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THERMAL ANALYSIS OF HYDRODYNAMIC JOURNAL BEARING FLUID FILM

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ABSTRACT

Hydrodynamic journal bearings are analyzed by using Computational fluid dynamics (CFD) and fluid structure interaction (FSI) approach in order to find Pressure profile and temperature distribution in the bearing structure, satisfying the boundary conditions. The Journal bearing is designed in ANSYS software. The journal is modeled as a moving wall with an absolute rotational speed and bearing is modeled as a stationary wall. Design parameters like pressure distribution and temperature distribution are considered for the analysis. It is assumed that the flow of lubricant is laminar and steady. Also cavitations effects in the bearing are neglected by setting all negative pressures to ambient pressures. Design data like journal diameter, clearance, L/D ratio, minimum film thickness, journal speed and oil viscosity are taking by machine design data book for making analytical calculation. The CFD results are compared in order to validate the model with the analytical results. Good agreements are found in modeling and analytical results.

KEYWORDS: *Computational fluid dynamics, Fluid Structure Interaction, Static pressure distribution, Temperature distribution, hydrodynamics properties, ANSYS.*

1. INTRODUCTION

1.1 Current scenario about journal bearing

Hydrodynamic type journal bearings are considered to be a vital component of all rotating machinery whose function is to support an applied load by reducing friction between the relatively moving surfaces. A journal bearing consists of a circular shaft, called the journal, is made to rotate in a fixed sleeve is called the bearing. The bearing and the journal operates with a small radial clearance of the order of 1/1000th of the journal radius. The clearance space between the journal and the bearing is assumed to be full of the lubricant. The radial load squeezes out the oil from the journal and bearing face and metal-to-metal contact is established. When the journal begins to rotate inside the bearing, it will climb the bearing surface and as journal speed is further increased.

The present modern industry uses machineries which are rotating at high speed and carrying deep rotor loads. In such application fluid film journal bearing is used. Fluid film journal bearing is a mechanical part designed to support a high load while permitting relative motion between journal and bearing surface. The fluid film bearing also called as hydrodynamic journal bearing. The journal and bearing wall are separated by fluid film which is applied between clearance spaces. Generally, radial clearance is very small in order of 1/1000th of journal radius. In existing fluid film bearing major problems occurs due to the failure of fluid film during the working condition. In existing fluid film journal bearing, under maximum load, metal to metal contact between journal and bearing takes place. Due to this maximum heat as well as friction is generated which overheats the surface of journal and bearing. Hence increases the power loss and reduces the life of bearing. [1] For this problem, various researchers have done remarkable exploration on special parameters of journal bearing. They initiate out steady state and transient analysis, loading capacity effect on journal bearing. But immobile some problems exist. This difficulty is associated with lubricant that is used in fluid film journal bearing. So the need is to find out solution on lubricant used in fluid film journal bearing to improve the performance of bearing. The pressure allocation is important parameter in load capacity estimation and dynamic analysis. In recent studies, CFD results have been compared with experimental as well as analytical results, and it shows that CFD results get validated. The paper presents various researchers effort done on journal bearing to

develop the performance of the bearing. The journal bearing is as shown in fig 1. [2]

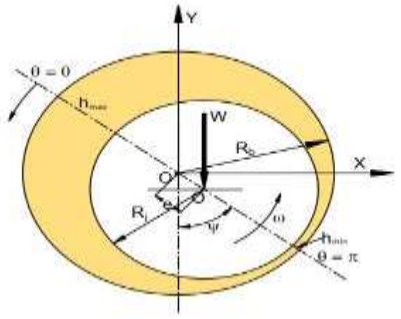

Fig 1: schematic diagram of circular Journal bearing

Ώ = Angular Velocity
θ = Bearing Angle
Hmax = Maximum Film Thickness
Hmin = Minimum Film Thickness
C = Radial Clearance
O= Journal Centre
Rb = Radius of Bearing
Rj = Radius of Journal
W = External Load
ε = Eccentricity

1.2 Material and Method

The paper presents various researchers effort done on journal bearing to develop the performance of the bearing. The main objective of this paper is to find out the recent work done on journal bearing. In this review, recent 25 papers on journal bearing have been considered. Various researchers focus on different parameters of journal bearing which influence the performance of bearing during the operating condition. They used different methods to analyze the operations of hydrodynamic journal bearing. The papers are categorized in various parameters such as pressure distribution, temperature distribution, bearing surface deformation, stress distribution in the bearing, load carrying capacity. In this review paper contain CFD, CSD, FEM and FSI technique of analysis. This paper considers 14 papers on pressure and temperature distribution in journal bearing under different conditions, 5 papers on bearing surface deformation, and 6 papers on load carrying capacity of journal bearing [3].

1.3 Pressure and Temperature Distribution

The fluid film pressure and temperature circulation is one of the essential operating parameters to identify the operating conditions of journal bearing. The pressure distribution is crucial in load capacity assessment as well as dynamic analysis. In fluid film journal bearing, viscous shearing phenomenon occurs, that causes power loss and temperature rise. Rising temperatures lead to viscosity reduction of oil and bearing deformation. Hence it is needed to study pressure and temperature distribution in journal bearing. [4]

1.4 Load Carrying Capacity

The load carrying capacity is a function of pressure distribution around the journal and surface, due to fluctuation in fluid film thickness. The load carrying capacity affected by the rising in shaft speed and eccentricity ratio.

2. PROBLEM FORMULATION AND OBJECTIVE

2.1 Problem Statement

To evaluate bearing's performance, study of various parameters such as pressure and temperature distribution, load carrying capacity, bearing surface deformation which manipulates the performance of fluid film journal bearing is conducted. The work presents the survey of this analysis of journal bearing using CFD analysis.

2.2 Objectives

The major objectives and pertinent work plan to fulfill these can be broadly summarized as:

1 To study the effects on journal bearing during the standard loading conditions.
2 To improve the efficiency of bearing using finite element analysis.
3 To predict the load on journal bearing.
4 To predict the temperature distribution.
5 To predict the pressure distribution.
6 To decrease the friction effect.

3. PRESENT WORK

3.1 Initiation and Problem identification

After reading the research papers related works the problem is found that several causes are responsible for damage of journal bearing which are explained above, the main parameters are temperature and pressure distribution which will be studied in this work.

3.2 Proposed system

Proposed system is that first of all literatures were reviewed, problem identification, define the objective and select the methodology to solve the problem.

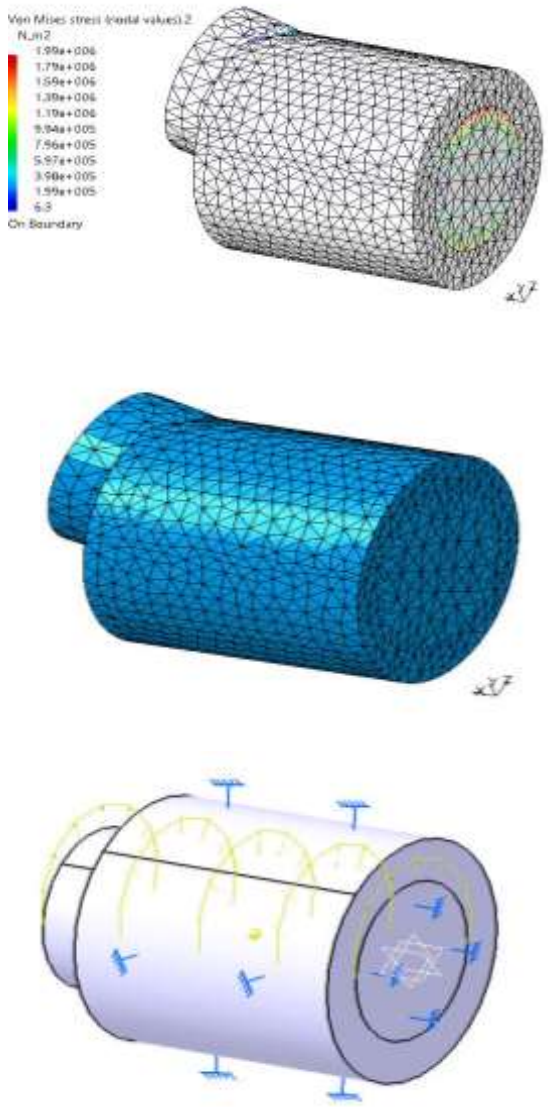

Fig2. Computational 3D model of fluid film geometry

4. CONCLUSION

This literature review presents various researchers' work on journal bearing to improve the performance of the bearing. Various analyses is done on different parameter of the bearing such as load carrying capacity, deformation and stress distribution on surface of bearing, pressure and temperature distribution on the journal bearing. Also analysis is done for different L/D ratios and eccentricity ratios to find out their effect on the journal bearing. The analysis is done by using various software available in this days such as computational fluid dynamic(CFD), Fluid structure interaction(FSI), computational structural dynamics(CSD), finite element method (FEM) also analytical and experimental analysis have completed. But still problem remains unsolved in film of fluid film journal bearing. So it's need to identify solution on other parameters such as lubricant used in fluid film journal bearing that is to find out optimize solution for journal bearing.

1) From literature, it is shows that CFD solutions get validated with experimental as well as analytical results.
2) Oil pressure and temperature in bearing depend on various factors such as bearing geometry, properties of fluid, rotational speed and force developed during working condition. These are the important elements, while considering the design of bearing.
3) It is recommended to identify thermo-hydrodynamic analysis of journal bearing, because it gives actual performance parameter of the bearing.
4) Various researchers have done remarkable investigation on different parameters of journal bearing, but still problem remains unsolved in film of fluid film journal bearing during the operation of bearing.
5) The failure of fluid film related with lubricant used in fluid film journal bearing.
6) Hence it is needed to optimize the material of film used in fluid film journal bearing.

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