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Thermo Hydrodynamic Analysis of Plan Journal Bearing by using CFD- FSI- Approach

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ABSTRACT: Journal bearings have the longest history of scientific study of any class of fluid film bearings. Structural distortion of the housing and the development of thermo hydrodynamic pressure in a full journal bearing is strongly coupled thus require a combined solution. Thermo hydrodynamic journal bearings are analyzed by using Computational fluid dynamics (CFD) and fluid structure interaction (FSI) approach in order to find deformation of the bearing. In this thesis, journal bearings for different L/D ratios and eccentricity ratios are modeled in 3D modeling software Pro/Engineer. The L/D ratios considered are 0.5 and eccentricity ratios considered are 0.8, 1.0 and 1.5. Journal bearing models are developed for speed of 2500 and 5000 rpm to study the interaction between the fluid and elastic behavior of the bearing. The speed is the input for CFD analysis and the heat transfer coefficient and temperature obtained from the CFD analysis is taken as input for thermal analysis.

I. INTRODUCTION

A surprisingly large number of bearings can be found all around us. Take automobiles, for example: there are 100 to 150 bearings in a typical car. Without bearings, the wheels would rattle, the transmission gear teeth wouldn't be able to mesh, and the car wouldn't run smoothly. A plain bearing is the simplest type of bearing, comprising just a surface and no rolling elements. Therefore the journal (i.e., the part of the shaft in contact with the bearing) slides over the bearing surface. The simplest example of a plain bearing is a shaft rotating in a hole. A simple linear bearing can be a pair of flat surfaces designed to allow motion; e.g., a drawer and the slides it rests on or the ways on the bed of a lathe. Plain bearings, in general, are the least expensive type of bearing.

JOURNAL BEARING NOMENCLATURE:

L=Length of the journal bearing, mm
D=Diameter of the journal bearing, mm
C=Radial clearance, mm
e=Eccentricity, mm

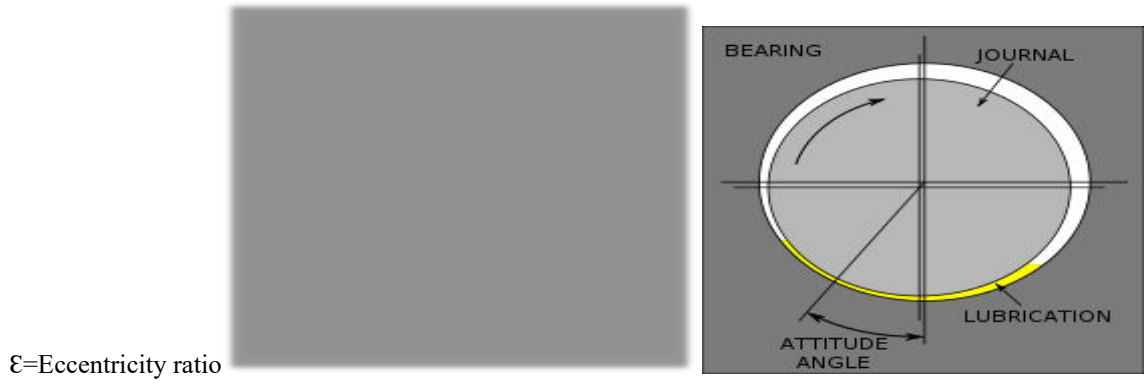


Fig.1. a schematic diagram of a journal bearing under a thermo hydrodynamic lubrication state showing how the journal centerline shifts from the bearing centerline.

II. METHODOLOGY

In this thesis journal bearings for different L/D ratios and eccentricity ratios are modeled in 3D modeling software Pro/Engineer. The L/D ratio considered are 0.5 and eccentricity considered are 0.8, 1.0 and 1.5. Journal bearing models are developed for speeds of 2500 & 5000 rpm to study the interaction between the fluid and elastic behavior of the bearing. The speed is the input for CFD analysis and the heat transfer rate obtained from the CFD analysis is taken as input for thermal analysis. Computational fluid dynamics (CFD) and fluid- solid-interaction (FSI) is done in ANSYS.

MODELS AND 2D DRAWINGS OF JOURNAL BEARING IN PRO- ENGINEER

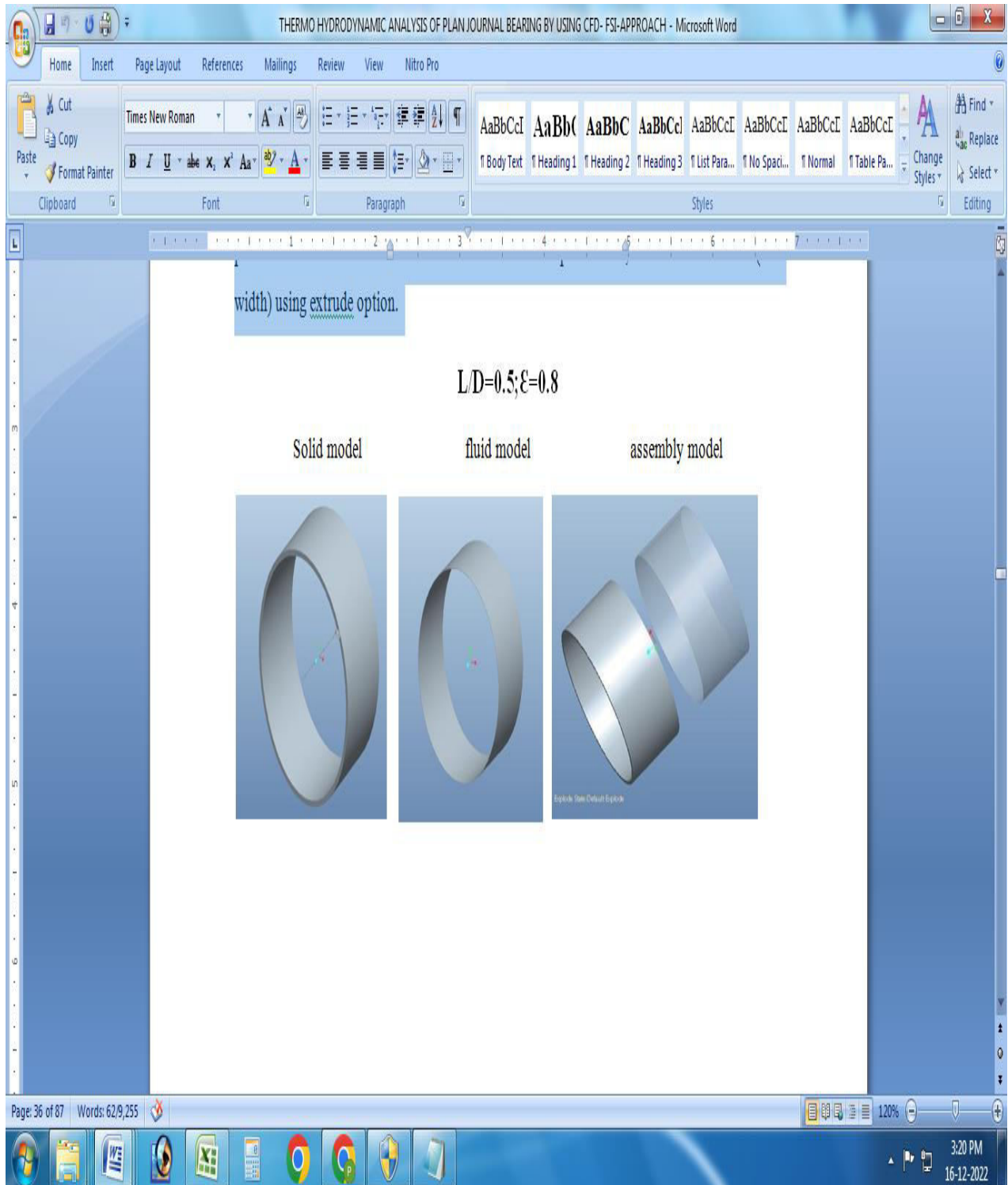
L/D ratio	Eccentricity		
0.5	0.8	1.0	1.5

III. PROBLEM IDENTIFIED

Oil film pressure is one of the key operating parameters describing the operating conditions in thermo hydrodynamic journal bearings. Thermo hydrodynamic journal bearings are analyzed by using Computational fluid dynamics (CFD) and fluid solid interaction (FSI) approach in order to find deformation of the bearing.

IV. RESULTS & DISCUSSIONS

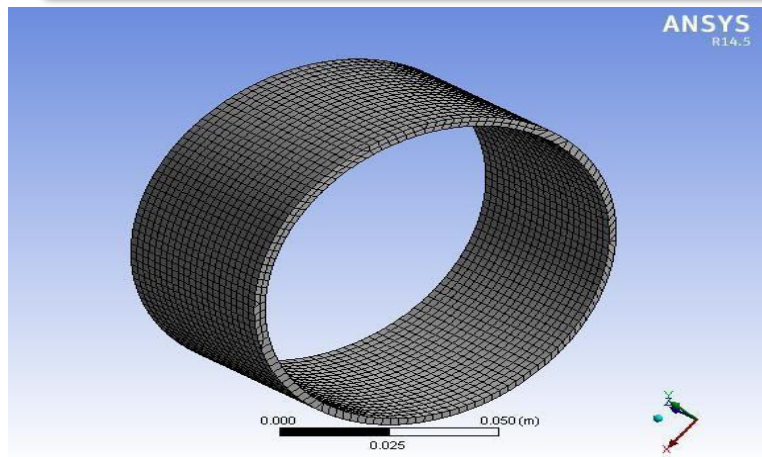
Models of journal bearing using pro-e wildfire 5.0. The journal bearing is modeled using the given specifications and design formula from data book. The isometric view and exploded view of journal bearing are shown in below figure. The profile is sketched in sketcher and then it is extruded up to 50mm, 100mm and 150mm (face width) using extrude option.

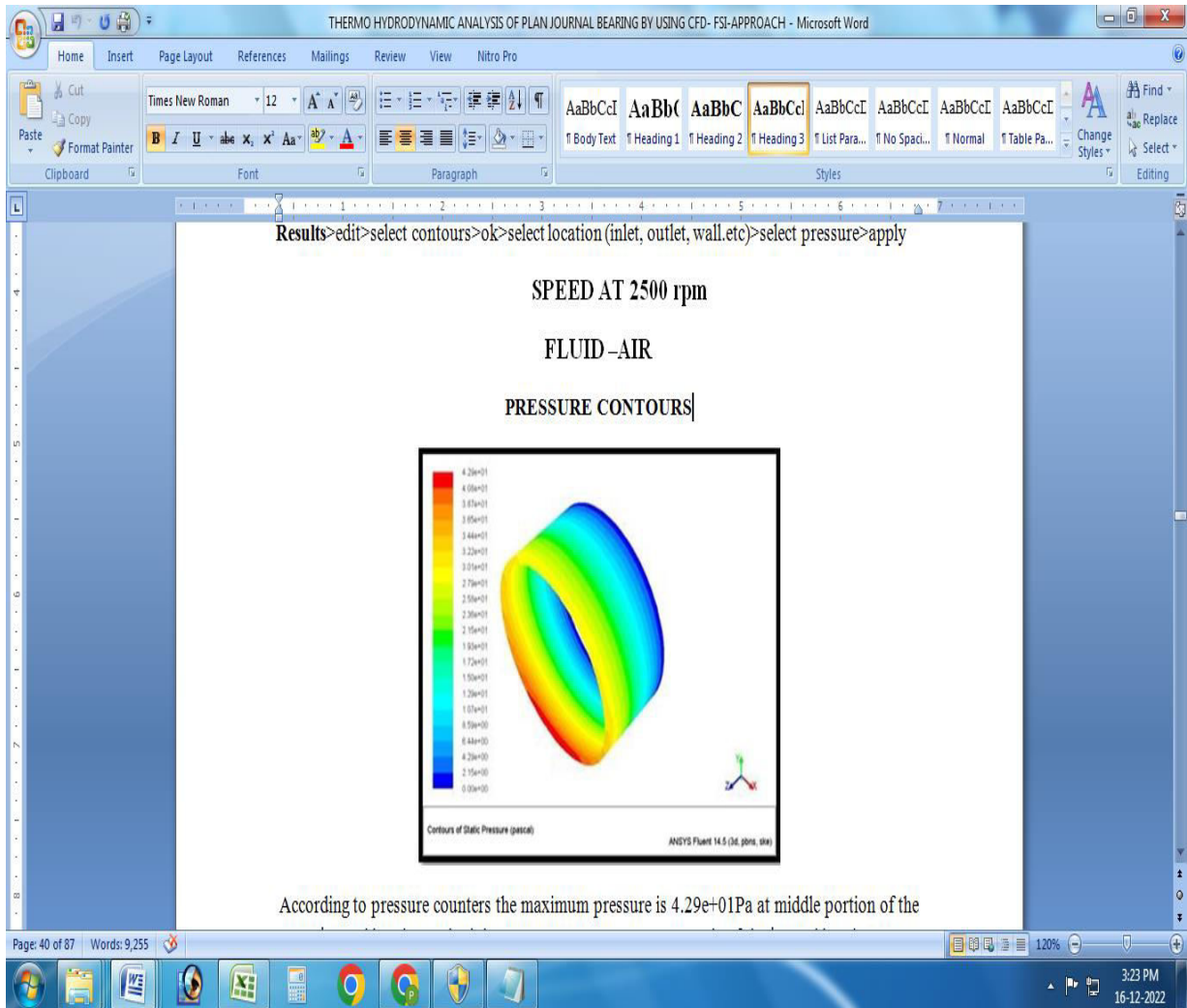


MODELS AND 2D DRAWINGS OF JOURNAL BEARING IN PRO- ENGINEER



Meshed model



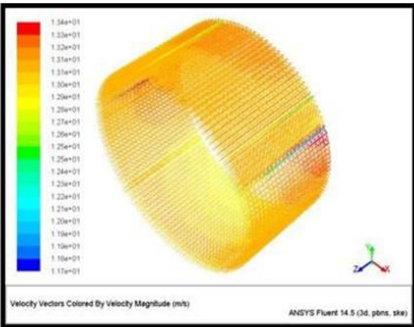




Microsoft Word window: THERMO HYDRODYNAMIC ANALYSIS OF PLAN JOURNAL BEARING BY USING CFD- FSI-APPROACH - Microsoft Word

circumference of the journal shaft of the journal bearing is shown in above fig, respectively for long and short journal bearing.

VELOCITY MAGNITUDE



Velocity Vectors Colored By Velocity Magnitude (m/s)
ANSYS Fluent 14.5 (3d, p6ns, s6k)

According to pressure counters the maximum velocity is $1.34e+01$ m/s at one end portion of the journal bearing and minimum velocity $1.17e+01$ m/s at another end of the journal bearing.

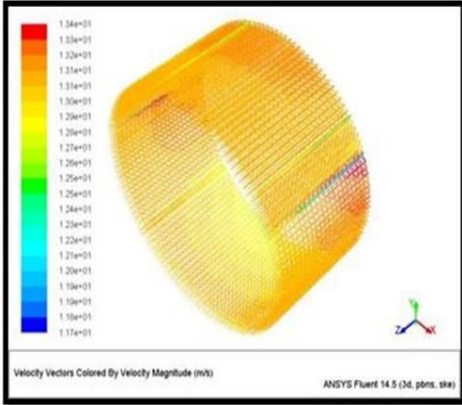
HEAT TRANSFER COEFFICIENT

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circumference of the journal shaft of the journal bearing is shown in above fig, respectively for long and short journal bearing.

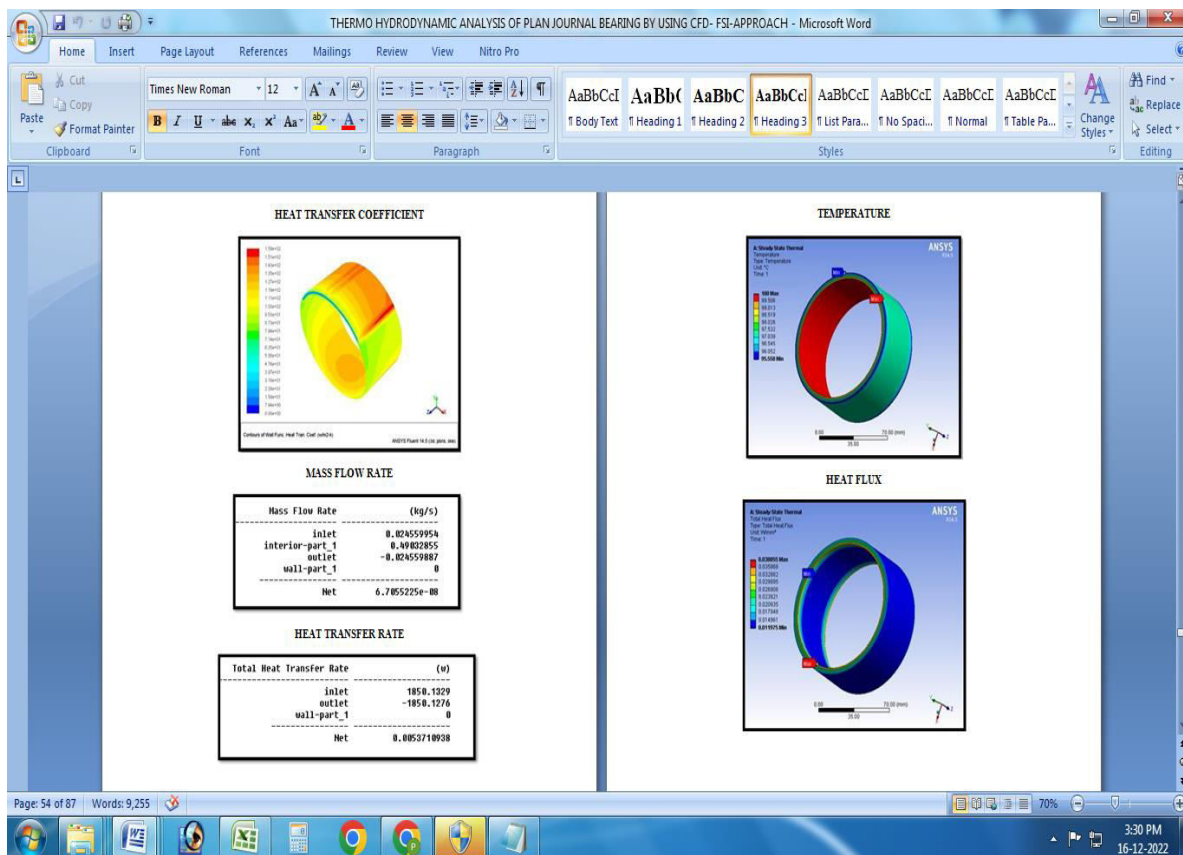
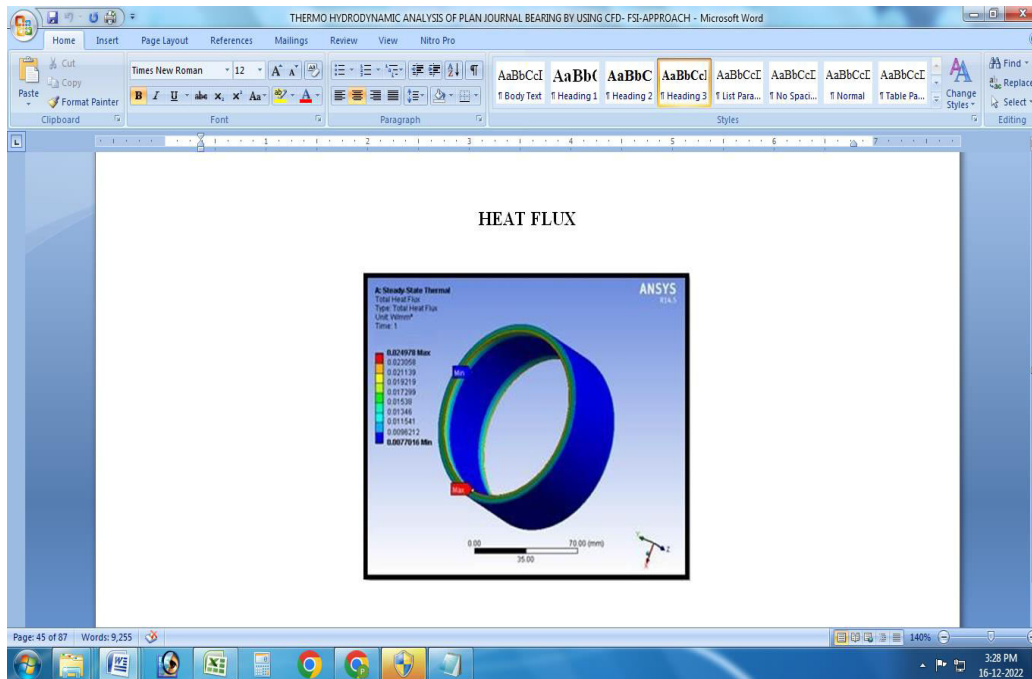
VELOCITY MAGNITUDE

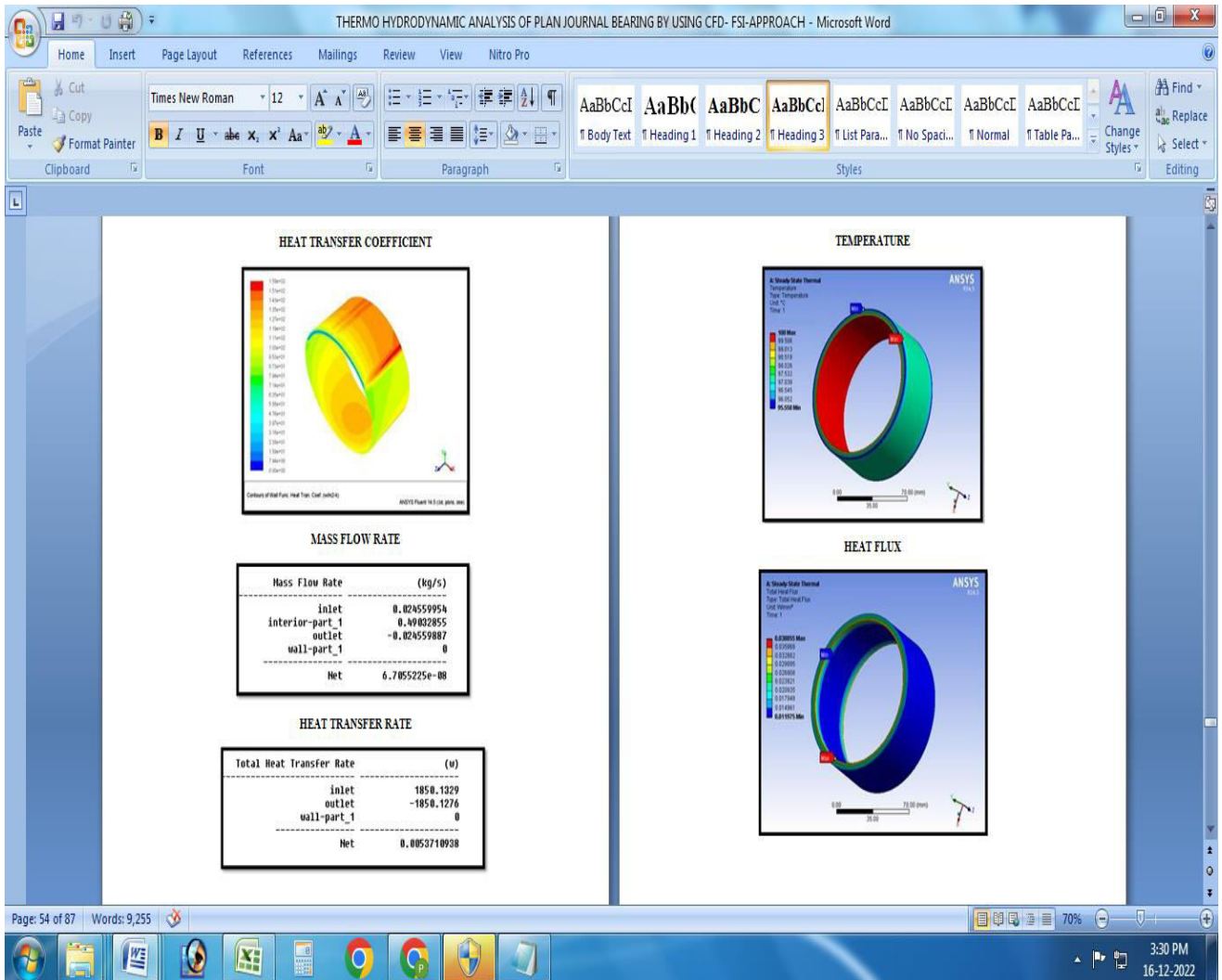


Velocity Vectors Colored By Velocity Magnitude (m/s)
ANSYS Fluent 14.5 (3d, p6ns, s6k)

According to pressure counters the maximum velocity is $1.34e+01$ m/s at one end portion of the

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V. RESULTS TABLE

Speed- 2500rpm

Ecce n tricity	Fluid	Pressur e (Pa)	Velocit y (m/s)	Heat transfe r coefficient (w/m ² - k)	Mass flow rate (kg/s)	heat transfer rate (w)	Tempe rature (K)	Heat flux (w/mm ²)
0.8	Air	4.29E+01	1.68E+01	3.39E+00	7.206e-7	0.2101593	100	0.024978
	helium	2.74E+01	1.34E+01	1.01E+00	4.059e-6	0.103042	100	0.07993
1	Air	4.93E+01	1.38E+01	9.92E+00	4.039e-6	0.200172	100	0.02454
	helium	3.34E+01	1.73E+01	3.17E+00	3.3644e-8	0.218414	100	0.04003



1.5	Air	6.75E+01	1.35E+01	9.54E+00	4.1387e-	0.31195	100	0.0236
	helium	5.19E+01	1.68E+01	3.06E+00	1.672e-			
				1	6			
				2	7			

VI. CONCLUSION

In this thesis, Thermo hydrodynamic journal bearings are analyzed by using Computational fluid dynamics (CFD) and fluid solid interaction (FSI) approach on different models by varying L/D ratios and eccentricity ratios using ANSYS in order to evaluate the fluid pressures, velocity, heat transfer coefficient, mass flow rate, heat transfer rate, temperature distribution and heat flux. Journal bearings for different eccentricities are modeled in 3D modeling software Pro/Engineer. The eccentricities considered are 0.8, 1.0 and 1.5 at different fluids (air and helium).

By observing the CFD analysis results, the pressure is increasing by increasing eccentricities thereby increasing the thermal flux values. Heat transfer rate values are increasing by increasing the speed by the fluid air. Mass flow rate more value at eccentricity 1.0 by the fluid air at 5000rpm. Heat transfer coefficient values are more for eccentricity 0.8 and fluid helium and thermal flux values are more for eccentricity 0.8 and fluid helium. So we concluded the thermo hydrodynamic journal bearing, the suitable eccentricity is eccentricity 0.8 and increases the efficiency by using helium when compare the air.

REFERENCES

1. Elasto-thermo hydrodynamic lubrication analysis of full 360 journal bearing using CFD and FSI techniques by B. S. Shenoy, R. S. Pai, D. S. Rao, R. Pai, ISSN 1 746-7233, World Journal of Modelling and Simulation Vol. 5 (2009) No. 4, pp. 315-320
2. Analysis of Thermo hydrodynamic Journal Bearing Using CFD and FSI Technique by Priyanka Tiwari, Veerendra Kumar, www.ijert.org, Volume/Issue: Vol. 3 - Issue 7 (July - 2014), e-ISSN: 2278-0181
3. JOURNAL-BEARING DESIGN AS RELATED TO MAXIMUM LOADS, SPEEDS, AND OPERATING TEMPERATURES by Samuel A. McKee, Part of Journal of Research of the National Bureau of Standards, Volume 19., October 1937
4. Journal bearing performance and metrology issues by S. Sharma, D. Hargreaves, W. Scott, Journal of Achievements in Materials and Manufacturing Engineering.
5. Analysis of a Rough Elliptic Bore Journal Bearing using Expectancy Model of Roughness Characterization by P.C. Mishra
6. P. Allaire, J. Nicholas, E. Gunter. Systems of Finite Elements for finite bearings. ASME Journal of Lubrication, Technology, 1972, (99): 187-197.
7. P. Bhat, B. Shenoy, R. Pai. Elasto-thermo hydrodynamic Lubrication Analysis of a Radially Adjustable Partial Arc Bearing Using Fluid Structure Interaction. in: Proc. of ASME/STLE International Joint Tribology Conference, San Diego, California, US, 2007, 1-3. IJTC'07, IJTC44479.
8. J. Booker, K. Huebner. Application of Finite Element Methods to Lubrication: an Engineering Approach. ASME Journal of Lubrication Technology, 1972, (94): 313-323.
9. P. Brajdic-Mitidieri, A. Gosman, et al. CFD Analysis of a Low Friction Pocketed Pad Bearing. ASME Journal of Tribology, 2005, 127(4): 803-812.
10. P. Chen, E. Hahn. Use of Computational Fluid Dynamics in Thermo hydrodynamic Lubrication. Proceedings of Institute of Mechanical Engineers: Part J, Journal of Engineering Tribology, 1998, (6): 427-435.
11. Thermo-thermo hydrodynamic Analysis of a Journal Bearing Using CFD as a Tool Mukesh Sahu, Ashish Kumar Giri, Ashish Das



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