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PERFORMANCE EVALUATION AND SIMULATION OF POLYMER BALL BEARING IN ELECTRIC MOTOR & CIRCULATING PUMP APPLICATION

Pritesh J.Thoriya[1], Prof.B.N.Gelot[2]
[1]*Mechanical Engg. Department, Government Engg. College, Dahod, priteshthoriya@gmail.com*
[2]*Mechanical Engg. Department, Government Engg. College, Dahod, bngelot@yahoo.co.in*

Abstract— The use of polymer bearing can improve performance as polymer material is self lubricating material. Nowadays the use of polymer bearing is increasing in place of metal ball bearing. The usage of polymers in bearings has been increasing in recent years due to certain valuable tribological properties, including their ability to self-lubricate and their resistance to corrosion. These advantages encourage manufacturers to use polymer bearings in corrosive and lubricant-free work environments as well as applications in which weight reduction is desirable. Ball bearing used to mount the shaft of circulating pump used in agriculture application has to work in corrosive environment and having continuous contact with water, due to which lubrication loss occur which will cause bearing failure. Ball bearing used to support shaft of industrial DC motor, according to application has to work in corrosive environments and sometimes lubrication is not possible which will cause bearing failure. Into this dissertation an analysis has been done to improve the performance of ball bearing used in electric motor and circulating pump application by using polymer ball bearing. This will provide corrosion free, less noisy and lubrication free performance. To compare the performance, analytical calculation and dynamic analysis of metal ball bearing and polymer ball bearing will be done and results in form of lifecycle and stresses formed on each element on bearing are compared for both materials.

Keywords-polymer, ball bearing, dynamic analysis, self-lubrication

I. INTRODUCTION

Bearings are made of different materials like metals, polymers, ceramics and composite and bearings are available in different sizes varies from 1mm to 400mm.[1] Field data analyses made by Tian indicates that lubrication loss and lubrication degradation are the main causes for failures in miniature bearings. [2] So the use of polymer bearing can improve performance as polymer material is self lubricating material. The usage of polymers in bearings has been increasing in recent years due to certain valuable tribological properties, including their ability to self-lubricate and their resistance to corrosion. These advantages encourage manufacturers to use polymer bearings in corrosive and lubricant-free work environments as well as applications in which weight reduction is desirable. Polymer ball bearing consists of Polymer Rings,Balls made of stainless steel, glass, polymer or other materials and a Polymer Cage. Polymer ball bearings can be made from a variety of materials and materials combination. The materials selected depend on the application. Polymers have significantly different properties than steel. One of the most unique properties is that they are corrosion and chemical resistant. The polymers used to make polymer ball bearings have a low coefficient of friction and are highly resistant to wear and fatigue. These self-lubricating bearings can run dry and require no lubricant. The high specific strength (strength to weight ratio) is a valuable properties where weight is an important design consideration. High dimensional stability throughout the lifespan is achieved by the low creep tendency of the polymer used. Prabhat Singh et al.[2] ,presented a research paper on " Fatigue Life Analysis Of Thrust Ball Bearing Using ANSYS", In Journal International Journal Of Engineering Sciences & Research Technology In 2014 in which they compares the total deformation of thrust ball bearing & contact stress b/w ball & raceways & its effect on fatigue life of thrust ball bearing. They made dynamic analysis in ANSYS and compare the result with experimental data and found that result given by ANSYS is good and effective. They use

Bearing Life cycle theory to calculate bearing life and in dynamic analysis they used von-mises stresses. C.Morillo,E.C.Santos et al.[3] , includes comparison of the performance of polymer with metal in rolling contact. This is carried out by monitoring the acoustic emission, vibration and operating speed of metal and polymer bearings during their operation and found one of the most common failure mechanisms in these kinds of bearings is lubricant degradation, which represents 36% of premature bearing failures. Polymer self-lubricated materials are considered as candidate materials for these applications where lubrication is critical. Pranav B. Bhatt et al.[4] , includes design of four points angular contact ball bearing is done used in propeller shaft of an air craft. Into this research work they have calculated bearing life cycle by using IS standard and compare it with dynamic analysis result getting from ANSYS. Here they use tetra method of meshing for dynamic analysis and found that ANSYS gives good effective result. The main objective of increasing life cycle is also achieved by changing inner groove radius, contact angle, number of balls and diameter of balls. After this they obtained that Life in working hours by design is 55.638 hours and by analysis it is 70 hours. Hitonobu Koike et al.[5], includes investigation of wear performance of hybrid ball bearing (PEEK-PTFE & Alumina Ball). They found that due to self lubrication properties of PEEK , the wear loss of hybrid ball bearing cycle was less. They have made experiment on 52mm ID PEEK material deep groove ball bearing and observe that the wear loss after $1.0 * 10^7$ cycles at 2000 rpm was 20mg only. They also found that Durability of PEEK material is higher than PTFE. They have generate following Graph of wear loss verses No. of Cycles and conclude that Roughness of PEEK decreased with increase in no of cycles. R.K. Upadhyay et al.[6] ,includes failure occurs in AISI 52100 Alloy Steel ball bearing which is having high compressive strength, low cost and good wear resistance. They found that cyclic load may be divide into two parts 1) Surface initiated and 2) sub-surface initiated. Both of this plays important role in fatigue failure of bearing. They recommend that Lubrication degradation is main reason of bearing failure so avoid it and use hard material to decrease contact stresses. J. Sukumaran et al.[7], includes a comparative study on water lubrication has been done to understand the fundamental aspects of tribology. Into this research work commonly used polymer such as PA6, POM, PEEK & PTFE studied for tribological behavior and found that under wet condition PTFE works better. They also found that on using water as a lubrication, it decreases co-efficient of friction to a specific value. K.Kida et al.[8] includes investigation of radial PEEK bearings rolling contact fatigue behavior under dry condition. Due to PEEK's self-lubrication ability, the radial PEEK-Alumina ball bearing lifetime was longer when testing at medium loads (between 85.6 N and 93.1 N) and at 600 rpm. TANG Zhaoping et al.[9], describes how contact analysis changes in stress, strain, penetration among the elements of ball bearing was showed by using ANSYS. After that simulation result was compared to theoretical values. Into this research work 6200 series ball bearing 3-D model is generated in APDL and then by using 8 nodes and 6 faces and free meshing of size 1.5 mm dynamic analysis has been carried out. They found that Max. contact stress from simulation was 8599MPa and from Hertzian theory it was 8572 MPa. They conclude that ANSYS have good consistency and this method of Simulation is useful for dynamic analysis of ball bearing.

II. METHODOLOGY

Nowadays polymer material becomes alternative of metals. Specially some properties of polymer like self lubricant, corrosion resistant, light weight we can implement it in many applications. As most important thing is PEEK material performs good under rolling contact fatigue. We have also seen that water lubricated PEEK performs better as it's frictional co-efficient decreases up to some value and wear rate also decreases. Simulation in ANSYS gives good and efficient result for life cycle calculation. We can utilize the performance of ball bearing used to mount shaft of circulating pump used in agriculture and electric motor having corrosive environment where lubrication is difficult and also having contact with water. We can find life cycle of rolling bearing for both the materials metal as well as polymer by analytical calculations and also by using ANSYS

and can compare the results. We can also compare the stress distribution for both the material using ANSYS.

III. CONCLUSION

Result obtained by Dynamic Analysis in form of life is compared with Analytical Result & Also results of both material is compared. Also the stresses on each element for both the materials are compared.

REFERENCES

[1] ISO–Isostandards–TC123–Plainbearings, (Http://Www.Isoorg/Iso/Home/Tore/Catalogue_Tc/Catalogue_Tc_Browse.Htm).

[2] Prabhat Singh et al. , " Fatigue Life Analysis Of Thrust Ball Bearing Using ANSYS", In Journal International Journal Of Engineering Sciences & Research Technology In 2014

[3] C.Morillo,E.C.Santos Et All, , "Comparative Evaluation Of Metal And Polymer Ball Bearings", In Journal Wear 302 (2013) 1499–1505, 2013

[4] Pranav B. Bhatt et al. , "Design, Modelling And Analysis Of A Single Raw Four Point Angular Contact Split Ball Bearing To Increase Its Life." In Journal International Journal Of Engineering Trends And Technology (IJETT) - Volume4 Issue6, 2013

[5] Hitonobu Koike et al. , "Observation Of Wear On PEEK-PTFE Hybrid Radial Bearings", In Journal Advanced Materials Research Vol. 683, 2013

[6] R.K. Upadhyay et al. , "Rolling Element Bearing Failure Analysis: A Case Study", In Journal Case Studies In Engineering Failure Analysis 1 (2013) 15–17 Elsevier, 2013

[7] J. Sukumaran, V. Rodriguez, P. De Baets, Y. Perez et al. , "A Review On Water Lubrication Of Polymers", Presented A Review In Ghent University (Ugent) And Catholic University Of Leuven (K.U. Leuven), 2012

[8] K.Kida et al. , "Self-Lubrication Of PEEK Polymer Bearing In Rolling Contact Fatigue", In Journal Tribology International 49 (2012) 30–38, 2011

[9] TANG Zhaoping et al. , "The Contact Analysis For Deep Groove Ball Bearing Based On ANSY", In Journal Procedia Engineering 23 (2011) 423 – 428, 2011

