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A Brief Analysisof Fluid film liquid lubricated cylindrical journal bearing

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ABSTRACT: The current study uses ANSYS software to investigate the fluid structural and computational fluid dynamic analysis of a hydrostatic bearing fluid film. For lubrication, journal bearings use various grades of oil or fluid, and we've used two different grades of SAE 20 and SAE 40 liquid. The pressure in the oil film in a fluid film bearing satisfies the Reynolds equation, which is a function of film thickness.The current study uses the length to diameter ratio (L/D) [1] and varied eccentricity ratios to calculate bearing deformation owing to loading conditions. The eccentricity is varied from 0 to 1.0 with intervals of 0.2 and starts with 0.3 as 0.3, 0.5, 0.7, and 0.9. The lubricants SAE 20 and SAE 40 are considered for analysis with the same boundary condition and the final output is compared for both liquid lubricants. ANSYS software is used to execute the CFD analysis and structure analysis. First, we run the CFD simulation, and the output is linked to the structural workbench to apply the pressures to the bearing.
KEYWORDS: CFD Computational fluid Dynamic, FSI fluid structure interaction, AR aspect ratio

I. INTRODUCTION:

An external source of pressurized fluid drive lubricant between two surfaces in a hydrostatic bearing, allowing for non-contact operation and load support.Huge (precise and controllable) direct stiffness as well as damping (energy dissipation) coefficients are provided by hydrostatic bearings, which can handle large loads without journal rotation.

Even in the absence of journal rotation, hydrostatic bearings rely on external fluid pressurization to provide load support and a high centering stiffness. Hydrostatic bearings' load capacity and stiffness are independent of fluid viscosity, making them excellent rotor support components in process fluid pumps.

Hybrid bearings will be used to replace oil-lubricated bearings in current applications to increase efficiency while reducing rotor spans and mechanical complexity. Hydrostatic bearings are used in today's cryogenic liquid turbopumps, allowing for an all-fluid film bearing technology with a small number of components and no DN limit functioning.

The bulk-flow analysis of turbulent flow hydrostatic bearings is discussed, as well as the static and dynamic performance characteristics of hydrostatic bearings supporting a water pump. A hydrostatic bearing with unrivalled dynamic force and stability is created by angling liquid injection.

The load capacity of hydrostatic bearings is derived from a combination of the pressure vs flow resistance effects through a feed restrictor and in the film lands, rather than shear flow driven effects (hydrodynamic wedge and surface sliding). The thrust and radial hydrostatic bearing designs for process fluid lubrication turbopumps are shown in Figure 1.

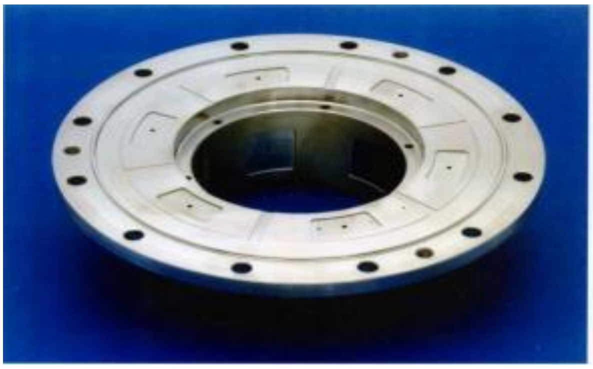



Figure 1.2 Hydrostatic radial and thrust bearings

Problem Identification: The hydrostatic general bearing is one of the bought out parts which is already define for specific load and RPM with some specific parameters so the scope of work is to limited to lubricant which play an important role. Here we have taken two lubricant to identify the performance of both lubricant and find out the interaction of fluid film with the elastic behaviour of bearing. SAE20 and SAE40 lubricant is consider for analysis in ANSYS software by using CFD and structure work bench with different eccentricity ratio.

Parameters of bearing:

Diameter of journal D	100 mm
Journal length L	50
Ratio (L/D)	0.5
Eccentricity mm e	ε x C
Radial clearance C	0.145 mm
Eccentricity ratio ε	0.3 to 0.9

Eccentricity calculation table on L/D at 0.5:

S No.	Ɛ	C	e = Ɛ×C
1	0.3	0.145	0.0435
2	0.5	0.145	0.0725
3	0.7	0.145	0.1015
4	0.9	0.145	0.1305

Analytical calculation of stress and force induced in bearing

$$F = \frac{\pi^2 D^2 \, L \, N}{30 * C} \mu$$

$$\sigma = \frac{F}{A} \text{ N/mm}^2$$

where
F = force N
D = diameter of journal bearing
L = length of bearing
N = speed
μ = coefficient of friction

II. METHODOLOGY:

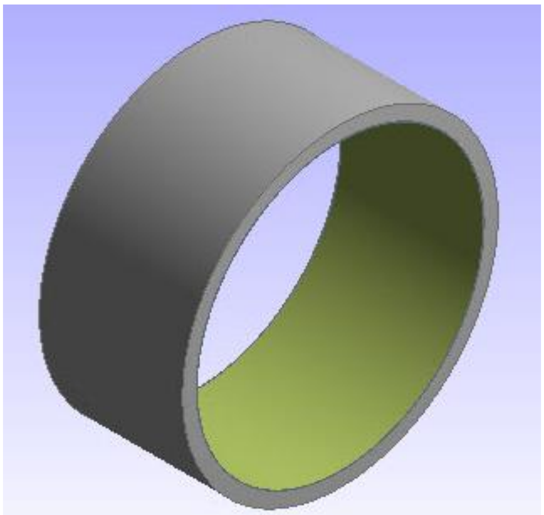
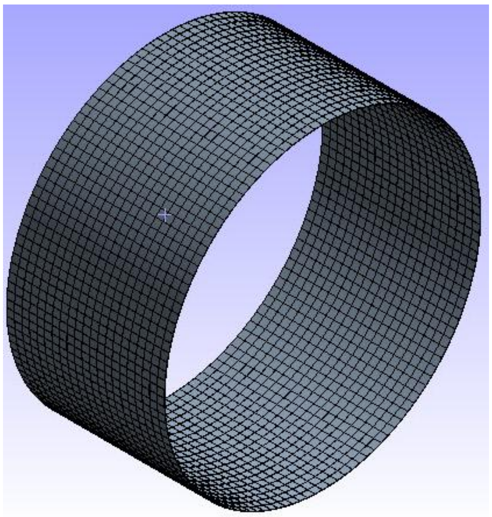
CFD Modelling and analysis of bearing

In order to simulate the bearing in ANSYS environment first of all a graphical model of journal bearing is to be developed or design with specified parameters in geometry tools then itsbrowsed for the analysis. The typical analysis sequence in the CFD tools is given below.

- Geometry
- Mesh
- Setup
- Solution
- Result

Geometry& meshing of journal bearing

The geometry is created by sketching of two-dimensional profile of bearing inner ring and then its revolve around the center of the bearing. A thin surface of fluid film is also created to define the geometry of fluid film. After modelling of bearing it required to mesh and divide whole geometry into small nodes and elements.

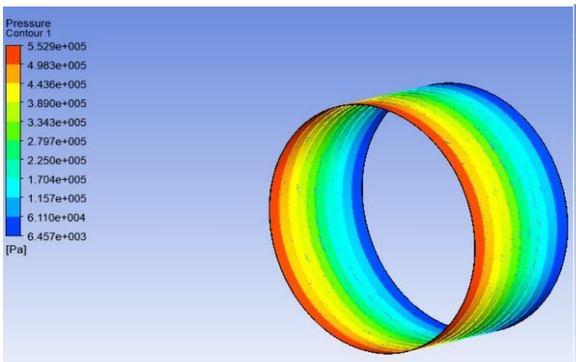



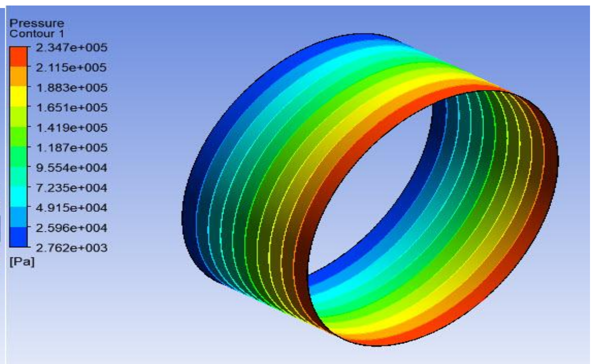
Setup & boundary condition
A thin geometry of surface is used to represent the profile of surface and based on the geometry inlet and outlet is defined to identify the flow of liquid and pressure based solver is used to simulate the analysis.

Property of fluid film

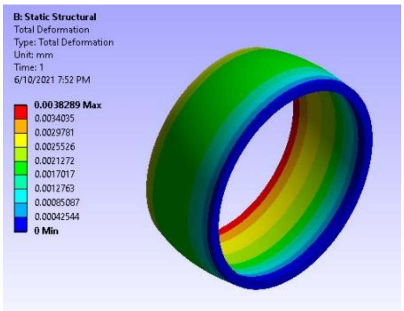
PROPERTIES	SAE20	SAE40	BABBIT MATERIAL
Density (kg/m3)	872	887	0.000007272
Thermal conductivity (w/m-k)	0.136	0.136	Young's modulus
Specific heat Cp(J/kg-k)	19252.96	1800	50,000MPa
Viscosity (kg/m-s)	0.0056	0.0056	Poisson's ratio
Velocity of flow (m/s)	10.45	10.45	0.35

Solution & result of CFD and structure analysis
After successfully run of simulation, it lead us to a result in graphical form to represent the behaviour of bearing under loading condition.

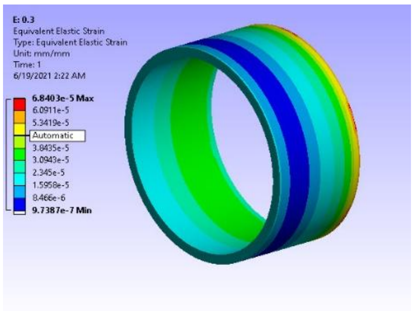




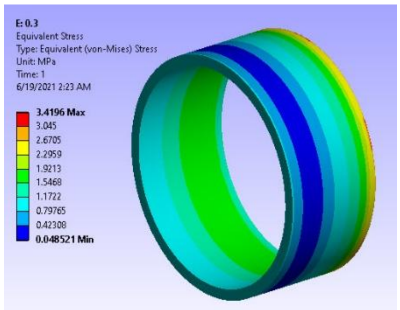
The CFD result is hyperlink with structure analysis workbench to apply the required pressure in the bearing.



Total deformation

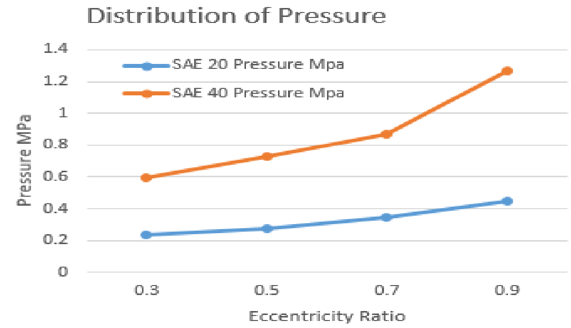


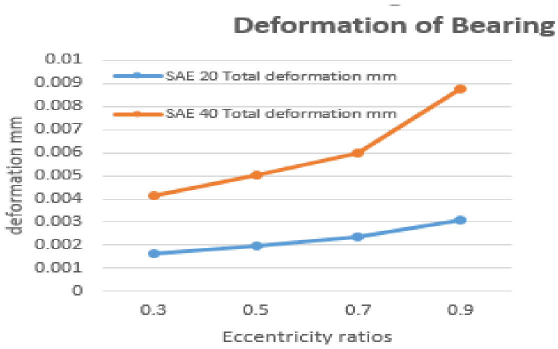
Elastic strain

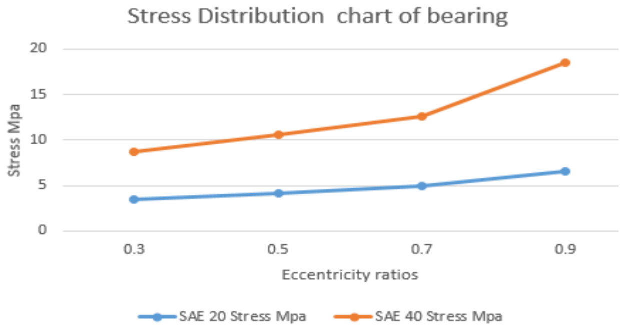


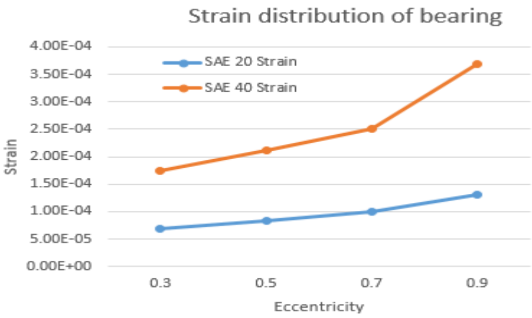
Stress distribution

Result of of SAE 20 and SAE 40 fluid film









The distribution of stress pressure deformation and strain of bearing is given here to identify the nature of fluid film and bearing under loading condition.

III. CONCLUSION

Based on the graph and data furnished in result section we concluded that the nature of graph for all cases is almost similar and small variation is found in case of eccentricity ratio of 0.9 for both liquids, its show some difference nature and vale is higher as compare to rest eccentricity ratio.so that we can say that the value of stress and other parameter is gradually increases and it becomes higher at the eccentricity 0.9.The bearing has a significant amount of distortion, as can be seen. When these data are compared, SAE 20 oil with an eccentricity ratio of 0.3 is the optimum choice for journal bearings.

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