

The Analysis of Fluid Film Journal Bearing By Using CFD Analysis



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ABSTRACT:

In this gift paper the overall performance evaluation of magazine bearing. the stability analysis of hydrodynamic journal bearings is carried out with the aid of many papers. diverse have a look at have been operating on performance of magazine bearing inclusive of lubrication conduct, steady kingdom analysis, and turbulence evaluation. here, a brief subjects is offered of the literatures available in previous few years. main emphasis is given to the stress and temperature distribution based totally identification evaluation on bearing. The goal of this paper is to find computational fluid dynamic analysis of magazine bearing. This paper attempts to evaluate the journal bearing performance on diverse parameters consisting of pressure distribution, bearing floor deformation, temperature distribution, and cargo carrying capability.

KEY WORDS: journal bearing, CFD analysis,

1. INTRODUCTION:

1. The item of lubrication is to lessen friction, wear, and heating of machine components that pass relative to each different.

2. A lubricant is any substance that, while inserted among the moving surfaces, accomplishes those purposes.

3. In a sleeve bearing, a shaft, or journal, rotates or oscillates inside a sleeve, or bushing, and the relative motion is sliding.

5. In an antifriction bearing, the main relative motion is rolling.

A follower may either roll or slide at the cam. tools teeth mate with each different via a mixture of rolling and sliding. Pistons slide within their cylinders. most of these applications require lubrication to lessen friction, put on, and heating. The contemporary present day enterprise makes use of machineries that are rotating at excessive velocity and wearing heavy rotor masses. In such application fluid movie journal bearing is used. Fluid film journal bearing is a mechanical detail designed to guide a high load even as allowing relative motion among magazine and bearing floor. The fluid movie bearing also known as as hydrodynamic magazine bearing. The magazine and bearing wall are separated by fluid film that is carried out between clearance spaces. typically, radial clearance is very small so as of 1/1000th of magazine radius.

In current fluid film bearing essential troubles takes place due to the failure of fluid movie at some point of the operating circumstance. In present fluid movie magazine bearing, under most load, steel to metallic touch between journal and bearing takes location. due to this most warmness in addition to friction is generated which overheats the floor of journal and bearing. consequently will increase the electricity loss and decreases the existence of bearing. [1] For this hassle, diverse researchers have completed exquisite investigation on exceptional parameters of journal bearing. They located out consistent country and brief evaluation, loading potential effect on magazine bearing. but still a few problems exist.

This problem is associated with lubricant that is used in fluid movie magazine bearing. So the need is to find out solution lubricant used in fluid movie journal bearing to beautify the vital parameter in load capability estimation and dynamic analysis. In recent research, CFD results have been as compared with experimental in addition to analytical results, and it indicates that CFD effects get confirmed.

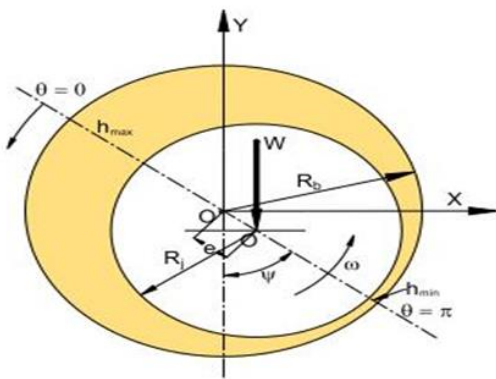


Fig 1: schematic diagram of circular Journal bearing.

1.1 TYPES OF LUBRICATION:

Five distinct forms of lubrication may be identified:

1. Hydrodynamic
2. Hydrostatic
3. Elasto hydrodynamic
4. Boundary
5. Solid film

Hydrodynamic lubrication means that the load-carrying surfaces of the bearing are separated by way of a rather thick film of lubricant, as a way to prevent steel-to-metal contact, and that the steadiness for this reason obtained may be explained by using the legal guidelines of fluid mechanics. Hydrodynamic lubrication is likewise known as complete-movie, or fluid, lubrication. Hydrostatic lubrication is acquired by way of introducing the lubricant, that's from time to time air or water, into the burden-bearing location at a stress excessive sufficient to split the surfaces with a fairly thick film of lubricant.

So, in contrast to hydrodynamic lubrication, this sort of lubrication does not require motion of one floor relative to another. Elasto hydrodynamic lubrication is the phenomenon that takes place whilst a lubricant is introduced between surfaces which can be in rolling touch, including mating gears or rolling bearings. The mathematical clarification requires the Hertzian theory of touch stress and fluid mechanics. Boundary lubrication when insufficient surface area, a drop in the velocity of the moving surface, a lessening in the quantity of lubricant delivered to a bearing, an increase in the bearing load, or an increase in lubricant temperature resulting in a decrease in viscosity-anyone of these may prevent the buildup of a film thick enough for full-film lubrication. When this happens, the highest asperities may be separated by lubricant films only several molecular dimensions in thickness. Solid-film lubricant when bearings operate at extreme temperatures, such as graphite or molybdenum disulfide must be used because the ordinary mineral oils are not satisfactory.

1.2 VISCOSITY:

- Let a plate A be moving with a velocity U on a film of lubricant of thickness h .
- We imagine the film as composed of a series of horizontal layers.
- Force F causing these layers to deform or slide on one another.
- Layer in contact with the moving plate are assumed to have a velocity U .
- Layer in contact with the stationary surface are assumed to have a zero velocity.
- Intermediate layers have velocities that depend upon their distances y from the stationary surface.

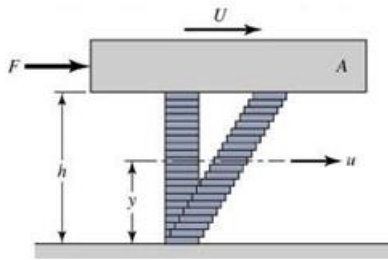


Figure 2: a plate move with a velocity U on a film of lubrication of thickness h

Newton's viscous effect states that the shear stress in the fluid is proportional to the rate of change of velocity with respect to y . Thus

$$\tau = \frac{F}{A} = \mu \frac{du}{dy} \tag{1}$$

Where μ is the constant of proportionality and defines absolute viscosity, also called dynamic viscosity. The derivative du/dy is the rate of change of velocity with distance and may be called the rate of shear, or the velocity gradient. The viscosity μ is thus a measure of the internal frictional resistance of the fluid. For most lubricating fluids, the rate of shear is constant, and $du/dy = U/h$. Thus, from Eq. (1),

$$\tau = \frac{F}{A} = \mu \frac{U}{h} \tag{2}$$

Fluids exhibiting this characteristic are said to be Newtonian fluids. The absolute viscosity is also called dynamic viscosity. Unit for τ is: Unit for du/dy is:

Thus, the unit for μ is: Another unit of dynamic viscosity in the metric system still widely used is called the poise (P). The poise is the cgs unit of viscosity and is in dyne-seconds per square centimeter (dyn.s/cm^2) It has been customary to use the centipoise (cP) in analysis, because its value is more convenient. When the viscosity is expressed in centipoises, it is designated by Z. The conversion from cgs units to SI units is:

$$\mu(\text{Pa} \cdot \text{s}) = (10)^{-3} Z (\text{cP})$$

The unit of viscosity in the (ips) system is seen to be the pound-force-second per square inch; this is the same as stress or pressure multiplied by time. The (ips) unit is called the *reyn*, in honor of Sir **Osborne Reynolds**. The conversion from (ips) units to SI is the same as for stress. For example, multiply the absolute viscosity in reyns by 6890 to convert to units of Pa.s.

Table -1: Nomenclature

Ω	Angular Velocity
W	External Load
θ	Eccentricity
Θ	Bearing Angle
Hmax	Maximum Film Thickness
Hmin	Minimum Film Thickness
C	Radial Clearance
E	Eccentricity Ratio
O	Journal Center
\bar{O}	Bearing Center

Ψ	Attitude Angle
Rb	Radius Of Bearing
Rj	Radius Of Journal

2. MATERIAL AND METHOD:

The principle objective of this paper is to find out the recent paintings carried out on journal bearing. on this evaluate, current 17 papers on journal bearing were considered. diverse researchers cognizance on distinctive parameters of magazine bearing which influence the overall performance of bearing in the course of the working circumstance. They used exclusive methods to analyze the operations of hydrodynamic journal bearing. The papers are classified in numerous parameters consisting of strain distribution, temperature distribution, bearing surface deformation, stress distribution in the bearing, load wearing potential. in this evaluation paper incorporate CFD, CSD, FEM and FSI approach of analysis. This paper considers 14 papers on pressure and temperature distribution in journal bearing under one of a kind conditions, 5 papers on bearing floor deformation, and 6 papers on load carrying potential of journal bearing.

3. RESULT:

The paper gives the survey of this evaluation of journal bearing. accurate valuation of bearing’s overall performance is an important element, for that it is required to observe diverse parameters which influence the overall performance of fluid film journal bearing. The parameters together with pressure and temperature distribution, load sporting capability, bearing floor deformation.

3.1 PRESSURE AND TEMPERATURE DISTRIBUTION:

The pressure distribution is important in load ability estimation as well as dynamic evaluation. In fluid movie journal bearing, viscous shearing phenomenon takes place, that causes electricity loss and temperature upward push. growing temperatures cause viscosity reduction of oil and bearing deformation. The fluid film stress and temperature distribution is one of the essential running parameters to perceive the operating conditions of journal bearing. subsequently it is needed to take a look at pressure and temperature distribution in journal bearing.

Mukesh shahu et al [2] presented thermodynamic look at of the 3 dimensional undeniable magazine bearing using CFD. in this paper, author discovered out pressure distribution on journal floor not best circumferentially but also axially, with and without thinking about temperature impact. three– dimensional bearing geometry and meshing generated in Gambit and look at the performance of bearing the use of fluent 6.3.26 software. From this it's far clear that growing frictional pressure increases the temperature and decreases viscosity in addition to maximum pressure of lubricant present inside the obvious magazine bearing.

Amit Chauhan et al [3] have offered thermo-hydrodynamic analysis of plain journal bearing. in the course of the analysis, deviation of strain and temperature is considered on the fluid movie. From end result it's far located that putting consistent viscosity at some stage in evaluation may additionally deliver wrong prediction about the bearing. So the prevailing paper gives destiny prediction of bearing performance. Amit singla et al[4] have used computational fluid dynamic (CFD) for analyze the hydrodynamic performance of round magazine bearing. They offered consequences for strain and temperature distribution during the bearing with the aid of considering variable viscosity, constant viscosity, and variable viscosity with cavitations.

From end result it is found out that when the viscosity is positioned consistent, temperature in addition to strain increases is extra in lubricant however in sensible concept growing temperature reduces the lubricant viscosity and it affect the bearing loading capability as a result at constant viscosity may additionally gives incorrect prevision, so the analysis is beneficial for thinking about the operating condition of bearing Priyanka tiwari [5] analyzed the performance of infinitely lengthy journal bearing the use of CFD and FSI approach. on this paper, required statistics for analytical calculation is taken into consideration from design information e book. The targets of this paper need to found out pressure and temperature version of journal bearing underneath regular kingdom situation. it's far located that most stress took place nearer to the region of minimal movie thickness. at some point of analysis, developed analytical model, and it's miles compared with simulation effects of ansys and discovered that CFD results validated with analytical solution.

S. Baskar and G. Sriram[6] found strain distribution on hydrodynamic magazine bearing the usage of SAE20W40, rapeseed oil and soybean oil for loading circumstance along with 300N and 450N and pace levels inclusive of 1500rpm and 1750rpm. The Bearing is tested the use of journal bearing test rig.(JBTR) for different vegetable oils and in comparison the outcomes with SAE20W40. And it is calculated that best 10% to 20% and 50% to seventy five% stress distribution variant came about in rapeseed oil and soybean oil. subsequently Soybean oil generated extra warmth in comparison to rapeseed oil, so the soybean oil isn't appropriate as a lubrication purpose for magazine bearing programs.Hu Yong et al[7] have supplied CFD simulation of magazine bearing with dimples beneath lubrication behaviors. the point of interest of the study is to calculated pressure distribution, friction force, friction coefficient below exclusive dimple and evaluating the textured floor sliding with smooth surface sliding. The impact of lubrication performance is identified with the aid of considering distinct dimple – depth, density, and

profile. From result it's far observed that dimple is useful for lubrication performances and reduces friction force however there may be lack of load ability.D. M. Nuruzzama et al[8] have calculated strain distribution and load potential of magazine bearing with the aid of analytical technique and finite detail technique. to check the validity, both the consequences have been as compared. in the course of calculation isothermal analysis was taken into consideration. with the aid of comparing each the outcomes it is recognized that at low eccentricity ratio rise the dimensionless load gradually and rise with excessive eccentricity ratio Nabarun Biswas and Prasun Chakraborti[9] labored on unsteady transient evaluation of 3lobe magazine bearing. creator used bodily residences SAE-50 for analysis motive in journal bearing.

They taken into consideration surface roughness as zero.nine and movement of shaft at 6000 rpm for evaluation various float parameters. Gambit is used for design and evaluation is achieved with the help of fluent .They look at six time steps 10, 30, 50, 70, ninety, and 110 sec for unsteady analysis and determined out after a hundred and ten sec the go with the flow becomes steady. At minimal oil movie thickness most strain is determined with increasing cost of roughness. Peeyush vats et al[10] have performed case study on warmth transfer via journal bearing. This paper presented thermal evaluation of journal bearing. the author has used FEM analysis to observed out warmth generated, temperature distribution and warmth dissipation during the magazine bearing. Theoretical as well as FEM analysis have carried out for magazine bearing.

From outcomes it's far confirmed that distinction among warmth dissipated and warmth generated in oil film become very huge, due to this temperature of the bearing rises and damaged the bearing pads. ok. M. Panday et al[11] have performed unsteady evaluation for skinny movie lubricated magazine bearing with one of a kind L/D ratios including zero.25, zero.five, 1, 1.five, and a couple of of. during the analysis, author

observed most pressure gift at minimal oil film thickness. also they found out that shear stress on surface of bearing and magazine is reduced with increase in L/D ratio, however the turbulent viscosity of lubricant rises with boom in L/D ratio. Arjun Panthi et al [12] have studied stress and temperature consequences on viscosity additionally found out effect of L/D ratio, rotational velocity and eccentricity ratio on pressure distribution on bearing. The analysis has performed the use of CFD device and effects acquired from the software program established with numerical effects were given from the use of Raimondi and Boyd chart method. From results, it's far expected that growing temperature increases strain however decreases of mindset attitude. Chaitanya k. Desai et al [13] have achieved experimental in addition to theoretical evaluation of stress distribution for various loading situations and working parameters in hydrodynamic magazine bearing. From effects it's miles concluded that maximum pressure generated where fluid film thickness is minimum and at cavitations area zero strain occurred, additionally growing speed and load on bearing increases the stress. Dr. Suwarna Torgal et al [14] have labored on regular kingdom thermal evaluation of hydrodynamic magazine bearing usin ANSYS.

Authors located out equivalent oil movie temperature of bush type magazine bearing the usage of ansys and MATLAB software program, because it's miles one of the crucial parameter which influences the operation of magazine bearing. From effects, it's miles confirmed that round 12% versions have a look at among two techniques. however Ansys gave extra specific answer than numerical method. Ravindra M. Mane et al [15] have offered pressure distribution in three-D model of plain journal bearing the usage of COMSOL Multiphysics and analytical model developed the usage of reynold equation. strain distribution is located out on infinitely short and infinitely long hydrodynamic bearing beneath steady country situation. From effects it expected that growing pressure is proportional to eccentricity ratio and stress increases along the route of eccentricity.

3.2 BEARING SURFACE DEFORMATION:

A.Ouadoud et al [1] have performed thermo-hydrodynamic and thermo-elasto hydrodynamic analysis of complete journal bearing the usage of numerical techniques this is CFD and FSI. on this paper finite extent and finite detail method is used to decide the strain, temperature and speed distribution inside the fluid movie, and bearing surface deformation underneath static load condition respectively. They determined out that the distortion because of stress plays crucial role in decide the behavior of bearing, also due to elastic outcomes minimum film thickness is affected.

Dinesh Dhande et al [16] have used fluid structure interaction method to found out deformation of the hydrodynamic magazine bearing. all through analysis, models are evolved for one-of-a-kind eccentricity ratios and speeds to investigate interplay between elastic behavior of bearing and fluid, also observed amount of deformation of the bearing. it's far determined that CFD-FSI approach is useful to determined influence of hydrodynamic and elastic conduct of the bearing. And this technique advanced correct performance of the bearing.

B.S. Shenoy et al [17] have used computational structural dynamics (CSD) and computational fluid dynamics (CFD) to look at the elasto-hydrodynamic lubrication behavior of full 360 journal bearing. the principle cognizance of this paper became to found out deformation and pressure distribution within the bearing liner befell due to ensuing forces. To calculated pressure distribution finite element method (FEM) became used. The simulation of elasto-hydrodynamic lubrication have verified with fashionable lubrication end result. The paper supplied, these techniques is successfully used for locating the floor deformation of bearing below static load. P. Gertzos et al [18] have provided three dimensional CFD analysis of magazine bearing with bingham fluid. The consequences located from fluent software compared with formerly investigation experimental and theoretical outcomes of Newtonian as well as

Bingham lubricants and it suggests true settlement. on this paper, the journal bearing overall performance checked in electro-rheological and magneto-rheological fluids. From outcomes it's miles concluded that the impact of yield stress is small for low eccentricity ratio at the magazine bearing. S. Chaitanya Kumar et al[19] have labored on CFD evaluation of hydrodynamic magazine bearing. at some stage in the evaluation they state that oil film stress is one of the critical parameter to describing the operating situation of hydrodynamic journal bearing. the author centered directly to the modeling of journal bearing for diverse L/D and eccentricity ratios, and evaluation is executed through using FSI method to find out strain, stress and deformation of hydrodynamic magazine bearing. in this paper, author located out strain distribution by means of sending the lubricant in between bearing and magazine. Then use the FSI method to perceive stresses and deformation of the magazine bearing. for this reason this technique has been correctly used to finding out the overall performance of the bearing.

3.3 LOAD CARRYING:

the load wearing capacity is a feature of stress distribution around the magazine and floor, because of fluctuation in fluid film thickness. the burden wearing ability stricken by the growing in shaft speed and eccentricity ratio. B. Manshoora et al [20] have located out that 3 directional numerical investigation of skinny film lubricated journal bearing for three turbulent models. For analysis reason taken into consideration one-of-a-kind L/D ratio of 0.25, 0.5, 1.0, 1.5 and a couple of 0 to find out result in phrases of static pressure, wall shear pressure and dimensionless load wearing capability of the skinny film magazine bearing. in this paper, wellknown $k-\epsilon$ version, Relizable $k-\epsilon$ model and Reynolds strain model (RSM) is used for simulation paintings of thin film lubricated magazine bearing. The comparison concluded that all models generate equal effects. consequently, from this paper, it was confirmed that, $k-\epsilon$ model become exact to do the simulation because it changed into handiest version and faster in comparison to RSM and $k-\epsilon$ Relizable. Jamaluddin Md Sheriff et al[21]

have investigated CFD evaluation to expect load carrying capability of linear magazine bearing and groove floor waviness with bio-based totally lubricant. From results it is concluded that load sporting capability of sinusoidal wavy floor is higher than linear journal bearing. however excessive load sporting potential acquired in linear journal bearing maintaining small eccentricity ratio and it's far the foremost operation of linear journal bearing. Marco Tulio C. Faria et al[22] have used finite element technique for dynamic in addition to regular country evaluation of oil – lubricated journal bearing. From outcomes it's miles clear that hydrodynamic long magazine bearing model must be evaluated due to the fact it could rises big errors within the bearing performance. Huixia jin et al[23] have completed numerical simulation of primary circumferential groove of hydrodynamic magazine bearing with the help of CFD software.

From end result it's miles determined out that groove intensity have an effect on the burden zssone, bearing sporting ability, cavitations zone and vapour fraction. Samuel Cupillard et al[24] have completed CFD evaluation of magazine bearing with smooth and textured surface. the point of interest of this study is to decide the have an impact on surface texture on eccentricity ratio and frictional force. in the course of the evaluation taken into consideration the float is laminar and isothermal at unsteady circumstance. From this observe it's far observed out that for mild loading situation accelerated the minimum movie thickness and decreased frictional force and for high loading conditions increasing pressure sector decreases the frictional pressure. Amit Solanki et al [25] have optimized the design parameter together with load sporting potential of hydrodynamic journal bearing using Genetic algorithm. From outcomes it concluded that the load carrying capability is proportional to rotational velocity of magazine, L/D ratio, period and radial clearance of magazine.

4. DISCUSSION:

This literature evaluate gives severa researchers' paintings on journal bearing to enhance the overall

performance of the bearing. numerous analyses is done on particular parameter of the bearing consisting of load carrying capability, deformation and pressure distribution on floor of bearing, stress and temperature distribution at the journal bearing. moreover analysis is accomplished for wonderful L/D ratios and eccentricity ratios to find out their impact on the magazine bearing. The evaluation is completed with the resource of the usage of numerous software program to be had on this days which include computational fluid dynamic(CFD), Fluid shape interplay(FSI), computational structural dynamics(CSD), finite detail technique (FEM) also analytical and experimental evaluation have completed. but though hassle stays unsolved in film of fluid film mag bearing. So it's want to turn out to be aware about answer on exclusive parameters such as lubricant applied in fluid movie journal bearing this is to discover optimize answer for mag bearing.

5. CONCLUSION:

these are the vital factors, whilst thinking about the design of bearing. Its suggests that CFD solutions get demonstrated with experimental in addition to analytical outcomes. numerous researchers have executed terrific research on specific parameters of journal bearing, but nonetheless hassle remains unsolved in film of fluid film magazine bearing during the operation of bearing. The failure of fluid film related with lubricant utilized in fluid movie magazine bearing. for this reason it's far needed to optimize the fabric of film utilized in fluid movie journal bearing. Oil stress and temperature in bearing rely on various factors along with bearing geometry, residences of fluid, rotational velocity and force evolved for the duration of running situation. it's miles advocated to pick out thermo-hydrodynamic analysis of magazine bearing, as it gives real overall performance parameter of the bearing.

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