Experimental Analysis of Hydrodynamic Journal Bearing

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***Abstract*- Hydrodynamic journal bearings are widely used due to their high load carrying capacity and good damping properties. Journal bearings have been widely used in rotating machinery. The bearing carries higher loads which reduces film thickness and also increase temperature of bearing due to fluid film temperature increment. The pressure distribution is important in both load capacity estimations (static performance) and dynamic analysis. We can analyze the pressure of fluid film and total deformation of hydrodynamic journal bearing by Fluid Structure Interaction technique. This paper describes FSI technique with optimization. Keywords: static performance, fluid interaction technique**

I. INTRODUCTION

Hydrodynamic journal bearing is defined as a mechanical element which supports high load due to wedge shape geometry formed during the relative motion between journal and bearing surface. Hydrodynamic journal bearing is widely used due to its high load carrying capacity and good damping properties [1]. The major problem with hydrodynamic bearing is failure of fluid film during the operation. This may cause metal to metal contact between journal and bearing surface. This leads to wear and friction which overheats the surfaces [6]. Hence the power loss increases. In this paper FSI technique has been used to predict the performance characteristics of a hydrodynamic journal bearing.[2] Three dimensional studies have been done to predict pressure distribution along journal surface [3]. The FSI technique can give accurate pressure distribution. The fluent and static structural modules are coupled to generate actual load on shaft and baring inner surface [4]. The optimization technique also used to get optimum results so that bearing can be modified so as to get better results.[7]

II. OPERATING CONDITIONS

The fig.1 shows the fluid film of bearing and oil inlet at upper side of fluid film. The material used for bearing is Aluminum.

Table I
Operating Conditions

Bearing Diameter	85
Bearing Length	60
Journal Diameter	50mm
Radial Clearance	0.3µm
Rotation Speed	4500rpm
Lubricant viscosity	0.0277 Pa. s
Lubricant density	860 Kg/m^3

III. MODEL AND MESHING

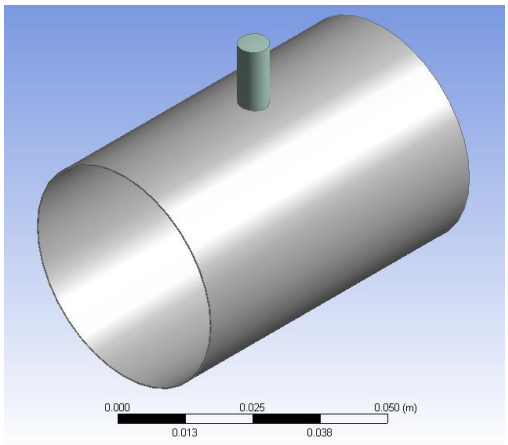


Fig. 1 Fluid Film Geometry in Ansys

The journal has given random offset origin while modeling the geometry. The origin of journal is considered as parameter(X and Y position of origin). The eccentricity and attitude angles also added in parameter set as input with random values. A relation between journal origin, eccentricity and attitude angle is made so that at end of solution we can get value of eccentricity and attitude angle.The meshing of fluid film is done in fluent meshing.

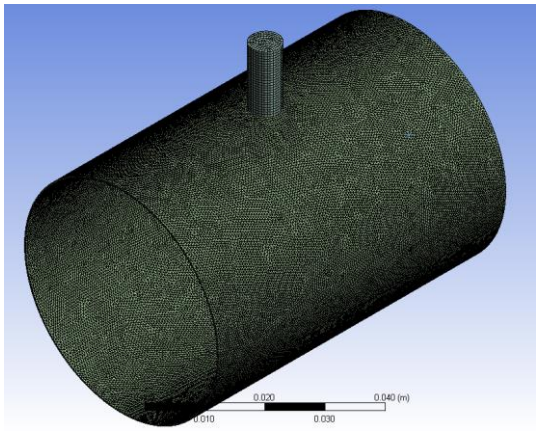


Fig. 2 Fluid Film Meshing

IV. BOUNDARY CONDITIONS

The inner surface of fluid film has considered as shaft and given rotations. The outer surface of fluid film is considered as wall. The inlet from top considered as pressure inlet and film thickness at end of fluid film is considered as outlet of oil.

Table II
Boundary Conditions

FSI wall Bearing	Wall
Shaft (Rotating)	4500 rpm
Pressure Inlet	101525 Pa
Pressure Outlet	0

V. SOLUTION

The solution has given simple method to solve the analysis. In solution we have to monitor mass flow at inlet and outlet and also we monitor pressure force on shaft in X and Y direction. As we are considering optimization the Fluent and Static Structural are coupled and Response Surface optimization module is attached to both. In optimization the module initially solves the various design points generated in module. The Design of Experiments is the initial step building a Response Surface over the design space. This section describes the selected input parameters and their variation range, the chosen Design of Experiments type, and the generated Matrix of Experiments.The explored design space is defined by the range of variation of the input parameters.The Response Surface is a meta-model built from the Design of Experiments for an efficient exploration of the design space. This section describes the selected type of meta-model, including its properties, the obtained quality, and the generated Response Points and charts.The minimum and maximum section reports the minimum and maximum values for each output parameter. These values are approximations found by the Min-Max Search on the Response Surface. The Optimization is based on Response Surface evaluations. This section describes the chosen Optimization type and the generated candidates and charts. The explored design space is defined by the range of variation of the input parameters eccentricity and attitude angle. After this we get Output Parameter Minimum (Response Surface Optimization system) and Output Parameter Maximum (Response Surface Optimization system).

	Candidate Point 1	Candidate Point 2	Candidate Point 3
P8 - eccentricity (m)	1.0381E-05	1.0864E-05	1.3375E-05
P9 - attitudeAngledeg (radian)	1.116	1.056	0.79788
P6 - Xload (N)	456.07	459.38	459.43
P7 - Yimbalance (N)	-226.06	-256.16	-418.14

Fig. 3 Optimization Results

The solution also gives total deformation of bearing and load on bearing as we are using system coupling.

VI. RESULT

Table III
Results

Maximum Pressure	3.607E05 Pa
Load in X direction	450 N
Load in Y direction	-224.8 N
Eccentricity	1.038E-05 m
Attitude angle	63.97°
Equivalent Stress (Max)	8.365E
Total Deformation	1.1058E-07m
Force Reaction Total	505.04 N

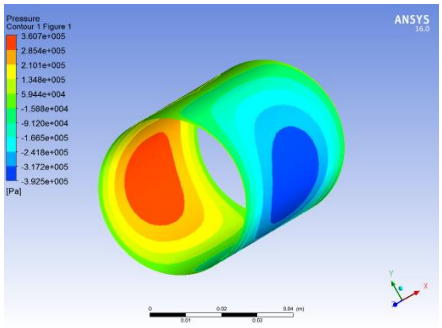


Fig.4 pressure contour of shaft figure

shows pressure contour of shaft for bearing of diameter 72 mm the maximum pressure is occurring at altitude angle of 63.97 degree The same pressure contour can be seen for bearing inner surface

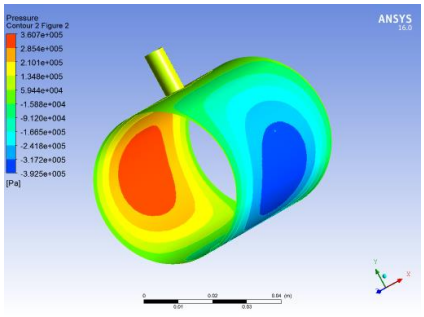
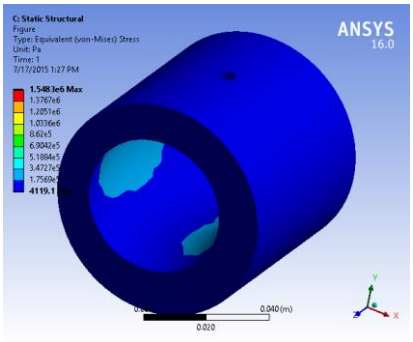


Fig.5 Pressure Contour of Bearing Inner Surface figure

shows total deformation of bearing due to pressure force occurring at inner surface .The total deformation for bearing with diameter 72 mm is 1.1058E07m



[1] Fig.6 Equivalent Stress on Bearing MukeshSahu, Ashish Kumar Giri, Ashish Das on "Thermodynamic Analysis of Journal Bearing Using CFD as a Tool" 3. ISSN 2250-3153 International Journal of Scientific and Research Publication, Volume 2, Issue 9, September 2012

due to pressure force occurring at inner surface the equivalent stress for bearing with diameter 72mm was 8.365E

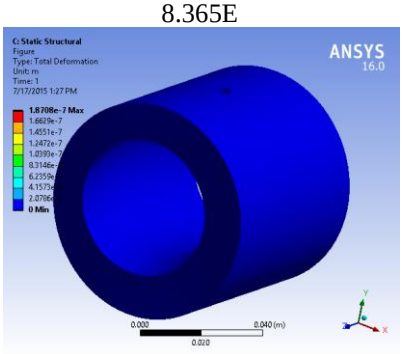


Fig.7 Total Deformation of Bearing.
Maximum pressure generated on shaft of bearing of diameter is 3.605E05pa

CONCLUSION

The FSI technique gives more accurate analysis of Journal Bearing. The optimization technique can be used to get optimized results of maximum pressure and load on bearing. We can also get value of eccentricity and attitude angle at which we are getting maximum pressure and load on bearing and shaft.

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