International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **05** Special Issue **01** | **2020**

Design and Application of Gas Foil Bearing

[1]Mr. Tushar G. Mangale, [2]Prof. Y.A.Kharche, [3]Prof. S.R.Shekokar, [4]Prof. N.A.Kharche

[1] *M.E. Student, Department of Mechanical Engineering, Padm. Dr. V.B. Kolte College of Engineering, Malkapur , India*

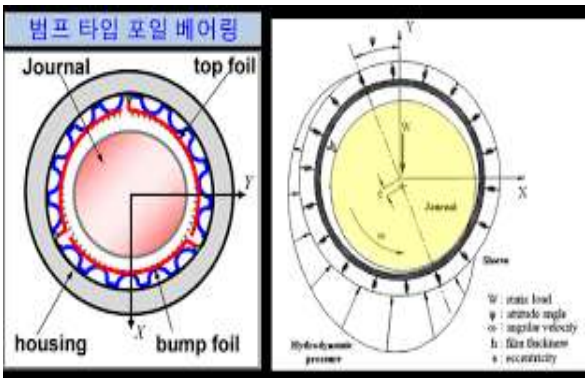
[2 3 4] *Assistant Professor, Department of Mechanical Engineering, Padm. Dr. V.B. Kolte College of Engineering, Malkapur , India.*

ABSTRACT

Foil bearings or gas foil bearings (GFB) comes under the category of air bearings. Here the shaft is supported by a thin foil journal lining. Once the shaft moves at high speed the fluid film pushes the shaft away to avoid contact. Shaft and foil are separated by high pressure fluid film (here ambient air in most cases) generated by rotation which pulls air into the bearing via viscosity effects. High speed of rotor with respect to the bearing creates this initial air gap which prevents wear and tear. Unlike aero and hydrostatic bearings GFBs do not need external pressurized system for working fluid hence these are self- staring bearings.

1. INTRODUCTION

Micro turbo machinery demands gas bearings to be light compact and should operate at varying temperature conditions. Gas bearings offer reduced heat generation low friction and don't require sealing and lubricant circulation system hence are compact, reliable and light weight also they eliminate process fluid contamination and are sustainable and eco-friendly, therefore GFBs with high stiffness and damping coefficients and low cost will enable it for commercial usage; but high cost and lack of sufficient knowledge and predictive tools have denied use of GFBs in mass produced applications. Low load carrying capability and minute film thickness causes its fabrication and installation costs money as well as time. Poor damping capacity due to low viscosity of air is another disadvantage.



2. LITERATURE SURVEY

Based on the literature review it is quite clear that many works have been carried out and completed in analysis of gas foil bearings. For the fluid film thickness (in this case air) the help of Reynold's equation is used and subsequently using finite difference method or similar numerical methods the pressure profile is calculated. And using these pressure values dynamic coefficients of foil bearings like stiffness and damping coefficients are calculated. In most of the models developed as of now top foil and bump foil is assumed as an elastic foundation structure and its static stiffness is oftenignored.

Here an attempt is made to design CAD model of a bearing and analyze it to obtain its static deflection under the influence of a normal load. After obtaining deflections at multiple loads one can easily obtain static stiffness.

Carpino and peng calculated stiffness and damping coefficients of a foil bearing supported elastically. Ambient gas is used as fluid film and properties are obtained by Reynold's equations. Structural model is designed and both the equations fluid and structural are coupled and perturbation method is deployed to obtain dynamic equations. FDM has been used to calculate all coefficients and it is found that the elastic foundation reduces these coefficients and these coefficients are very much important in determining rotor shaft stability and calculations of rotor dynamics. As this methods calculates all above coefficients in general manner from perturbation equations numerical errors are less and accuracy is more.

3. IDENTIFICATION OF RESEARCH GAP

For the fluid film thickness (in this case air) the help of Reynold's equation is used and subsequently using finite difference method or similar numerical methods the pressure profile is calculated. And using these pressure values dynamic coefficients of foil bearings like stiffness and damping coefficients are calculated. In most of the models developed as of now top foil and bump foil is assumed as an elastic foundation structure and its static stiffness is oftenignored.

4. PROBLEM IDENTIFICATION

Foil bearings were first developed in the late 1950s by AiResearch Mfg. Co. of the Garrett Corporation using independent R&D funds to serve military and space applications. They were first tested for commercial use in United Airlines Boeing 727 and Boeing 737 cooling turbines in the early and mid- 1960s.[3] Garrett AiResearch air cycle machine foil bearings were first installed as original equipment in 1969 in the DC- 10's environmental control systems.

Garrett AiResearch foil bearings were installed on all US military aircraft to replace existing oil-lubricated rolling- contact bearings. The ability to operate at cryogenic gas temperatures and at very high temperatures gave foil bearings many other potential applications.[4]

5. MAIN OBJECTIVES

- Develop CAD models of a bump-type gas foilbearing.
- Finite element analysis of GFBs.
- Calculate stiffness values for different GFBs
- Deflections for different load values
- Static structural analysis

6. APPLICATIONS

Turbomachinery is the most common application because foil bearings operate at high speed The main advantage of foil bearings is the elimination of the oil systems required by traditional bearing designs. Other advantages are:

- Higher efficiency, due to a lowerheat loss to friction; instead of fluid friction, the main source of heat is parasitic drag
- Increased reliability
- Higher speed capability
- Quieter operation
- Wider operating temperature range (40–2,500 K)
- High vibration and shock load capacity
- No scheduledmaintenance
- No external support system
- Truly oil free where contamination is an issue
- Capable of operating above critical speed

7. REFERENCES

[1] *Giri L. Agrawal (1997). "Foil Air/Gas Bearing Technology — An Overview" (PDF). Publication 97-GT-347. American Society of Mechanical Engineers.*
[2] *Giri L. Agrawal (July 1998). "Foil Bearings Cleared to Land" (PDF).1978-1980 (120). Archived from the original (PDF) on 15 April 2016.*
[3] *M. A. Barnett and A. Silver (September 1970)."Application of Air Bearings to High-Speed Turbomachinery". Technical Paper No. 700720. Society of Automotive Engineers.700720.*
[4] *Heshmat, Hooshang(September 2005). "Major Breakthrough in Load Capacity, Speed and Operating Temperature of Foil Thrust Bearings". Technical Paper No. WT2005-63712. American Society of Mechanical Engineers. WT2005-63712. Archived from the original on 2008-02-14. Retrieved 2006-09- 25.*
[5] *R. M. "Fred" Klaass and Christopher DellaCorte (2006). "The Quest for Oil-Free Gas Turbine Engines". SAE Technical Papers. SAE. 2006-01-3055. Archived from the original on 2007-09-30.Retrieved2007/08/18.*
[6] Some early history is reported in Giri L. Agrawal (1997), "http://www.rddynamics.com/pdf s/foil-97-gt-347.pdf — An Overview" (PDF). Publication 97- GT-347. American Society of Mechanical Engineers.
[7] *Rowe, W. Brian (2012). Hydrostatic, Aerostatic and Hybrid Bearing Design. Butterworth-Heinemann. pp.1–4. ISBN 0123972396.*
[8] *Girard, L. Dominique(1852).* "Hydrostatic nut and lead screw assembly, and method of forming said nut", issued 1994-12-29