THERMAL ANALYSIS OF JOURNAL BEARING USING CFD UNDER NON-ISOTHERMAL CONDITION

Dissertation-II

Submitted in partial fulfillment of the requirement for the award of degree

Of

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by

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Under the guidance

of

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TOPIC APPROVAL PERFORMA

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PROPOSED TOPIC : Thermal Analysis of Journal Bearing Using FEM under non-isothermal condition.

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	**Parameter**	**Rating (out of 10)**
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2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	7.00
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	7.50
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5	Social Applicability: Project work intends to solve a practical problem.	7.50
6	Future Scope: Project has potential to become basis of future research work, publication or patent.	7.50

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Final Topic Approved by PAC: **Thermal Analysis of Journal Bearing Using FEM under non-isothermal condition.**

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CERTIFICATE

I hereby certify that the work being presented in the dissertation entitled "THERMAL ANALYSIS OF JOURNAL BEARING USING CFD UNDER NON-ISOTHERMAL CONDITION" in partial fulfillment of the requirement of the award of the Degree of Master of Technology and submitted to the Department of Mechanical Engineering of Lovely Professional University, Phagwara, is an authentic record of my own work carried out under the supervision of Mr. VIJAY SHANKAR (Assistant Professor) Department of Mechanical Engineering, Lovely Professional University. The matter embodied in this dissertation has not been submitted in part or full to any other University or Institute for the award of any degree.

(29-11-2017)

(GOPI KAKANI)

11304021

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

(29-11-2017)

Mr. VIJAY SHANKAR

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The external viva-voce examination of the student was held on successfully ________________

Signature of Examiner

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TITLE **PAGE NO.**

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SYMBOLS

ρ	=	Density of fluid
K	=	conductivity of fluid/lubricant
T	=	Temperature of lubricant
G	=	Gravitational acceleration
P	=	Fluid film pressure
μ	=	Viscosity of fluid
θ	=	Angle of inclination for the vertical load
E	=	eccentricity ratio
H	=	Fluid film thickness
C	=	clearance between journal and bearing
N	=	Eccentricity ratio
U	=	Circumferential velocity
N	=	Speed of journal in revolution/minute
D_s	=	Diameter of shaft
D_b	=	Diameter of bearing

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The selection of the project and this report has brought immense joy and gratitude. I am truly grateful to the faculty, our loving parents and University for encouraging us and uploading to the success of the project.

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ABSTACT

This report on Journal Bearings gives us brief information on Surface texture; Coefficient of friction; Load carrying capacity; Pressure distribution; Minimum film thickness; and viscous forces.

Journal bearings are machine elements commonly used in all mechanical systems with rotating shaft subjected to high surface speed or applied load for the support of rotating shaft since the beginning of industrial revolution.

The innovatory modifications in the field of journal bearing are at quite slow speed. In the field of tribology tools requires high stiffness to improve accuracy. Thus it is necessary for the designer to study the parametric influence of journal bearing quantitative as well as qualitative. Since there have been lot of developments in design, the parametric optimization has been performed by many researchers. Numbers of researchers have been working on different aspects of performance of the journal bearing, ranging from temperature rise, geometry of grooves, damping, eccentricity ratio and clearance etc. Based on the state of art in bearing identification, valuable discussions are made with future directions.

To carry out both the experimental and computational analysis on the journal bearing and to comparing the obtained results.

CHAPTER-1

INTRODUCTION

1.1 JOURNAL BEARINGS:

Hydrodynamic bearings are machine parts that are usually used for various applications fluctuating from little motors to vast turbines which are used to create control producing units. A journal bearing is normal hydrodynamic bearing in which roundabout shaft called Journal and it is made pivot in a settled sleeve called Bearing. Their outline and development might be moderately of straightforward however the hypothesis and study operation of these orientations is might be very difficult. The investigation of journal bearing goes under Tribology. The science that arrangements with rubbing, lubrication, wear in all the reaching parts which are in relative movement is called Tribology.

The collaboration degree between the lubricant and the strong surface impact the greasing up property of bearing. The round shaft called journal and settled sleeve called bearing will have great warm properties, quality and load conveying limit. The contact coefficient between the journal and bearing come to be low keeping in mind the end goal to get great execution of the journal bearing. The immediate contact between the bearing and journal is stayed away from to misfortune in the material when no heap and as the pole begin revolution the lubricant interferes with the takes shaft and bearing and expands the leeway at last comes into same pivot of turn. The majority of concentrates on journal direction depend on the presumption that both the journal and bearing are unbending bodies. It is notable that under overwhelming stacking states of the course in a few applications when using heading with layers on the contact surfaces, twisting of these contact surfaces is noteworthy and can't be overlooked. Versatile disfigurement of the bearing liner under hydrodynamic weight changes the liquid film profile adjusts the weight circulation and along these lines changes the execution attributes of journal orientation. In this manner, operational execution turns out to be fundamentally not the same as those registered in established HD hypothesis where the bearing liner is expected.

As of late, after the advance in PC innovation, numerous scientists started to utilize business Computational Fluid Dynamics (CFD) programs in their examinations. The fundamental preferred standpoint of CFD code is that it utilizes the full Navier– Stokes conditions and gives an answer for the stream issue likewise relevant in exceptionally complex geometries.

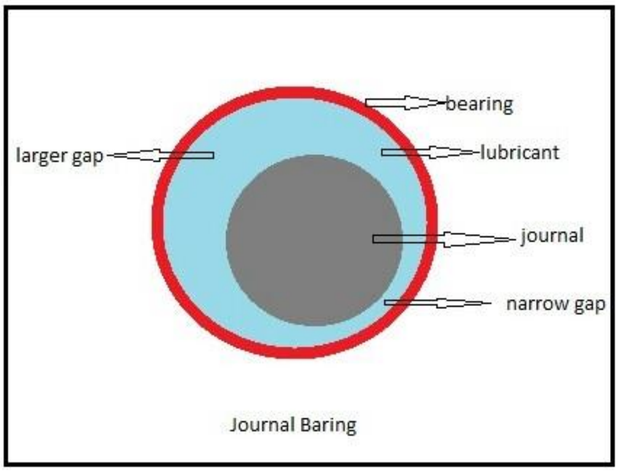


Fig.1 (Journal Bearing)

1.2 MAIN PARTS:

The significant parts of the journal bearing are shaft which is additionally called journal and journal is that parts of the pole which is under the bearing surface, removable bearing shell parts and oil. The primary work of removable bearing shell parts are to bolsters the heap which is hitting on the journal. On the off chance that we need to keep the metal to metal contact between the surfaces of the journal bearing then we provide lubricant between their surfaces which make smoothness and because of the pivot of the pole they make film of oil and, for example, their surfaces are isolated from each other. That is shaft pivot under the bearing and it constrained increasingly liquid in to the bearing surface and because of this revolution they apply a power on liquid because of which weight is made on the fringe of the bearing.

1.3 NEED OF LUBRICATION:

The motor oil does not get claim it's self in the bearing. It has need to keep up in the motor. Since if appropriate lubricant will be not in the motor at that point rubbing between moving parts will occur because of which moving parts of the bearing might be harmed. Lubricant is kept up in the journal bearing either by outer office like engine or because of hydrodynamic activity of the pole. In this manner appropriate oil in the journal bearing is imperative to expel the surface to surface contact between unique parts in the journal bearing and to smooth working of the moving parts.

1.4 HYDRODYNAMIC LUBRICATION:

An oil framework in which liquid supporting film is create because of the hydrodynamic activity of the pole then such sorts of oil framework is characterized as the hydrodynamic oil and because of this reason such sorts of journal bearing is called hydrodynamic journal bearing.

The foremost of hydrodynamic bearing is appeared in fig.2. At first the journal is very still (a). Right off the bat the surface of the pole is in contact with the surface of the bearing because of the activity of load W. at the point when the pivot of journal begins it will get on the surfaces of the bearing (b) and in the event that we increment the speed of the journal again then it has ability to drive the more liquid in the bearing which has appeared in figure. since it constrain the more liquid in the bearing surface hence weight is made which isolate the surfaces of the journal and bearing (c).

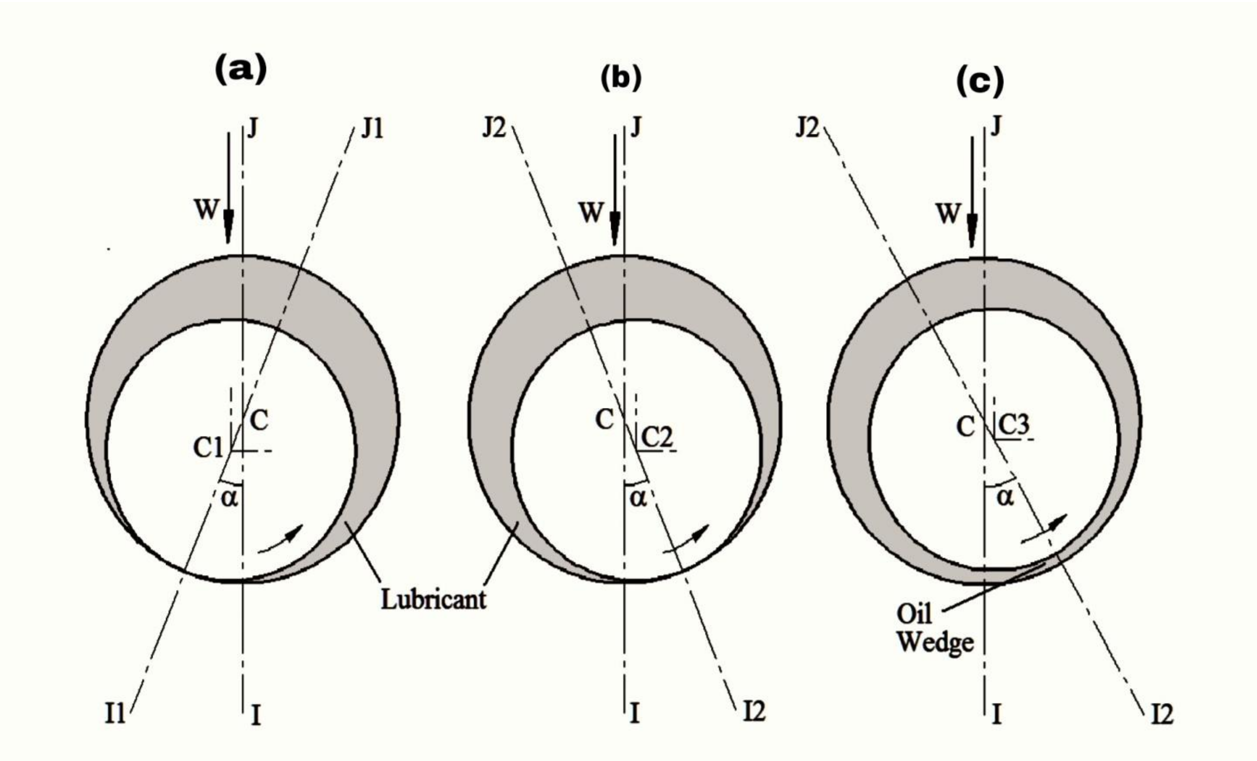


Figure:2 (Hydrodynamic Journal Bearing)

At the point when the turn of the shaft is begin then it has a limit because of their rapid to compelling the more liquid in to the bearing surface. Because of driving liquid in to the bearing they apply compel on the surfaces of the bearing fringe and because of this power weight is made. Since because of the revolution of the journal the arrangement of liquid film thickness is crated which isolate the surfaces of the journal and the bearing the weight circulation on the outskirts journal bearing is appeared in figure 4. At the point when journal is in full pivot at that point there is full arrangement of film thickness is occurring and no metal to metal contacts between the surfaces of the bearing and journal and such kind of lubrication is called hydrodynamic lubrication.

1.3 HYDROSTATIC LUBRICATION:

An arrangement of oil in which the partition of two surfaces are occurring because of the supply of oil in the middle of their surfaces of both journal and bearing by external sources like pump. This sort of bearing is called remotely pressurized bearing on the grounds that in this bearing oil is supply under high weight. The utilization of hydrostatic bearing is in vertical turbo generators, rotators and ball factories.

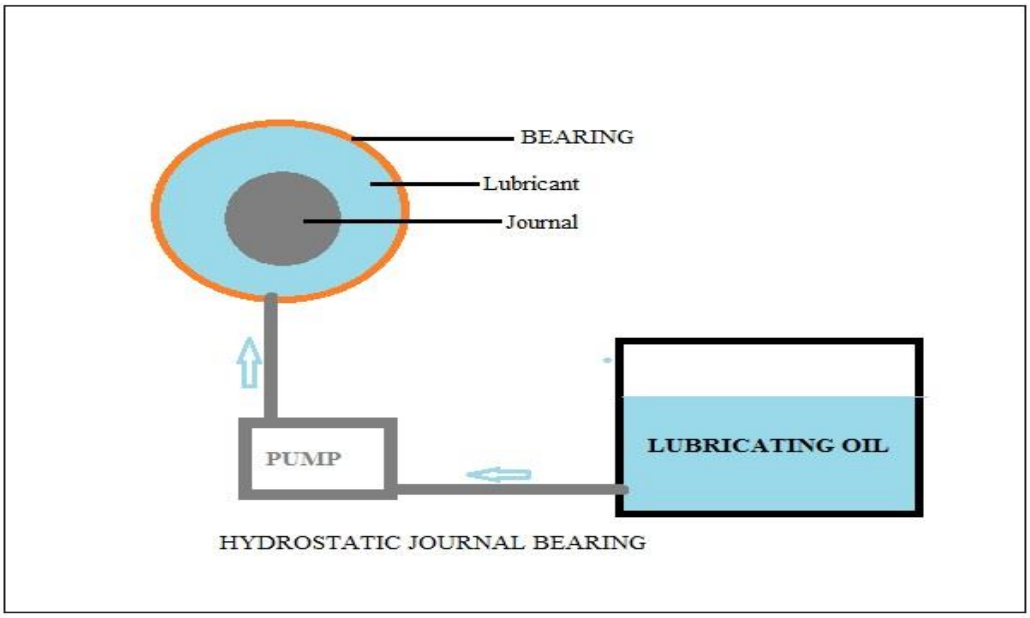


Figure: 3 (Hydrostatic Journal Bearing)

1.4 THIN FILM LUBRICATION:

A state of oil where there is an incomplete contact between the moving parts of bearing and it is because of the low speed of the shaft, inadequate supply of oil or deficient surface range, unreasonable load and misalignment. This sort oil is found in entryway pivot and sliding machine devices. Thin oil film is additionally called limit oil. At the point when there is over the top load on the journal then liquid film gets totally break and metal to metal to contact between the moving surfaces is occurring and accordingly outrageous limit oil is exist. Extraordinary limit oil is occurring dependably at the point where there is a greatest load. The marvels of outrageous limit oil depend on the hypothesis of problem areas. Journal bearing is additionally works on the limit oil when there is low speed and over the top load acing on the shaft.

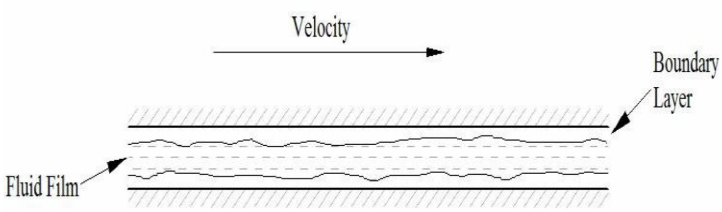


Figure: 4 (boundary lubrication)

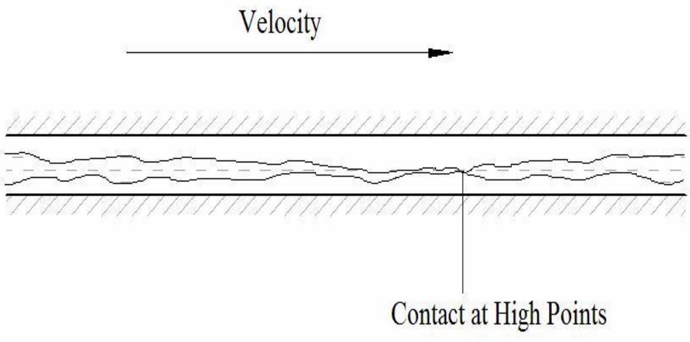


Figure: 5 (Extreme boundary lubrication)

1.5 TERMINOLOGY OF JOURNAL BEARING:

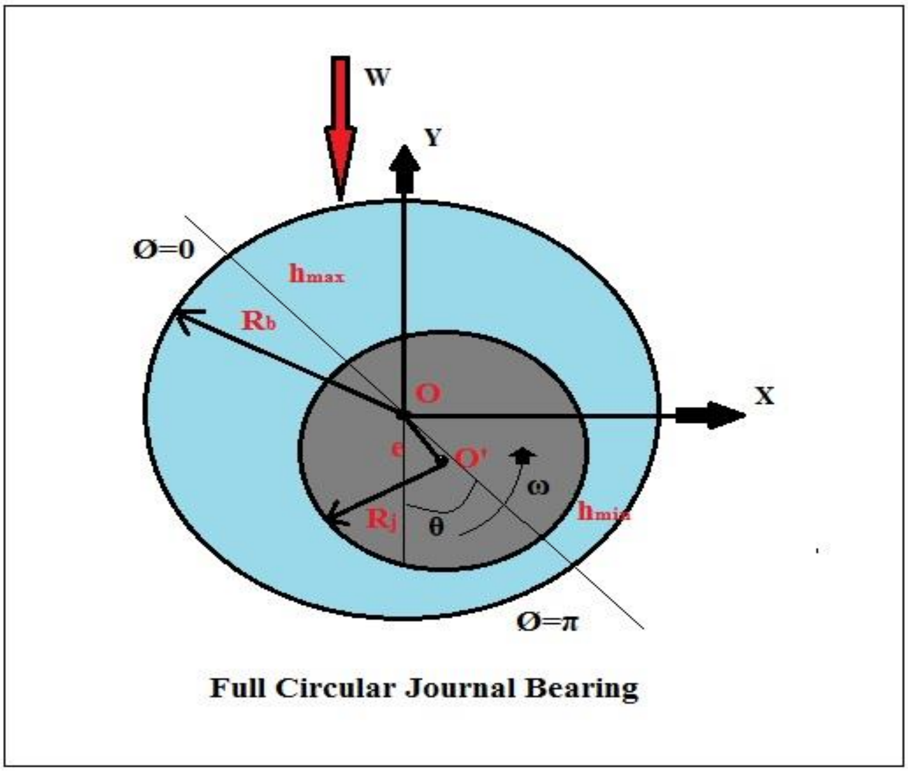


Fig.6. Terminology of Journal Bearing

R_b = Radius of Bearing

R_j = Radius of Journal

O =Journal Centre

O' =Bearing Centre

e =Eccentricity

h_{min} =Minimum oil film thickness

h_{max} =Maximum oil film thickness

W=Vertical load

ω= Angular velocity

Θ= Angular distance

1.6 STRIBECK CURVE:

Stribeck chart used to depict the method of oil. Right off the bat the journal is rest in the bearing .I this case there is no relative movement between the journal and bearing and furthermore there is no liquid film thickness. Accordingly there is a fractional contact between the surfaces of the journal and surfaces of the bearing. Be that as it may, when journal begin to pivot in the bearing then it require some investment to create the liquid thickness and weight in the leeway space. Amid this time there is halfway surface to surface contact between the journal and heading. Hence in this time film thickness exhibit in the bearing surface is called thin film oil and it is additionally called limit oil. At the point when as the speed of journal bearing is expanded more colossal measure of liquid is pushed in to the wedge moulded freedom space because of this adequate weight is develop which isolate the surfaces of the journal and bearing and furthermore arrangement liquid film is occurring and this liquid film is called thick film lubrication.

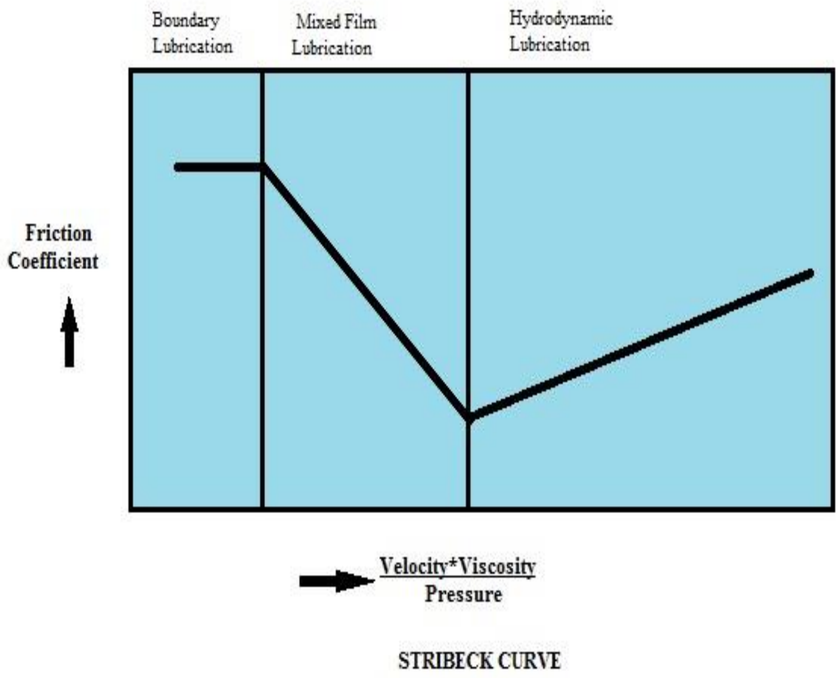


Fig.7 (Stribeck Curve)

Boundary Layer Lubrication: When shaft is at rest there is contact between journal and bearing so maximum friction takes place in boundary layer lubrication.

Mixed Film Lubrication: When the shaft starts rotating fluid film lifts the shaft upwards due to viscous forces and these results in decreasing in the friction.

Hydrodynamic Lubrication: After reaching the minimum point of friction and due to viscous forces and high velocities in hydrodynamic lubrication, the friction due to viscous forces increases linearly.

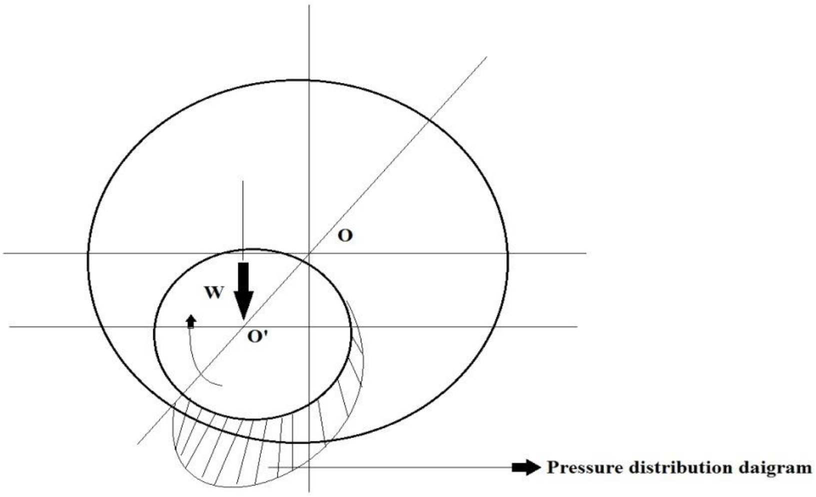


Fig.8.pressure distribution diagram

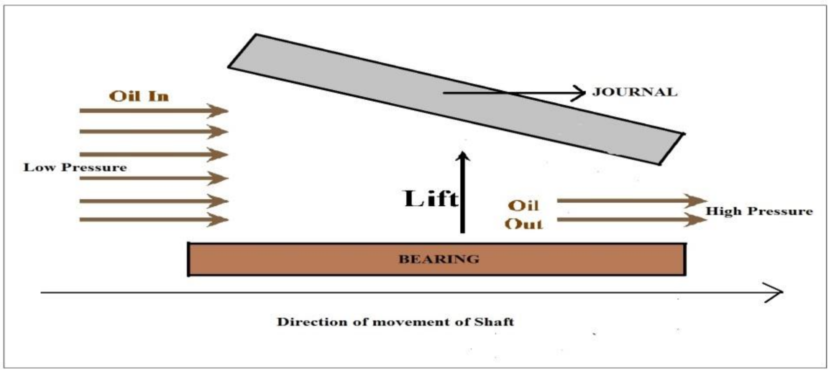


Fig.9.pressure variation diagram

CHAPTER-2

SCOPE OF THE STUDY

2.0 SCOPE OF THE STUDY:

A journal bearing is mechanical device which is used to diminish contact between two sections and it is fundamental parts of the motor. Journal bearing is used as a part of that circumstance where there is part of movement is occurring in the bearing. This sort of device might be a spiral or sleeve bearing and such kind of device has four noteworthy parts which all cooperate to help a heap. For persistent working of journal bearing they need to require consistent supply of oil to diminish the grating between the surfaces. Peoples keep on changing the oil of truck and auto for smooth working of their moving surfaces. The principle objective of dairy bearing is to keep the control of the moving parts. For the most part the significance of bearing is that parts of shaft which is under the bearing and they remain nearly contacts with the bearing surfaces.

Depending upon the type of application journal bearings is considered are of two cases, they are mentioned as The journal shaft can be settled and the sleeve can move opposite to the hub of the pole. That is simply the sleeve can position. The sleeve can be settled and the journal shaft can act naturally placing contingent on the heap sort. What eve the sort of utilization in a journal bearing, the position of the journal or the sleeve is specifically identifies with the outer load. At the point when the bearing is adequately provided with oil and under zero loads, the journal shaft or sleeve will pivot concentrically inside the bearing. At the point when a heap is connected the journal or sleeve moves offbeat position framing a wedge state of oil film, where the heap supporting weight is created. The leeway will be of the request of one thousandth of the distance across of journal.

The work includes a coordinated approach between theoretical calculation and computational analysis of performance of journal bearing under different conditions design and develops comprehensive and feasible setup for the purpose of fine working of journal bearing.

CHAPTER-3

OBJECTIVES OF THE STUDY

The objectives of my research work is to carry out both CFD analysis and experimental work of lubricated journal bearing functioning at different operating condition by supplying lubricant whose properties are known or by considering for the easy calculation of the problem and comparing the both the results.

The present study mainly focuses on various types of factors which mainly affects the performance of journal bearing. The factors that affect the performance of the journal bearing are coefficient of friction, load carrying capacity, minimum oil film thickness.

The main proportional work of this research is to carry out the working of journal bearing under different load factors and to know how the pressure is varies from point to point. The design of this work is carried out in software called CFD (Computational Fluid Dynamics).

Stribeck curve which deals with coefficient of friction and viscosity, velocity, pressure in the all lubrication methods that are static lubrication mixed lubrication and dynamic lubrication.

CHAPTER-4

REVIEW OF LITERATURE

QIYIN LIN (2017):

The impact of surface on the execution of the journal bearing working under the transient condition is explored by a liquid structure association (FSI) approach. The key parameter of the present work is the uprooting of the journal and additionally the whimsy proportion which better speaks to the genuine operation of a journal bearing than the customary methodologies that depend on the relentless state presumption. The outcomes demonstrate that relying upon its position in the circumferential heading; a surface may either upgrade or hinder the execution of a journal bearing as far as the age of the heap conveying limit.

MARK DESJARDINS (2013):

This undertaking proposition portrays the reason, system and expected results of an investigation into a full journal bearing and the impact of wear on execution. Specifying the hypothetical investigation of a full journal bearing will be performed and contrasted with the outcomes got by a computational liquid dynamic (CFD) examination. Wear, it's potential causes, and aversion will be portrayed and supplemented by a CFD examination of the impact of wear seriousness and area on the bearing execution also, liquid attributes. The investigation will recommend conceivable framework changes to amend issues coming about from wear. Key assignments and points of reference are recorded and depicted to guarantee consistence with tight undertaking plan. Arrangements of fundamental assets, references and potential distribution areas are additionally given.

FANGRUI LV (2017):

This paper examines property of vertical misaligned journal bearing, pointing to give a way to deal with productively investigating identical supporting point area what's more, conveying limit of misaligned journal bearing without using numerical reproduction. Identical supporting point area is depicted through the dimensionless pivotal arrange of proportional supporting point and exhibited versus length-breadth proportion, capriciousness proportion, and dimensionless misalignment point. The proportion between misaligned bearing conveying limit and relating adjusted bearing conveying limit is eluded as to misalignment factor for conveying limit with respect to short. Elements of proportional supporting point area and misalignment factor for conveying limit reliant on length-width proportion, capriciousness proportion, and dimensionless misalignment point are acquired. By common cases, the correctness's of the capacities are checked to meet building prerequisites.

Christian Kim Christiansen (2017):

A hydrodynamic bearing has been researched using both the conventional two-dimensional (2D) Reynolds condition, and the full arrangement being the three-dimensional (3D) Navier-Stokes conditions. The two methodologies are to come about by playing out an examination of two bay depression plans: the pivotal and the circumferential furrow, individually, on a holding on for length-to-measurement proportion of 0.5 presented to a sinusoidal stack design. Weight disseminations, journal circles and frictional misfortunes are looked at. The demonstrating of scores by weight limit conditions versus geometric conditions is inspected. It is examined if the nearness of a groove increments frictional misfortunes and the expansion identifies with groove measurements. Moreover, the in ounce of the notch outline on the low end is contemplated using the 3D arrangement.

Faisal Rahmani (2016):

This paper endeavours to explore the dynamic qualities of a powder lubricant up journal bearing. The firmness and damping coefficients are acquired using limited irritation technique. The soundness furthest reaches of the rotor speed is gotten for a framework comprising of a solitary rotor circle amidst an adaptable shaft having indistinguishable plain round and hollow journal direction at the finishes. The limit speed of flimsiness for a rotor upheld on powder lubricant up journal bearing is contrasted and that of oil lubricant up journal bearing. The numerical outcomes demonstrate that a rotor upheld on powder lubricant up journal heading stays stable for a speed restrain substantially higher than that for oil lubricant up direction.

Raghu Yogaraju (2016):

In this paper, points of interest identified with preparatory research made towards building up a novel semi-dynamic journal bearing have been introduced. The examination which is transcendently trial in nature utilizes a test fix outlined and manufactured with the end goal of mimicking a multi-lobed journal bearing and furthermore to examine the likelihood of using brilliant materials for transformation of a roundabout bearing profile to a multi lobed bearing profile amid operation. Preparatory test examines have shown that while shape memory analysis (SMA) can be used as a medium to apply important powers at recognized areas to get the coveted profile shapes for a multi-flap bearing setup encouraging the advancement of semi dynamic journal direction, ovality proportions of the bearing profile under scrutiny extending from 1.5 to 2 have been acknowledged by appropriate use of direct powers in restricting bearings. The execution upgrade characterized as far as solidness and damping of the recently designed bearing comparable to two lobed bearing over the traditional bearing has been examined. The test fix is adaptable in nature, with an office to explore assortments of semi dynamic journal orientation. The investigation shows an expansion in powerful firmness and damping with increment in the modality proportion of the semi-dynamic journal orientation.

Amit Chauhan (2014):

Hydrodynamic journal direction is used as a part of apparatuses which are pivoting at high speeds and conveys overwhelming burdens. These outcomes in high temperature ascend in the oil film which fundamentally influences the execution of bearing. Thermo-hydrodynamic examination come to be completed keeping in mind the end goal to acquire the practical execution parameters of journal bearing. Thermo-hydrodynamic investigation of roundabout journal bearing has been mimicked by using Computational Fluid Dynamics approach. This approach illuminates the three dimensional Navier-feeds condition to foresee the bearing execution parameters, for example, the weight and temperature of the lubricant along the profile of the bearing. The CFD method has been connected through ANSYS Familiar programming. The oil stream is to come to be laminar and the unfaltering state condition has been accepted in the present work. The impact of variety of weight and temperature on the oil film has been considered amid contemplate.

Aki Linjamaa (2017):

The constant interest for higher power thickness prompts an extremely difficult operational condition for sliding heading with respect to weights and misshapenings. Comprehension of the disfigurement conduct of vigorously stacked heading turns out to be considerably more articulated when present day cross breed multilayer outlines are considered. The point of this investigation is to build up a numerical, multi-physical model for the assessment of journal bearing execution. Hydrodynamics depended on the Reynolds condition and misshapenings were figured using the coordinated limited component strategy. Versatile and warm distortions significantly affect bearing execution and those misshapenings can be balanced with properties of polymer layer. The plan of half and half direction is sensitive and their properties must be custom fitted as indicated by the working conditions.

Yong-Bok Lee et al. (2015):

In this paper we have describe the performance of elctrorheological lubricant; That is in this paper an electro rheological lubricant is applied to a rigid rotor system which is supported by a hydrodynamic bearing. Since it has supported by a hydrodynamic bearing thus they are subjected to sudden imbalance forces and certain dynamic rotating load. The pressure of electro rheological fluid film thickness is varies with electrical field strength and it depends upon the electro rheological fluid film thickness and yield shear stress. It has found that load carrying capacity of the electro rheological is more than as compared to the Newtonian lubricant and to handle sudden dynamic load its performance can be controlled. By increasing the magnitude of electric field strength we can increase the load carrying capacity of the electro rheological lubricant up to a certain limitation and we can also reduce the unbalanced forces which is created due to the certain unbalanced masses and the forces.

De Choudhury et al (2014):

In this paper the predicted and measured bearing metal temperature of tilting-pad journal bearing are measured. They notice that eccentricity ratio and the geometric preload have a major influence on the bearing temperature and asperse design charts may be needed to accurately estimate the pad metal temperature.

Ravindra M.Mane et al (2013):

In this paper the analysis of hydrodynamic plain journal bearing has been done by using COMSOL Multi-physics software. By steady state analysis we have obtained pressure distribution in plain journal bearing. To obtain the pressure distribution in plain journal bearing by numerical methods and comsol we have used generalized equation of Reynolds and boundary condition of summer-field have been used. For infinitely long plain journal bearing Reynolds equation has been solved. Pressure distribution obtained by simulation of comsol multi-physics software has compared with analytical solution and it has found that solution obtained by simulation is same as an analytical solution. Only the magnitude of pressure is differing but their graphs are same as an analytical solution.

Mohammad Ali Ahmad et al (2012):

In this paper the analysis of hydrodynamic bearing such as plain slider bearing and journal bearing are discussed. Briefly different types of lubrication are described and mechanism of pressure developed in the oil film is studied. The petroff's equation for a lightly loaded bearing is derived. The derivation of Reynolds equation is carried out and it is applied to plane slider bearing with fixed and pivoted shoe and journal bearing.

Vijay Kumar Dwivedi et al (2013):

In this paper we have found that when we use hydrodynamic journal bearing then its application become wide in high speed rotating machine such as compressor, gas turbine, water turbine, steam turbines, alternators etc. As we know that when rotor rotates at high speed then lubricant which is flow in the clearance space of the journal and bearing they become turbulent and for decelerated or accelerated journals the threshold speed of instability is crossed from the both sides. That is in this paper to compute the static and dynamic performance parameter numerical method has been used. And the the analysis is carried out for the case of short bearing approximation aspect ratio under different fluid flow regime that is laminar, transition, and turbulent flow condition assuming the perfectly rigid journal and bearing.

Salmiah Kasolang et al (2013):

In this paper experimental work was conducted to determine the effect of oil supply pressure at different oil groove position on torque and frictional force in hydrodynamic in journal bearing, and it was found that oil supply pressure and groove position had affected the frictional force and torque in journal bearing.

Binu K.g et al (2014):

In this paper by using Tio_2 nanoparticles lubricant additives load carrying capacity of plain journal bearing is studied. It has seen that by using Tio_2 nanoparticle in the lubricant the viscosity of lubricant is increased and by using Krieger-Dougherty viscosity models it has been modelled. In simulating the viscosities of Tio_2 nanoparticle dispersion in engine oil is has experimentally verified for the validation of modified Krieger-Dougherty model. By using modified Reynolds equation the evaluation of load carrying capacity and pressure distribution has done theoretical for various Tio_2 nanoparticle concentration and aggregate sizes. Results were found that by using Tio_2 nanoparticle lubricant additives without nanoparticles the load carrying capacity of journal bearing has increased as compare to plains oils.

M. Mehdizadeh et al (2014):

Since we know that journal bearing is a sensitive part of steam turbine and it failure taking place due to different mechanism of fatigue, wear, and crush during condition of service. When failure is taking place due to the mechanism explained above turbine gets shut whose result is become working condition of different parts of bearing gets altered. Here steam turbine whose capacity is 320,000 their failed altered parts are examined. Hardness test of failure analysis has performed by utilization of stereographic, optical microscopy, scanning electron microscopy, energy dispersive x-ray spectroscopy.

Tala-Ighil et al. (2007):

In this paper he has studied the effects of surface texture on journal bearing characteristics under steady state operating condition. They have divided the work in to two steps. The first one serves to quantify the evolution of the characteristics with the texture parameter and deduce their optimize values. The second steps enhance the performance of the journal bearing progressively taking in to account the optimized values of the texture parameter, especially the texture deposition.

FU yan-li et al (2003):

In this paper by sudden changing velocity and load the Transient temperature field is ascertained in journal bearing by using Newton-Raphson strategy and examinations the bearing execution numerically. At oil and hedge interface warm twisting of the shrubbery and sensible warm limit condition are considered. To understand the movement condition of journal bearing and Reynolds condition, film thickness condition at the same time and to acquire the speed of the journal focus and weight appropriation Newton-Raphson technique is used at each progression. At that point the liquid film compel is procured through basic of liquid film constrain and the increasing speed and position of the journal focus are gained through the distinction of the speed. By using an effective limited distinction plot. By consolidating the vitality condition and Reynolds condition transient three dimensional temperature field of the bearing is gained through nodal temperature and weight. It is discovered that the methodologies which are presented here meet rapidly and spare figuring time incredibly.

4.1 Conclusion for the Literature review:

Following points have been noted on the basis of literature review presented above.

- There has been very less work found in the field of the journal bearing where the properties of lubricant have been considered depending on the temperature.

- There are very less paper dealing with CFD analysis of journal bearing for thermal effects.

- There are also very less paper dealing with the both computational and experimental work and comparing both the results.

CHAPTER-5

EXPERIMENTAL SETUP AND CFD SOFTWARE

5.1 EXPERIMENTAL SETUP:

Fig.10 journal bearing setup

5.2 Main Parts:

1. Journal
2. Bearing
3. Oil tank
4. Measuring unit
5. Tubes

Fig.11 Tubes layout

5.3 About CFD software:

CFD is a procedure in which numerical strategies are used to take care of the stream issue with. To take care of the issue in CFD we as a matter of first importance we distinguish the adequate arithmetical condition for the issue and after that apply limit condition on it. By the assistance of summed up Navier stroke condition we make the general articulation for transport condition. There are diverse sorts of work and which work techniques is to apply it is rely upon the geometry of the issue and precision of the issue

CFD software uses the above Reynolds equation to determine pressure variation. In computational analysis we will select fluid flow fluent in the launcher. After that different steps to be followed accordingly the given data. In geometry we select the 2D module. And now design the journal bearing according to the given dimensions. And also apply faces from the surfaces to see the solid structure of designed model. Now meshing part comes first select the total structure and apply fine meshing and generate it. And now by selecting edge selection tool provide the named sections of the model i.e. inlet, outlet, journal, bearing. Now solution part comes where we select the lubricant of known properties and apply boundary conditions to the different named sections. As inlet-pressure inlet, outlet-pressure outlet, journal-wall but moving wall with no slip and bearing as stationary wall. And finally we go to the result part where we get the required plots, velocity profile, pressure profile and temperature profile by using contour1.

5.4 Name of the boundary conditions:

Inlet

Outlet

Inner wall (journal)

Outer wall (bearing)

Name selection of the flow region is required in simulation of problem in computation fluid dynamics software, because the software doesn't know where the solution should be done and at which region. Name selection is known as boundary condition in the post processing. By defining boundary condition we can see any result on the specified flow region.

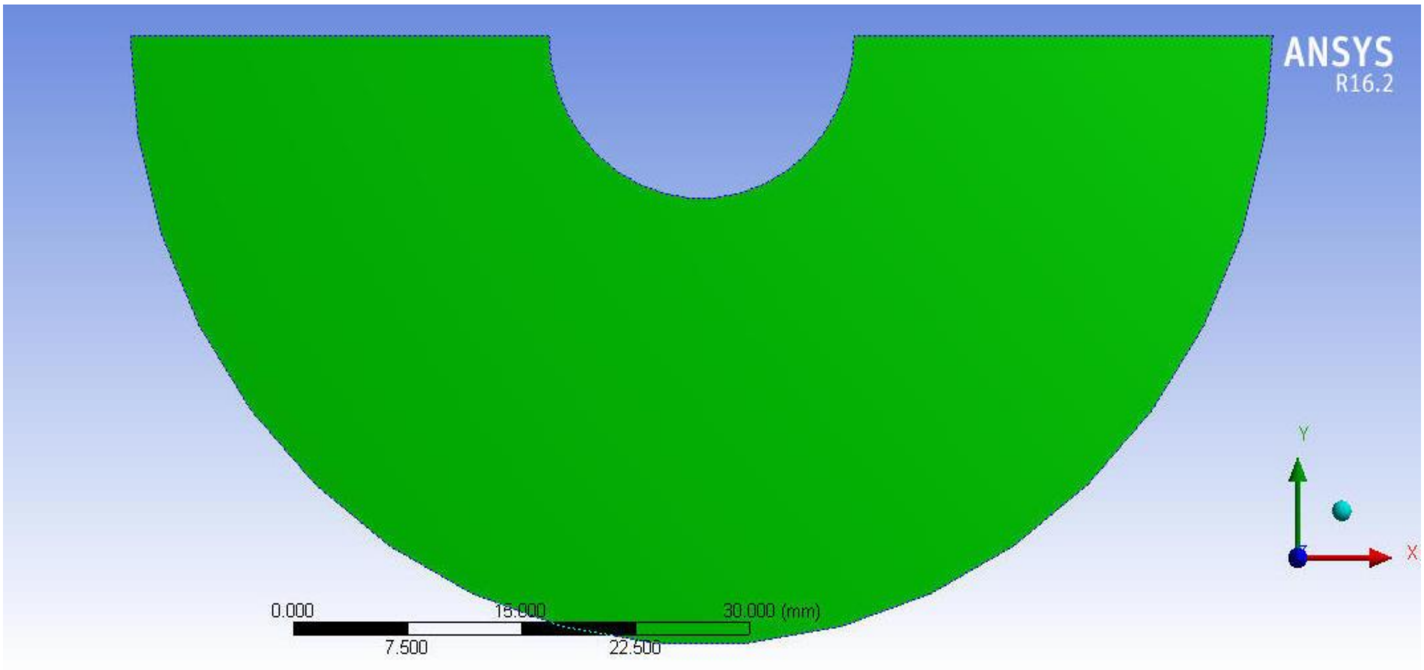
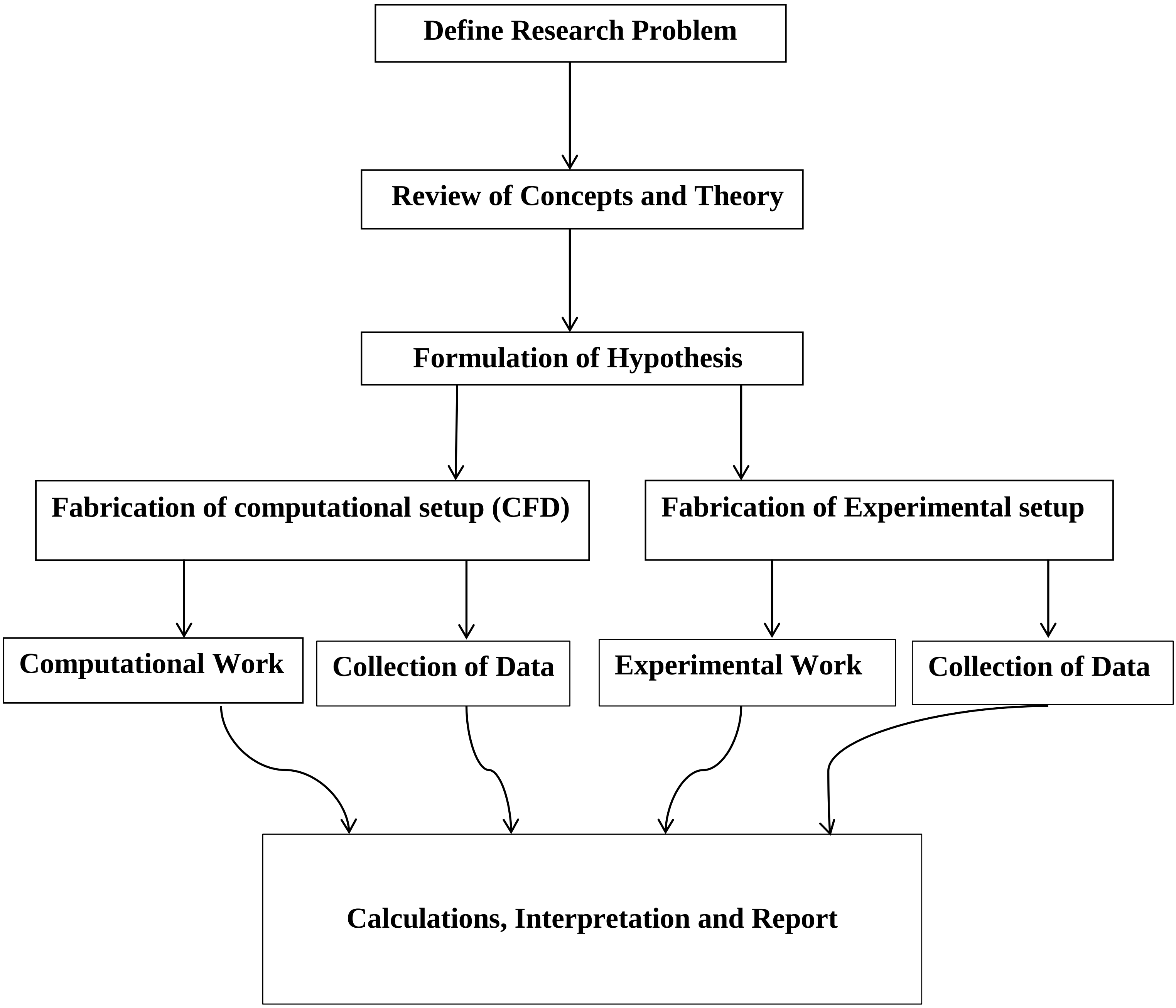


Fig. 12 Geometry diagram

CHAPTER-6

RESEARCH METHODOLOGY

This chapter deals with some of the steps to be followed in research methodology which are mentioned below:



6.1 Problem Background:

There are diverse sorts of issues which happen in the Hydrodynamic journal bearing. Because of improper for supply of oil in the bearing the age of warmth happens in huge sum because of which metal temperature increments and bearing gets harmed. Load is likewise fundamental factor which may harm bearing. On the off chance that expansive load is connected on the journal then its introduction ends up plainly inappropriate because of which journal and bearing surface begin to strike each other and they get harmed.

CHAPTER-7

PROPOSED WORK PLAN WITH TIMELINES

Computational and Experimental work that is to be conducted takes certain planning's accordingly to the availability of time. The proposed work will be conducted according to the time line provided.

Month	Work done/ to be done	Description
August 2017	Selection of topic	Brief knowledge on the selected topic
September 2017	Literature review	Literature survey on papers collected
September 2017	Problem background	Obtained a problem statement on the journal bearing to work
October 2017	Experimental work	Collecting data and performing experiment and taking the results
October 2017	Computational work	Installed the CFD software
November 2017	computational work	Performing the computational analysis on the collected data and obtained results and plots.
November 2017	Report	Started report writing on the obtained results
November 2017	Report	Completed the report writing and followed by submission takes place.
December 2017	Final Presentation	Will present the completed work till now both in experimental and computational analysis.
Jan-May 2018	Future Work	Will work on the future work in the coming semester.

Table.1 Work plan and Timeline

CHAPTER-8

EXPERIMENTAL WORK

8.1 Aim of the work: The aim of this experimental work is to study the pressure variation of lubricating oil at different working loads in the journal bearing setup.

8.2 Requirements:

- Lubricating oil SAE-40 (4 litres.)
- Power supply: 220 v AC single phase.
- Journal bearing setup with journal having circumferential tubes (1 to 12) and axial tubes (a, b, 12, c, d)
- Oil tank
- Measuring unit.

8.3 Theory of the work:

The part of the bearing which revolves inside it is called journal and it is subjected to load a right angles to the axis of the shaft (journal). As he speed of the shaft increases the viscous force which results in the drag the oil between he surfaces of the journal and bearing also increases them. More and more of the load will be taken by the oil film in the convergent portion of both journal and bearing. This slowly lifts the line of action round the direction of motion of the shaft. Ultimately the oil film will may break into, so that the two surfaces are completely separated and the load will be moved from the journal to the bearing by the oil. And how the hydrodynamic journal bearing works is shown in the fig.2

8.4 Experiment Procedure:

a) Fill the oil tank with lubrication oil (SAE-40)

b) Drain out the air from all the tubes on manometer and check whether the level balance with supply level.

c) Check for some leakage of oil is there, and this leakage is necessary for cooling purpose.

d) Check the direction of rotation of the shaft and increase the speed slowly.

e) Now set the speed for particular rpm and let journal run for about 15 minutes to achieve the study level of the oil.

f) Now add the weights and keep the balancing rod in horizontal position by moving the weights on the rod and observe the study levels in the tubes.

g) And now after when manometer levels settled down after running 15 minutes , take the pressure readings on 1-12 manometer tubes where circumferential pressure distribution takes place and a, b, 12, c, d where axial pressure distribution takes place.

h) Repeating the experiment for different speeds and loads.

i) Note down the readings of settled level in manometer tubes.

j) After the completion of the experiment set the dimmer to zero and switch off of main supply.

8.5 Learning outcomes from experimental work:

- In this experiment I learned about how viscous forces are responsible for the drag and lift of the moving shaft (journal).
- How pressure distribution takes place at different loads and weights.
- How lubricating oil is distributed between the journal and the bearing.
- Also how the action of hydrodynamic bearing takes place.
- Hydrostatic oil film lubrication.
- Mixed oil film lubrication.
- Also how boundary layer lubrication comes between both the journal and bearing when the higher loads act on the shaft.

CHAPTER-9

RESULTS AND DISCUSSIONS

9.1 Bearing input data:

NAME	SYMBOL	VALUE
Bearing length	L	90mm
Bearing diameter	d_b	75.05mm
Journal diameter	d_j	25.05mm
Radial clearance	C	50mm
Eccentricity	e	37.5mm
Eccentricity ratio	k	7mm
Load on bearing	w	9.81N
Speed of the shaft	N	30rpm
Film thickness	h	30.5mm
Bearing material	__	Babbitt

Table.2.Bearing input data

9.2 Lubricant input data:

NAME	SYMBOL	VALUE
Lubricating oil	__	Sae-40
Density	ρ	889 kg/m3
Specific heat	c_p	1800j/kg-k
Viscosity	μ	0.0911kg/m-s
Thermal conductivity	k	0.7w/m-k

Table.3.Lubricant input data

9.3 Experimental Observations:

Supply head of oil, p_s= 1000mm Weight= 1 kg (9.81N) Speed=30rpm

TUBE NO.	Pressure head, p (mm)	Displacement of fluid (mm)
1	880	400
2	880	140
3	880	30
4	880	-26
5	880	-70
6	880	-100
7	880	-150
8	880	-235
9	880	-440
10	880	-390
11	880	60
12	880	1400
A	880	1100
B	880	1310
C	880	1380
D	880	1260

Table.4 Observation table

Here 1 to 12 tubes are circumferential tubes along the diameter of journal and A, B, C, D, 12 are axial tubes along the axis of the journal.

9.4 CFD SIMULATION:

Table.5 parameters for CFD simulation

Geometry type	2D geometry
Surfaces	Surfaces from sketch
Surface area	2054mm2
No. of edges	4
Meshing method	Fine meshing
Growth rate	1.20
Named sections	4
No. of iterations	10000
Initialisation methods	Hybrid initialisation
Angular velocity	0.032m/s
Rotational velocity	0.064rad/sec

For computation analysis for geometry dimensions are taken from the table.2

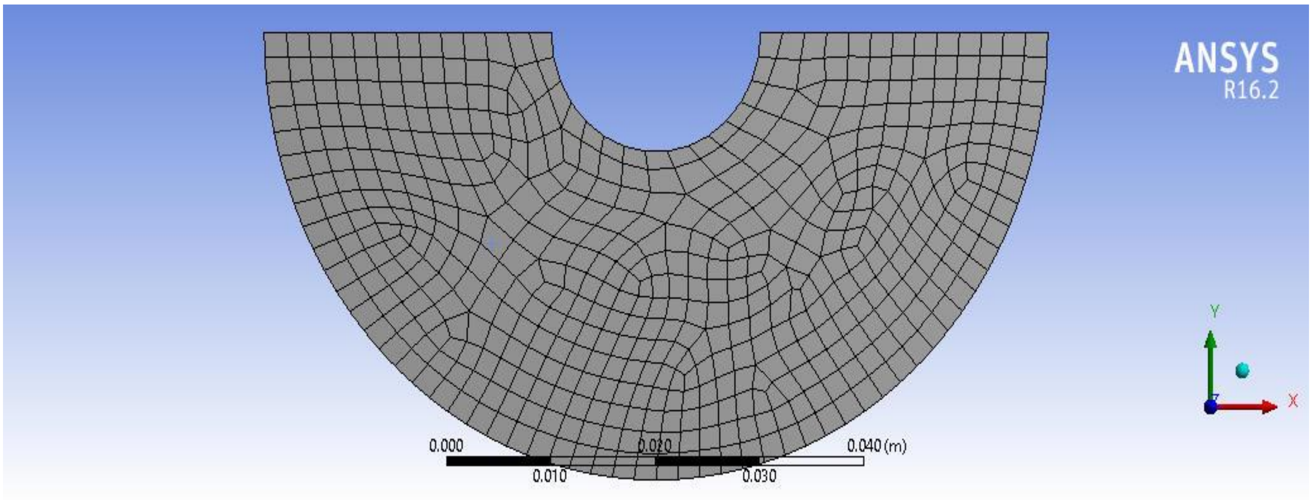


Fig.13 Meshing diagram

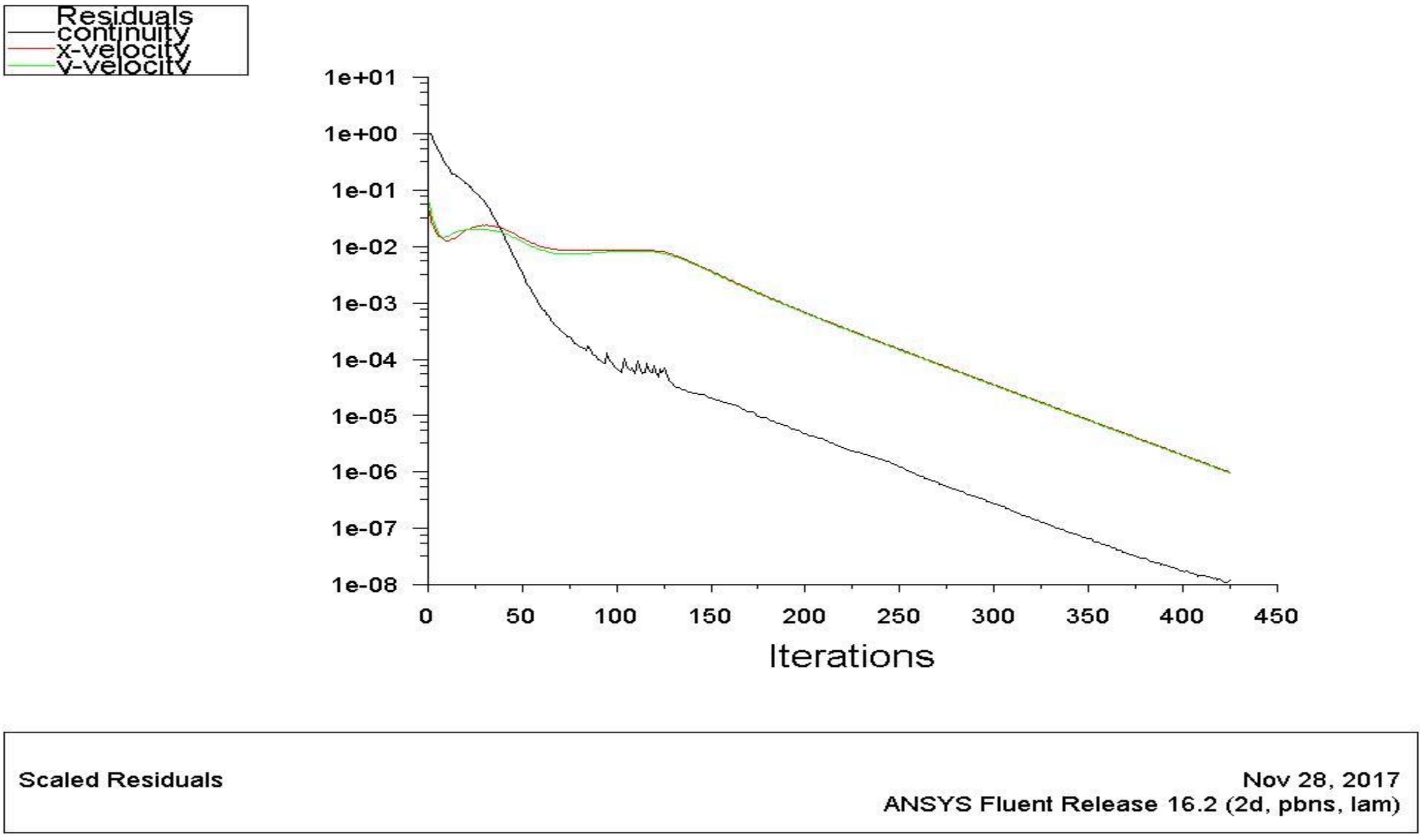


Fig.14 Iterations diagram

Boundary Conditions:

Journal – wall – moving wall – rotational velocity – 0.064rad/sec.

Bearing – wall – stationary wall.

Inlet – pressure inlet.

Outlet – pressure outlet.

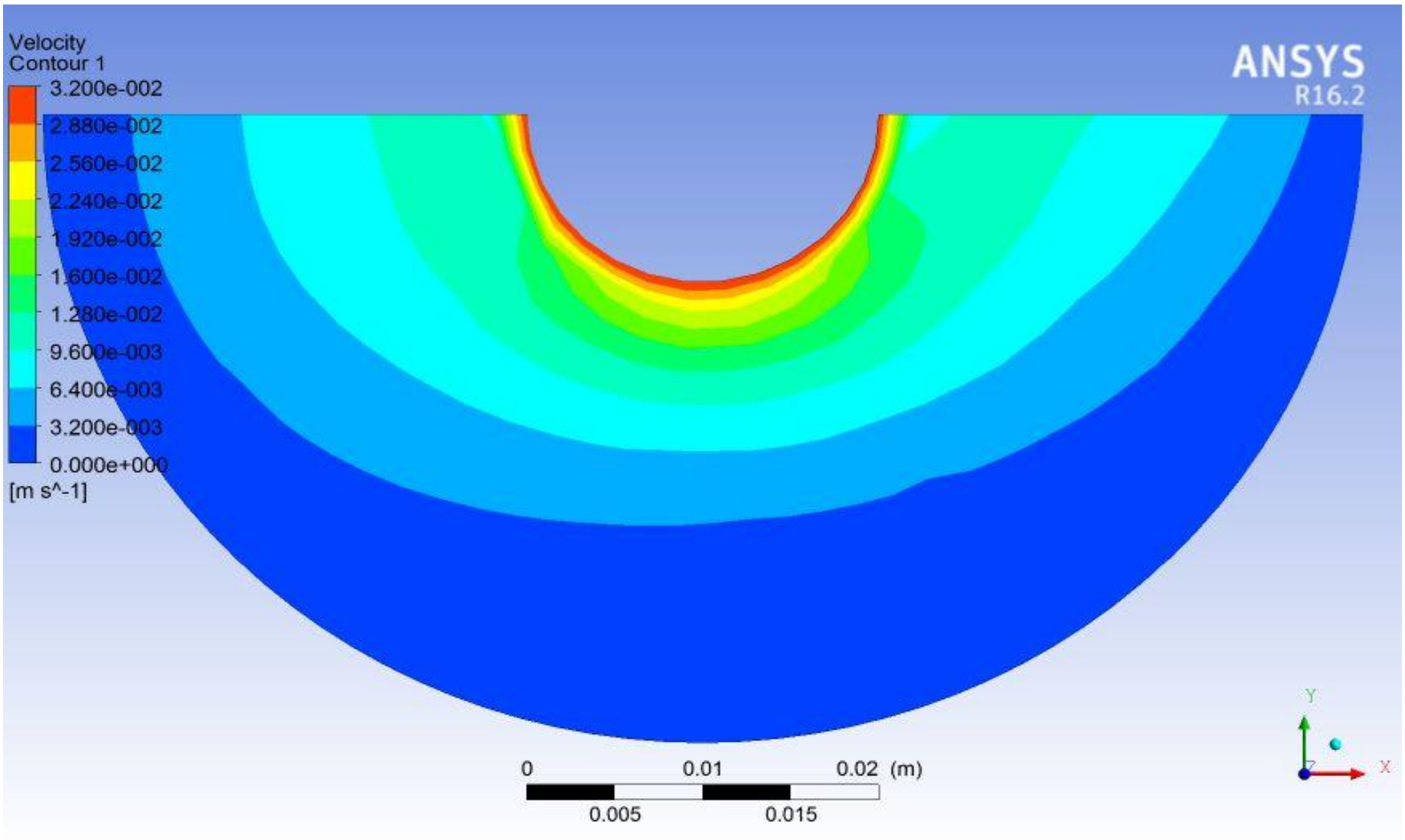


Fig.15 Velocity profile

CHAPTER-10

CONCLUSIONS AND FUTURE WORK

This chapter includes conclusion of my present study and future work.

- Viscous forces are responsible for the drag and lift of the moving shaft (journal).
- Pressure distribution takes place at different loads and weights and also depends upon direction of rotation and speed also how lubricating oil is distributed between the journal and the bearing.
- How the action of hydrodynamic bearing takes place, hydrostatic oil film lubrication, mixed oil film lubrication. Also how boundary layer lubrication takes between both the journal and bearing when the higher loads act on the shaft.
- The film thickness varies both in tangential as well as radial direction. At a given radius film thickness is maximum at minimum pressure and minimum at maximum pressure. At a given angle film thickness increases from inner radius to outer radius.
- Pressure developed along the direction of rotation due to hydrodynamic action is maximum corresponding to the mean radial position. Pressure developed along the direction of flow due to the hydrodynamic action is maximum corresponding to the angular (3.14 rad.) position.
- Film thickness developed along the direction of flow due to the hydrodynamic action is maximum along the minimum pressure. Film thickness developed along the direction of due to the hydrodynamic action is minimum corresponding to mean angular (3.14) position.
- After this we will show how the radial velocity changes from journal to bearing.
- Also fluid properties changes as the temperature increases, considering this we will assume the non-isothermal condition for the lubricating oil.

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