load.

However, effects of grain shape and size of silica sand plays an important role in determining the parent binder and moisture content of the ball rolling elements. For instance the energy of the solid crystal tend to expand due to the nature of the compound sand grain fig 2.12 using ***hooke's*** law due to the nature of the molding sand which disintegrate at higher temperature. That is the compound that was used to test the sand contaminant were cemented together and they fail when screened with microscope. In country like Nigeria sand are classify by nature of texture simply as loamy soil, sandy soil and clayey soil

ISSN No:-2456-2165

Fig 2.13 Marginal difference between inner and outer raceways



VII. CONCLUSION

In this research it was found that the chemical compound used for making the cores of ball bearing are not properly considered by the phase of nucleation transformation. The base oil is differ by oxidation number and their position in the electrochemical series table should be well reviewed by manufacture using approximate regression factor with climatic change. first climatic change simplify the nature of chemical concentration of the viscous fluid at standard temperature and pressure of gas at s.t.p value which can be affected by entropy, enthalpy and free Gibb's energy and rate of reaction that is increased in mechanical advantage by velocity greater is by 0.2 percent with speed more than 120 to 140 km/hr should be monitored by the vehicle inspector officer on traffic which causes unprecedented [26] break down of heavy duty truck or motorist which might affect the stress- strain of the mechanical table 1.14 properties of other rotary path .If the shield is not guided with the thermal material should be known to maintain stable load zone which can affect the stoichiometric by reducing an indirect combustion of fuel by the propeller when rotated by the gearing system for internal combustion engines (I.C.E).mounting problem were analysis by simply designing an ergonomic elastic fitted material with friction modifiers using nanostructure compound by rearranging the atom and molecules using palladium, platinum and gold shows no effects in atmospheric change condition by [increasing rainfall, speed corrosion and increasing temperature and pressure weakens the mechanical properties and viscoelasticity of materials]. Some metal that do not undergo hydrolysis should be used a coating the surface of the ball rolling element [25] to avoid reduction – oxidation reaction. The sand forms sediment on the wall lining which causes crack and water film pool which lead to crack .Because the grease has a working temperature and the ball bearing that is under cooling temperature which forms new nuclei by the effect of dendrites. A forecasting software should be used to monitor the transformation of viscous grease from it more viscous state to liquid viscous phase. But in fig 1.15 it was observed that the bimetallic material with variation in solubility and liquid compressibility the isothermal expansion can not be monitored so easily except ensuring avoidance of poor machining and heating of the molten metal above it critical value. Hence a thermostat is needed to read the thinning shear and the base number of the grease lubricant to prevent shot run of available gauge of the grease when filled in the hubs. Each of the table above plays a significant role in analyzing the nature of heat transient using the navier stokes principle. Recent researchers were able to notice the cage housing the ball expand [26-27] but without actually stating the derivative condition of such condition by mathematical integral by volume and area using explicit functions. Most circular rings expand fast by air fig 2.13 circulation due forced convention and difference in density by diffusive motion by ratio 2/3th it linear expansions then the hydrophobic and hydrophilic has to be chemically formulated in any emulsifier as a safety measure in wheels and hubs which will change the Boolean operation and polyface three dimensional [28] shade mode and rendering speed up time

RECOMMENDATION

The rate of reaction of water mixture in grease with sand contaminants alongside ball bearing shields at constant heat flux should be designed with nano structured glass with a rearranged molecules and atom to mutually attract grease not water films to reduce corrosion .Hence mechanical digital automation should be developed in formulating the saturation point with solubility separation phases transducer feedback loop. Also the grease should have a catalyst which can speed up the water dehydration at the leak rings by thermal dissociation.

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