DESIGN AND ANALYSIS OF BALL BEARING

Author: 1. M.DEVENDRAN PG Scholar, Department of Mechanical Engineering, Al – Ameen Engineering College. Erode, Tamilnadu.

ABSTRACT: The main objective of our project is to explore the analysis of a ball bearing. This has entailed performing a detailed thermal analysis. The study deals with dynamic, modal and transient thermal analysis. A proper Finite Element Model is developed using Cad software Pro/E Wildfire 4.0. Here we are doing the material optimization of balls used in bearing. We are designed the 3D model of the axle by using pro-e software and the analysis are made by different combination of materials for the bearing and the analysis carried out using ansys software. In this project we are analyzing the rotational velocity and moment acting on the bearing by the two materials. Presently the bearing is made by the stainless steel material. we are testing the same load for ceramic material. Then the thermal analysis is done to determine the total heat flux in the existing ball bearing for the given temperature conditions. The temperature acting on the inner surface of the bearing is applied and the results were also used to determine the total heat flux for a particular material.

1. INTRODUCTION

1.1 Materials Already Used:

There are essentially two choices for the material used in ball bearings - chrome steel or stainless steel. Since the material plays a major part in the performance of a bearing in any given application, it is very important that the correct material is used. Note that the specified material applies to the load bearing components only - the rings and the balls. The retainer and the shields (if used) are usually made from a different material and are subject to separate specification.

1.2 Chrome Steel:

This is the standard material used for ball bearing applications where load capacity is the main consideration. The machinability of this steel is excellent, giving smooth, low noise raceway finishes, together with superior life. Chrome steel material is recommended in applications where corrosion is not a factor.

1.3 Stainless Steel:

400 series martensitic stainless steel is the standard material for miniature and instrument ball bearings where corrosion resistance is more important than load capacity. There are 3 types of 400 series stainless steel used in the bearings described in this handbook. These materials have evolved in response to different manufacturing and application needs. It is important to note that the actual material used is generally determined by the manufacturer, and cannot be specified by the user. The bearing part numbering system gives the appropriate codes for each material type.

2. CERAMIC BEARING AND CERAMIC BALL BEARINGS CLASSIFICATION

Press materials: ceramic bearings can be divided into zirconia ceramic bearings, silicon nitride ceramic bearings, ceramic bearing compound.By the structure: ceramic bearings can be divided into: zirconia ceramic bearings with cage, silicon nitride ceramic bearings with cage, composite ceramic bearing with retainer. General ceramic bearing retainer materials to polytetrafluoroethylene (PTFE) as a standard configuration, you can also use glass fiber reinforced nylon 66 (GRPA66-25), special engineering plastics (PEEK, PI), stainless steel (SUS316, SUS304), Brass (Cu) and so on. Ceramic materials because of pocket-hole cage processing, molding technology and other problems, still less use; as retainer material restrictions for special occasions and developed using a non-retainer all-ceramic zirconia full ball bearings and silicon nitride balls full Full ceramic ball bearings and full ceramic bearings composite.

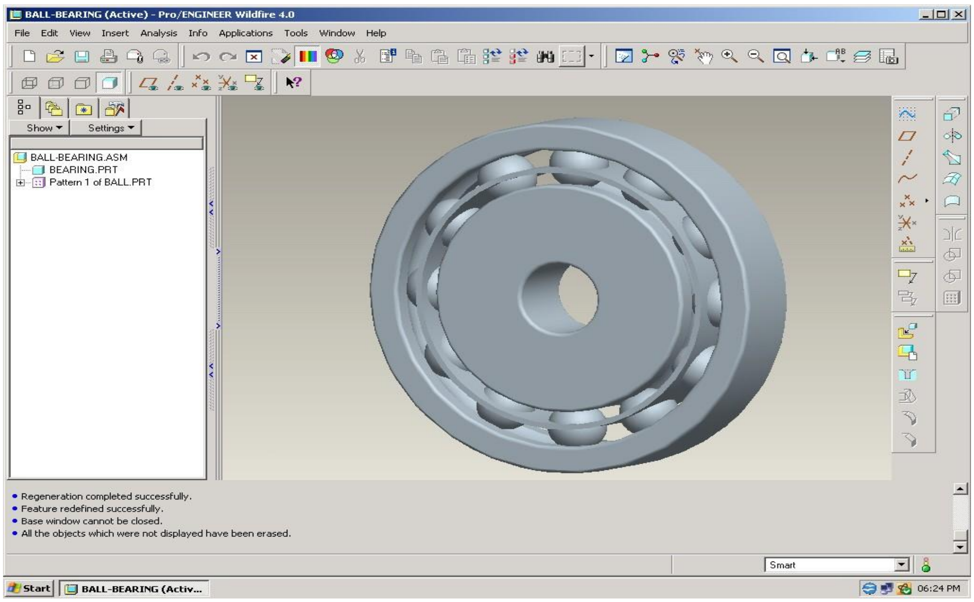
Divided by the integrity of the material: ceramic bearings to the above mentioned major components inside and outside the ring and rolling elements are mostly ceramic material, it is defined as the ceramic bearings; if the bearing outer rings and rolling elements are part of the ceramic material is not used when we it is defined as the hybrid ceramic bearings. The use of hybrid bearings is more extensive use of ceramic materials known as ceramic ball bearings, can be divided into zirconia ceramic ball bearings, silicon nitride ceramic ball bearings.

Different materials and different structure of the ceramic bearing and ceramic ball bearings in use need attention vary, please check the specific details of the ceramic bearing and ceramic ball bearings professional manufacturer for more help.

3. LOOKING CERAMIC BEARING AND CERAMIC BALL BEARINGS WITH PROSPECTS

Ceramic bearing and ceramic ball bearings have many excellent properties such as: self-lubricating, high temperature, corrosion resistant, magnetic, electrical insulation, etc., yet in the wider field of development and utilization of potential applications is enormous. The first high-quality high-speed ceramic ball bearings: excellent service to the domestic machine tool industry, high-speed, high precision spindle, spindle bearing a large amount of the estimated annual demand picked up in a few million units or more. But the high-precision spindle bearings precision bearings requires relatively high quality and more stringent requirements as the G5 P4-bearing ceramic ball above the level of precision is currently able to produce very few manufacturers, product stability is poor. Second: the medium-quality ceramic bearings in oil exploration, oil refining, in particular, fine chemicals, chemical fiber, new energy, printing and dyeing, electroplating, water treatment, marine development, deep-water pumps, acid pumps, high temperature, vacuum, magnetic resonance, electrical insulation, medical, X-ray tube and the food industry and many other areas can be extensive and well used. Many only require the general accuracy level; medium and low speed and load; requirements bearing resistant to a certain concentration of acid, alkali and salt corrosion; resistant to 300 ¯ 400 ℃high temperature; non-magnetic, electric, non-toxic; can be used without oil or lubrication of the working medium itself; in seawater can also be used. Bearing applications in these areas account for a very large proportion of special bearings and ceramic bearings and ceramic ball bearings are fully capable to replace, and can barely reach the metal bearing the work of competent and incompetent, engineering ceramics has its irreplaceable position. Have such a huge market for the premise, our product development and manufacturing can create a new way to broaden the application areas of ceramic bearing greater. The new materials, new processes, new technologies to better serve the production.

4. BEARING DESIGN



5. MATERIAL PROPERTIES

Structural	**Si3N4**	**Stainless Steel**
Young's Modulus	3.17 e+005 MPa	1.93 e+005 MPa
Poisson's Ratio	0.27	0.31
Density	3.29 e-006 kg/mm3	7.75 e-006 kg/mm3
Thermal Expansion	3.3 e-006 1/ºC	1.7 e-005 1/ºC
Thermal	Si3N4	Stainless Steel
Thermal Conductivity	2.4 e-002 W/mm ºC	1.51 e-002 W/mm ºC
Specific Heat	0.17 J/kg ºC	480 J/kg ºC

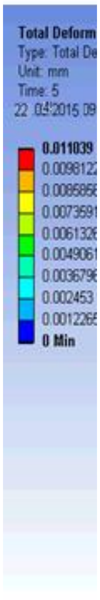
6. INPUTS & RESULTS OF STAINLESS STEEL AND CERAMIC

6.1 Stainless steel

6.1.1DYNAMIC

6.1.2 Total Deformation

www.ijaser.in
ISSN: 2455-9288

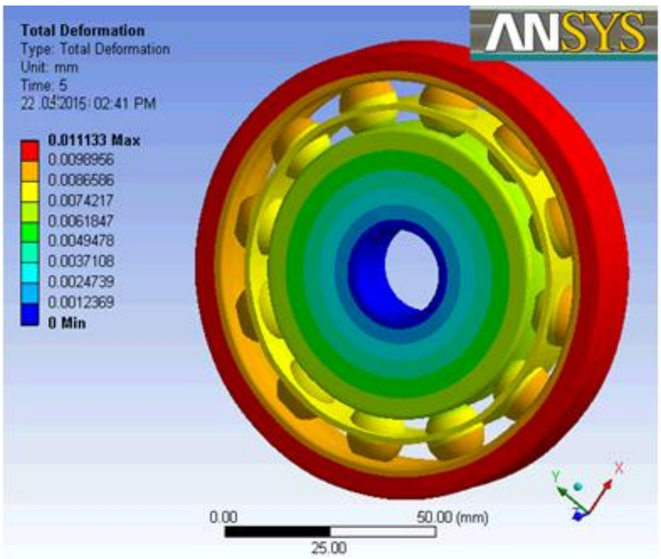


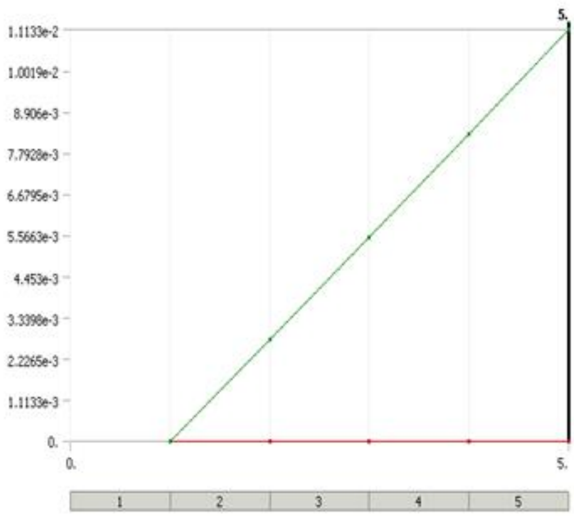
	STAINLESS STEEL		Si3N4	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM

6.2 Si3N4 CERAMIC

6.2.1 DYNAMIC

6.2.1 Total Deformation





7. COMPARISON OF STAINLESS STEEL AND Si3N4

Total deformation (mm)	0	0.011039	0	0.01133
quivalent elastic strain(mm/mm)	4.1274e^{-6}	0.00047875	3.1357e^{-6}	0.00048118
Equivalent stress (Mpa)	0.79659	92.398	0.99401	92.868
Total deformation 1(mm)	33.013	33.015	34.489	34.49
Total deformation 2(mm)	33.014	33.014	34.489	34.49
Total deformation 3(mm)	33.013	33.014	34.489	34.49
Total deformation 4(mm)	0.062856	65.129	0.10357	68.363
Total deformation 5(mm)	8.4466	47.254	9.0095	49.59
Total deformation 6(mm)	0.12992	65.19	0.12754	68.44
TEMPERATURE(ºC)	21.768	158.15	21.768	156.31
TOTAL HEAT FLUX(W/mm^2)	4.0199e^{-6}	1.1178	4.0589e^{-6}	1.4045
DIRECTIONAL HEAT FLUX (W/mm^2)	-0.92726	0.89011	-1.1771	1.1264

CONCLUSION

Experimental results are obtained from testing the conventional ball bearing and optimized bearing under total deformation, equivalent strain and stress, temperature are listed in the Table. Analysis has been carried out by dynamic, nodal and thermal. The stainless steel material is used as a conventional. The results for dynamic, nodal and transient thermal such as total deformation (0.01133mm), equivalent elastic strain (0.00048118mm/mm), and equivalent stress (92.868Mpa), temperature (156.31ºC), total heat flux (1.4045W/mm2) and directional heat flux(1.1264W/mm2) in each direction are determined. Comparing the optimized ball bearing and the conventional ball bearing, optimized ball bearing posses the high withstand temperature. Hence we concluded optimized ball bearing is suitable.

REFERENCES

1. Design data book -P.S.G.Tech.
2. Machine tool design handbook –Central machine tool Institute, Bangalore.
3. Strength of Materials - R.S.Kurmi
4. Manufacturing Technology - M.Haslehurst.
5. Design of machine elements - R.S.Kurmi