International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 14th Sept 2019. Link :http://www.ijiemr.org/downloads.php?vol=Volume-08&issue=ISSUE-09

Title **FRACTURE AND FATIGUE ANALYSIS OF A COMPOSITE JOURNAL BEARING AT DIFFERENT ECCENTRICITY AND L/D RATIOS**

Volume 08, Issue 09, Pages: 655–663.

Paper Authors

PUTTA SATYANARAYANA, MISS. P. RADHIKA

G V R & S COLLEGE OF ENGINEERING & TECHNOLOGY - [GVR&S], GUNTUR, ANDHRA PRADESH

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

FRACTURE AND FATIGUE ANALYSIS OF A COMPOSITE JOURNAL BEARING AT DIFFERENT ECCENTRICITY AND L/D RATIOS

[1]PUTTA SATYANARAYANA,[2]MISS. P. RADHIKA
[1]M-TECH SCHOLAR, DEPARTMENT OF MECHANICAL ENGINEERING IN G V R & S COLLEGE OF ENGINEERING & TECHNOLOGY - [GVR&S], GUNTUR, ANDHRA PRADESH
[2]ASSISTANT PROFESSOR DEPARTMENT OF MECHANICAL ENGINEERING IN G V R & S COLLEGE OF ENGINEERING & TECHNOLOGY - [GVR&S], GUNTUR, ANDHRA PRADESH

ABSTRACT Journal bearings have the longest records of medical look at of any elegance of fluid film bearings. In a fluid film bearing, the stress in the oil film satisfies the Reynolds equation which intern is a feature of film thickness. Structural distortion of the housing and the improvement of hydrodynamic pressure in a complete journal bearing are strongly coupled as a consequence requires a blended solution. Oil film pressure is 1 of the key working parameters describing the operating conditions in hydrodynamic journal bearings. Hydrodynamic journal bearings are analyzed by the use of Computational fluid dynamics (CFD) and fluid structure interplay (FSI) method to be able to locate deformation of the bearing. In this thesis journal bearings for different L/D ratios and eccentricity ratios are modeled in 3D modeling software program CREO. The L/D ratios considered are zero.5, 1.Zero, 1.5 and eccentricity ratios taken into consideration are 0.2, 0.5, 0.7 and 0.Nine. Journal bearing models are developed for pace of 2000 rpm to look at the interplay between the fluid and elastic behavior of the bearing. The speed is the input for CFD evaluation and the strain acquired from the CFD analysis is taken as enter for structural evaluation. Computational fluid dynamics (CFD) and fluid shape interplay (FSI) is accomplished in ANSYS. In this thesis the fracture analysis of composite journal bearing to finding the J-integral and stress intensity factor.

1. INTRODUCTION TO BEARINGS

A fairly big wide variety of bearings can be discovered all around us. Take motors, as an example: there are 1 hundred to a hundred and fifty bearings in an average automobile.

The handiest instance of a undeniable bearing is a shaft rotating in a hole. A easy linear bearing can be a couple of flat surfaces designed to allow movement; e.G., a drawer and the slides it rests on or the ways on the mattress of a lathe.

Plain bearings, in trendy, are the least luxurious kind of bearing.

1.1 BEARINGS:

Bearings enhance the capability of machinery and assist to keep power. Nevertheless, bearings are critical for the stable operation of machinery and for making sure its pinnacle overall performance. The word "bearing" contains the that means of "to undergo," inside the feel of "to assist," and "to carry a burden." This refers back to the truth that bearings help and convey the load of revolving axles.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Fig 1.1: Roller Bearing DESIGN

The layout of a simple bearing depends at the kind of motion the bearing have to offer. The 3 types of motions viable are:

• Journal (friction, radial or rotary) bearing: This is the most not unusual sort of undeniable bearing; it's miles of the axles of railroad wheel sets, enclosed via journal packing containers (axle boxes). Axle box bearings nowadays are now not plain bearings but instead are rolling-detail bearings.

• Linear bearing: This bearing presents linear movement; it may take the shape of a round bearing and shaft or some other matching surfaces (e.G., a slide plate).

• Thrust bearing: A thrust bearing offers a bearing floor for forces acting axial to the shaft.

1.4 MATERIALS

PLAIN bearings should be crafted from a cloth this is durable, low friction, low put on to the bearing and shaft, immune to elevated temperatures, and corrosion resistant. The difficult constituent supports the load even as the smooth constituent helps the hard constituent. In general, the more difficult the surfaces in contact the lower the coefficient of friction and the more the strain required for the 2 to seize.

1. Polyetheretherket1 (PEEK)

Polyetheretherket1 (PEEK) is generally utilized in fundamental bearings. Polyetheretherket1 (PEEK) bearings are designed to not harm the journal in the course of direct contact and to accumulate any contaminants in the lubrication.

1. Bi-material

Fig 1.3.1 Split bi-material bushings: a metal exterior with an inner plastic coating

APPLICATIONS:

- trains
- airplanes
- washing machines
- refrigerators
- air conditi1rs
- vacuum cleaners
- photocopy machines
- computers
- satellites

LUBRICATION

Lubrication is the procedure or approach employed to lessen friction between, and wear of 1 or each, surfaces in near proximity and transferring relative The lubricant can be a strong, (e.G. Molybdenum disulfide MoS_2) a strong/liquid dispersion, a liquid along with oil or water, a liquid-liquid dispersion (a grease) or a gasoline. or through the liquid being pumped below strain among the surfaces.Lubrication can also describe the phenomenon in which discount of friction takes place unintentionally, which can be risky such as hydroplaning on a road.The science of friction, lubrication and put on is referred to

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

as tribology.Adequate lubrication permits clean continuous operation of system, reduces the charge of damage, and forestalls immoderate stresses or seizures at bearings.

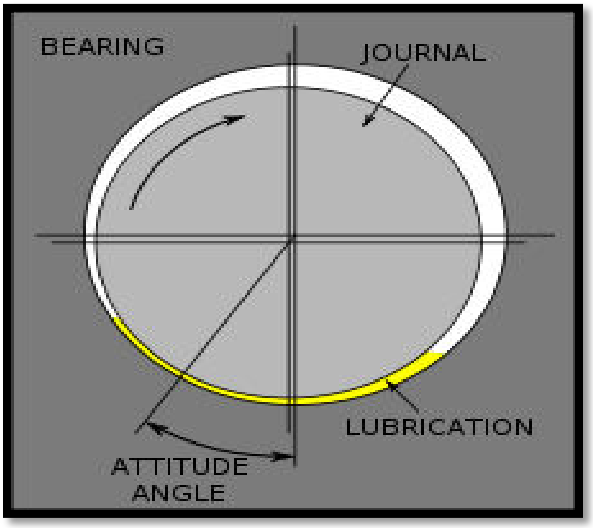


Fig 1.6.1 A schematic diagram of a journal bearing under a hydrodynamic lubrication state showing how the journal centerline shifts from the bearing centerline.

LITERATURE REVIEW

In the paper via B. S. Shenoy [1], Conventional technique of acting an EHL analysis on a bearing entails development of complex codes and simplification of real physical version. This paper presents a methodology to model and simulate the Overall Elasto-Hydrodynamic Lubrication of a full magazine bearing using the sequential software of Computational Fluid Dynamics (CFD) and Computational Structural Dynamics (CSD). Here, the coupled field analysis uses the abilities of commercially available Finite Element Software.

ANSYS/FLOTRAN incorporating the approach of Fluid Structure Interaction (FSI). The strain discipline for a full journal bearing operating below laminar drift regime with numerous L/D ratios is received by way of CFD. Stress distribution and deformation inside the bearing liner because of resulting pressure force is evaluated the use of FEM, gratifying the boundary conditions. The stress distribution indicates the crucial factors inside the bearing shape. The results show reasonable agreement in popular.

INTRODUCTION TO CAD

Computer-aided layout (CAD), also referred to as computer-aided design and drafting (CADD), is the usage of laptop era for the method of layout and layout-documentation. Computer Aided Drafting describes the technique of drafting with a laptop. CADD software, or environments, provide the user with enter-equipment for the cause of streamlining design tactics; drafting, documentation, and production approaches.

INTRODUCTION TO PRO/ENGINEER

Pro/ENGINEER Wildfire is the usual in 3-D product design, presenting enterprise-main productiveness gear that sell fine practices in design at the same time as ensuring compliance with your industry and organisation requirements. Integrated Pro/ENGINEER CAD/CAM/CAE solutions permit you to layout faster than ever, even as maximizing innovation and excellent to in the end create superb merchandise.

Finite Element Method:

Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a fundamental evaluation technique for resolving and substituting complex troubles by using easier 1s, acquiring approximate solutions Finite element approach being a flexible device is used in diverse industries to resolve numerous practical engineering problems. In

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

finite element approach it is viable to generate the relative outcomes.

METHODOLOGY:

In this thesis magazine bearings for distinctive L/D ratios and eccentricity ratios are modeled in 3D modeling software Pro/Engineer. The L/D ratios taken into consideration are zero.5, 1.Zero, 1.5 and eccentricity ratios considered are zero.2, zero.5, zero.7 and zero.9.

Journal bearing fashions are evolved for pace of 2000 rpm to look at the interplay among the fluid and elastic conduct of the bearing. The velocity is the enter for CFD analysis and the pressure acquired from the CFD evaluation is taken as input for structural analysis.

Computational fluid dynamics (CFD) and fluid structure interaction (FSI) is finished in Ansys.

JOURNAL BEARING MODEL CALCULATIONS

L/d ratios 0.5, 1.0&1.5

Eccentricity ratio=0.2, 0.5, 0.7&0.9

Length calculations

L=length of journal, mm

D=diameter of journal, mm

L/d=0.5	L/d=1.0	L/d=1.5
D=100mm	D=100mm	D=100mm
L=0.5×100	L=1.0×100	L=1.5×100
L=50mm	L=100mm	L=150mm

Eccentricity calculations

Ɛ=e/c

E=eccentricity mm

C=radial clearance, mm

C=0.145mm according journals

4.3 MODELS AND 2D DRAWINGS OF JOURNAL BEARING IN PRO-ENGINEER

L/D ratio	Eccentricity ratio			
0.5	0.2	0.5	0.7	0.9
1.0	0.2	0.5	0.7	0.9
1.5	0.2	0.5	0.7	0.9

4.4 PROBLEM IDENTIFIED:

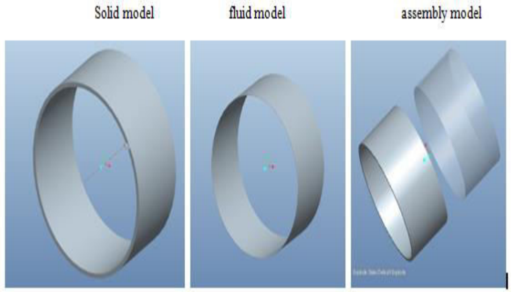
Oil movie stress is 1 of the key running parameters describing the working situations in hydrodynamic magazine bearings. Hydrodynamic magazine bearings are analyzed by means of the use of Computational fluid dynamics (CFD) and fluid shape interaction (FSI) approach so that it will discover deformation of the bearing.

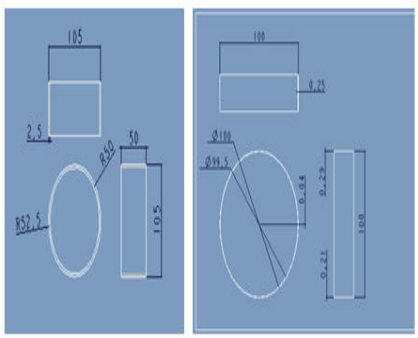
RESULTS & DISCUSSIONS

5.1 Models of journal bearing using pro-e wildfire 5.0

The journal bearing is modeled using the given specifications and design formula from data book. The isometric view and exploded view of journal bearing are shown in below figure. The profile is sketched in sketcher and then it is extruded up to 50mm, 100mm and 150mm (face width) using extrude option.

L/D=0.5;Ɛ=0.2





5.2 ANALYSIS OF JOURNAL BEARING - FSI (FLUD STRUCTURE INTERFACE)

L/D RATIO=0.5, 1.0&1.5

ECCENTRICITY RATIO (Ɛ) =0.2, 0.3, 0.7&0.9

FLUID - SAE 20W OIL

BEARING MATERIAL - BABBIT

BOUNDARY CONDITIONS

For CFD evaluation, speed and stress are implemented on the inlets. For structural evaluation, the boundary situations are the strain received from the result of CFD evaluation and displacement.

When L/D =0.5 & ECCENTRICITY=0.2

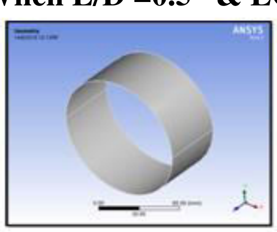


Fig 5.1: Geometry model Fig 5.2: Meshed model

The version is constituted as 1 cylinder with a diameter D of 100 mm and every other 1 with a diameter of ninety nine.5 mm, with eccentricity ratio of zero.2. The version is designed with the help of seas1d-e and then import on ANSYS for Meshing and analysis. The evaluation via CFDFSI method is used with a purpose to calculating stress profile and temperature distribution. For meshing, the fluid ring is divided into linked volumes. Then all thickness edges are meshed with 360 periods. A tetrahedral structure mesh is used. So the overall range of nodes and factors is 6576 and 3344.

Select faces → right click → create named section → enter name → air inlet

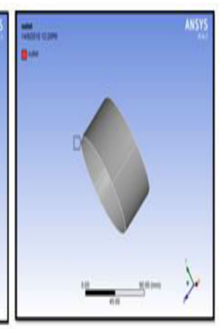
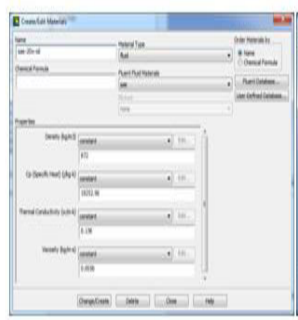


Fig 5.3: naming the lubricant inlet section Fig 5.4: naming the lubricant outlet section



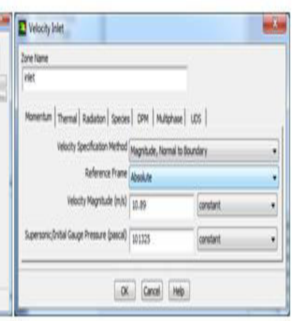


Fig 5.5: specifying the fluid material Fig 5.6: specifying the inlet pressure

Boundary conditions>inlet>enter required inlet values

Solution > Solution Initialization > Hybrid Initialization >completed

Run calculations > no of iterations = 10> calculate > calculation complete>adequate

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Results>edit>pick out contours>good enough>pick location (inlet, outlet, wall.Etc)>pick out pressure>practice

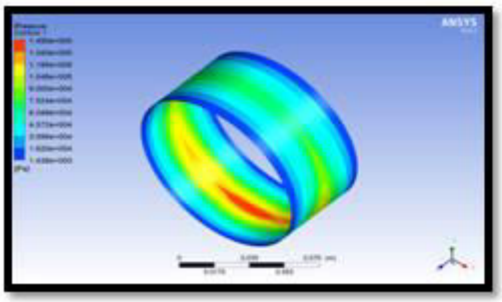


Fig 5.7 Pressure contours

According to stress counters the most stress is 1.490e+005Pa at middle portion of the magazine bearing and minimal pressure 1.438e+003Pa at ends of the journal bearing. The plain journal bearing has most effective 1 high point stress alongside the circumference of the magazine bearing. This is because of geometry of bearing and the way the fluid gap expands and contracts once across the circumference of the magazine shaft. A normal pressure distribution along the circumference of the magazine shaft of the magazine bearing is shown in above fig, respectively for long and quick magazine bearing.

Select static structural>now percentage the geometry of fluid glide (fluent) to geometry of static structural>and switch the answer of fluid waft (fluent) to setup of static structural

Used cloth Polyetheretherket1 (PEEK)

Density=0.00000973kg/mm3

Young's modulus=50000MPa

Poisson's ratio=zero.25

Now proper click on the version in static structural>geometry

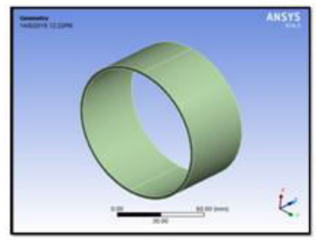


Fig 5.8 Geometry model

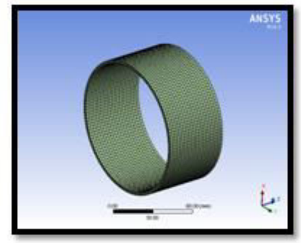
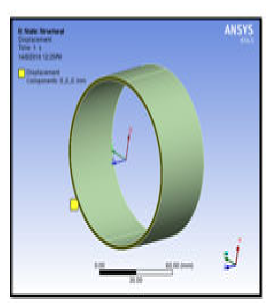


Fig 5.9 Meshed model

The model is constituted as 1 cylinder with a diameter D of 100 mm and every other 1 with a diameter of 1 hundred and 5 mm. The version is designed with the assist of pro-e after which import on ANSYS for Meshing and evaluation. The evaluation by using CFDFSI approach is used if you want to calculating stress profile and temperature distribution. For meshing, the fluid ring is divided into 2 connected volumes. Then all thickness edges are meshed with 360 intervals. A tetrahedral structure mesh is used. So the total range of nodes and elements is 8975 and 5583.

Right click on on the static structural>insert>pick out displacement>choose solving location in the model observe



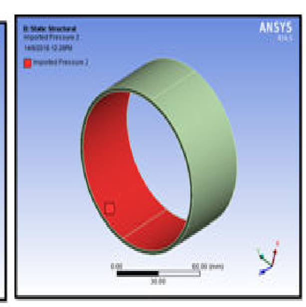


Fig 5.10: selecting the displacement and select fixing area in the model

Fig 5.11: imported load from CFD and applied the pressure area on the complnt

Right click on the static structural>insert>imported load from

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

CFD>insert>pressure>select pressure area on the comp1nt>apply
total deformation

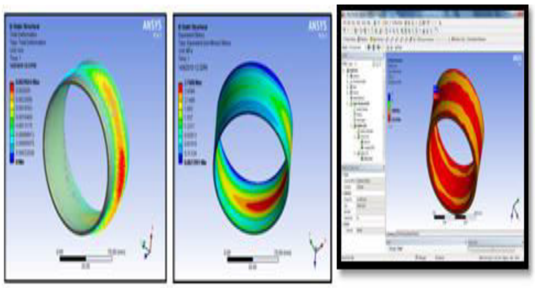


Fig 5.12: total deformation Fig 5.13: equivalent stress safety factor

This technique gives the deformation of the bearing due to action of hydrodynamic forces Developed that's essential for accurate overall performance of the bearings operation beneath extreme conditions It is located that there may be tremendous quantity of deformation of the bearing.

When the loads applied on magazine bearing the use of Polyetheretherket1 (PEEK), the most deformation value is 0.0029644mm

When the loads applied on journal bearing using Polyetheretherket1 (PEEK), the maximum stress value is 2.7608MPa at middle portion of the journal bearing and minimum stress is 0.0072991MPa.

RESULT TABLE

L/D ratio	Eccentricity ratio	Pressure (Pa)	Displacement(mm)	Stress (MPa)
0.5	0.2	1.49E+05	0.0029644	2.7608
	0.5	2.066E+05	0.0053614	3.8927
	0.7	2.812E+05	0.0083703	6.1225
	0.9	3.634E+05	0.010352	7.5886
1.0	0.2	2.488E+05	0.0086261	4.8936
	0.5	3.121E+05	0.015092	6.2448
	0.7	4.031E+05	0.026131	10.581
	0.9	5.379E+05	0.045613	16.994
1.5	0.2	3.523E+05	0.019325	7.0022
	0.5	4.215E+05	0.041523	10.241
	0.7	5.151E+05	0.07221	16.498
	0.9	6.449E+05	0.10981	23.94

COMPARISON OF RESULTS FOR DIFFERENT L/D RATIOS

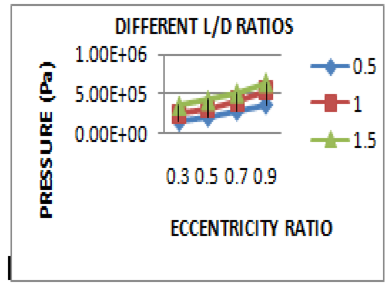


Fig 5.4.10 PRESSURE PLOT

Variation of maximum pressure for various eccentricity ratios and l/d ratios

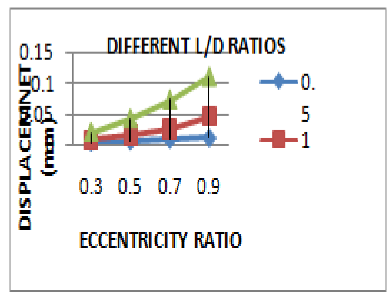


Fig 5.4.11 DISPLACEMENT PLOT

Variation of maximum deformation for various eccentricity ratios and l/d ratios

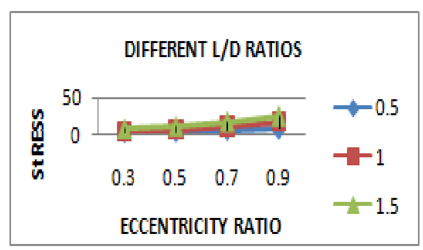


Fig 5.4.12 STRESS PLOT

Variation of maximum stress for various eccentricity ratios and l/d ratios.

CONCLUSION

In this thesis, Hydrodynamic journal bearings are analyzed by using Computational fluid dynamics (CFD) and fluid structure interaction (FSI) approach on different models by varying L/D ratios and eccentricity ratios using Ansys in order to evaluate the fluid pressures, Stress distribution and deformation in journal bearing. Journal bearings for different L/D ratios and eccentricity ratios are modeled in 3D modeling software creo. The L/D ratios considered are 0.5, 1.0, 1.5 and eccentricity ratios considered are 0.3, 0.5, 0.7 and 0.9.By observing the CFD analysis results, the pressure is increasing by increasing the L/D ratios and eccentricity ratio thereby increasing the displacements and stress values.By this thesis, deformation and stresses of the bearing due to action of hydrodynamic forces developed which is important for accurate performance of the bearings operation under severe conditions can be evaluated. It is observed that there is substantial amount of deformation of the bearing By observing the static analysis the stress values are increases by increasing the L/D ratio of journal bearing. The minimum stress value at 0.2 eccentricity ratio, L/D ratio 0.5. In particular, they are phenomena in which a crack propagates deeply into the depth direction, such as through fracture of an inner ring under fitting stress. Contact stress is compressive in 3 axes, but the values are different; then strain can be tensile in the direction at a right angle to the maximum-compression stress direction. We consider that the crack propagates by this tensile strain. When contact stress is small, a crack, produced by some cause, can propagate by this elastic tensile strain. When contact stress is large, residual tensile strain is produced by plastic deformation and this residual tensile strain can also influence the crack propagation.

REFERENCES

1. Journal bearing overall performance and metrology issues by means of S. Sharma, D. Hargreaves, W. Scott, Journal of Achievements in Materials and Manufacturing Engineering
2. Analysis of a Rough Elliptic Bore Journal Bearing the use of Expectancy Model of Roughness Characterization by P.C. Mishra
3. P. Allaire, J. Nicholas, E. Gunter. Systems of Finite Elements for finite bearings. ASME Journal of Lubrication, Technology, 1972, (99): 187–197.
4. P. Bhat, B. Shenoy, R. Pai. Elasto-hydrodynamic Lubrication Analysis of a Radialy Adjustable Partial Arc Bearing Using Fluid Structure Interaction. In: Proc. Of ASME/STLE International Joint Tribology Conference, San Diego, California, US, 2007, 1–3. IJTC'07, IJTC44479.
5. J. Booker, K. Huebner. Application of Finite Element Methods to Lubrication: an Engineering Approach. ASME Journal of Lubrication Technology, 1972, (94): 313–323.
6. P. Brajdic-Mitidieri, A. Gosman, et al. CFD Analysis of a Low Friction Pocketed Pad Bearing. ASME Journal of Tribology, 2005, 127(4): 803–812.
7. P. Chen, E. Hahn. Use of Computational Fluid Dynamics in Hydrodynamic Lubrication. Proceedings of Institute of Mechanical Engineers: Part J, Journal of Engineering Tribology, 1998, (6): 427–435.

8. Thermohydrodynamic Analysis of a Journal Bearing Using CFD as a Tool Mukesh Sahu, Ashish Kumar Giri, Ashish Das
9. Journal bearing overall performance and metrology issues S. Sharma a,*, D. Hargreaves b, W. Scott b a School of Engineering Systems, Queensland University of Technology, Brisbane, Queensland, Australia b School of Engineering, RMIT University, Melbourne, Victoria, Australia * Corresponding writer: E-mail cope with: subash_sharma@rmit.Edu.Aul
10. Wolfinger P., 'Analysis of Various Parameters Associated with Oil Lubricated Journal Bearings', M.Tech Thesis, Rensselaer Polytechnic Institute, Hartford, 2011, USA.