iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: V Month of publication: May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34734

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Analysis on Active Hydromagnetic Journal Bearing using Ansys

Yuvaraj Ballal[1], Sourabh Patil[2], Nandkumar Mohite[3], Ashish Pawar[4], Rajnandini Patil[5], Pranav Mohite[6], Shubham Shetake[7]
[1, 2, 3, 4, 5, 6]Annasaheb Dange College of Engineering and Technology, Ashta, Maharashtra.

Abstract: In this study Active hydromagnetic journal bearing is designed and analysed by using ANSYS tool. Active Hydromagnetic journal bearing is a combination of Hydrodynamic journal bearing & Active magnetic bearing. We know that hydrodynamic journal bearing used to low speed and high load carrying capacity & its drawback is at high-speed shaft surface is come in contact and there wear also happen. In this condition hydrodynamic bearing also damages from contaminants as dirt or ash, also in the rise in temperature. In the active magnetic bearing is used to high speed and low load carrying capacity. When increasing load carrying capacity of active hydromagnetic bearing, it also increases design of active hydromagnetic bearing. When combining Hydrodynamic journal bearing & Active magnetic bearing it reduces drawback of both bearing. It working on high speed and high load carrying capacity. When combining both bearing considering main parameter is clearance in hydrodynamic journal bearing & Air gap in active magnetic bearing.

I. INTRODUCTION

Rotating machinery is incredibly common and wide utilized in the trendy industrial world. Steam turbine, compressors, pumps and jet engines are the foremost renowned and unremarkably used rotating machinery. Within the application of rotating machines one in all the key issues to be resolved, is that the safety and stability regarding rotor dynamics. “The high-speed machine is utilized in machining, that may be promising advanced producing technology for minimise cost and increasing productivity. Motorised spindle wont to attaining larger accuracy, that demands rotating machinery to run at high speeds, because of high heat generation the bearing. In trendy engineering technology fluid mechanics and magnetic bearing innovated in several ancient support forms have several benefits like long life, high speed, precision, no friction and abrasions. Hydrodyanamic and magnetic bearings are utilized in many industrial applications like machine operation and fossil fuel handling. They are additionally utilized in the turbo molecular pumps, and energy storage systems of high speed flywheels.”[10]. Active hydromagnetic journal bearing (AHJB) is new and innovative kind of bearing, that is employed to retain move shafts from low to high speed operations. It’s a mix of hydrodynamic journal bearing (HJB) and active magnetic bearing (AMB). The active hydromagnetic journal bearing is used for the active stability control of the rotor bearing system as well as to increase the load carrying capacity of the bearings. In the following section, the properties and performance characteristics of the hydrodynamic parts are given. Subsequently the active magnetic bearing properties, characteristics additionally given. In term of its mathematics and, operation and its dynamic properties.

II. BEARING DESIGN

A. Hydrodynamic Journal Bearing Geometry

In rotor-bearing systems hydrodynamic journal bearings are widely used as with excellent properties.

1) Raimondi And Boyd Method

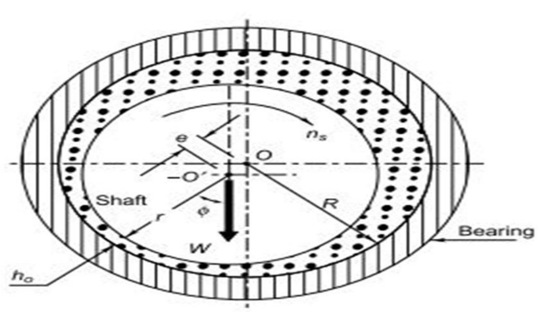


Fig No.1- hydrodynamic journal bearing

©IJRASET: All Rights are Reserved

where,
c = radial clearance (mm)
R = radius of bearing (mm)
r = radius of journal (mm)
e = eccentricity
ho = minimum film thickness (mm)

B. Selection Of Parameters

1) length-to-diameter ratio

a) When (l/d) >1, the bearing is called 'long' bearing.
b) When (l/d)<1, the bearing is called 'short' bearing.
c) When (l/d) =1, the bearing is called 'square' bearing.

2) Unit Bearing Pressure: The unit bearing pressure is,load per unit of projected area of the bearing in running condition. The unit bearing pressure for starting conditions should not exceed 2 N/mm2.

3) Startup Load: It mainly consists of the dead weight of the shaft and its attachments. The start up load used to determine the minimum length of the bearing on the basis of starting conditions.

4) Radial Clearance: The practical value of radial clearance is 0.001 mm per mm of the journal radius.

Material	*Radial clearance*
Babbitts	(0.001) *r* to (0.00167) *r*
Copper–lead	(0.001) *r* to (0.01) *r*
Aluminium–alloy	(0.002) *r* to (0.0025) *r*

Chart No. 1 – Selection of radial clearance

5) Minimum oil Film Thickness: There is a lower limit for the minimum oil film thickness, below which metal to metal contact occurs and the hydrodynamic film breaks. This lower limit is given by, h0 = (0.0002)r

6) Maximum oil Film Temperature: The lubricating oil tends to oxidise where the operating temperature exceeds 120°.

C. Theory (Hydrodynamic Journal Bearing)

1) Sommerfeld No.(S)

The Sommerfeld number is given by,
Sommerfeld No.(S) = [μ*N(rps)]*(r/c)^2/P]

where,
S = Sommerfeld number (dimensionless)
μ = viscosity of the lubricant (Ns/mm2)
N = journal speed (rps)
p = unit bearing pressure, (N/mm2)

2) Load Carrying Capacity (W)

Load Carrying Capacity (W) = [μ*N(rps)*L*D]*(r/c)^2/S]

Where,
W = Load Carrying Capacity(Radial Load)
S = Sommerfeld number (dimensionless)
μ = viscosity of the lubricant (N-s/mm2)
N = journal speed (rps)
r = radius of journal (mm)
c = radial clearance (mm)
L = Length of bearing
D= Diameter of bearing

©IJRASET: All Rights Reserved

3) Coefficient of friction variable, frictional torque and frictional power

Coefficient of friction variable (CFV) = (r/c)*f
[CFV value taken from RAIMONDI AND BOYD charts]

Where,
f = coefficient of friction
The frictional torque is given by Mt= fWr N-mm.
Frictional power = (2πN) (fWr) N-mm/s
= (2πN) (fWr) (10^–3) W
= (2πN) (fWr) (10^–6) kW

= (2πN) (fWr) /10^6 kW

4) Flow of Lubricant

The flow variable (FV) is given by,
FV = Q/(r*c*N*L)

Where,
L=length of bearing
Q=flow of variable (mm^3/s)
Given in the RAIMONDI AND BOYD chart.

5) *Maximum Pressure of Oil:* The maximum pressure (Pmax) developed in the film is calculated from the ratio (P/Pmax), Given in the RAIMONDI AND BOYD chart.
6) *Temperature Rise:* The total heat generated in the bearing is carried away by the total oil flow in the bearing, the expression for temperature rise can be given by,

Taverage = Ti +(dt/2)

Where,
Ti = initial temperature
dt = 8.3*P*(CFV)/(FV)

D. Theory (Active Magnetic Journal Bearing)

Active magnetic bearing is composed of four horseshoe-shaped electromagnets.
This configuration is shown in fig. the four magnets are arranged evenly around a circular shaft that can be levitated, which is made from a ferromagnetic material, such as iron. Each horse shoe shaped ferromagnet can produce a force that attracts the journal to it, and thus, all four electromagnets must act in concert, to produce a force of arbitrary magnitude and direction on the rotor.

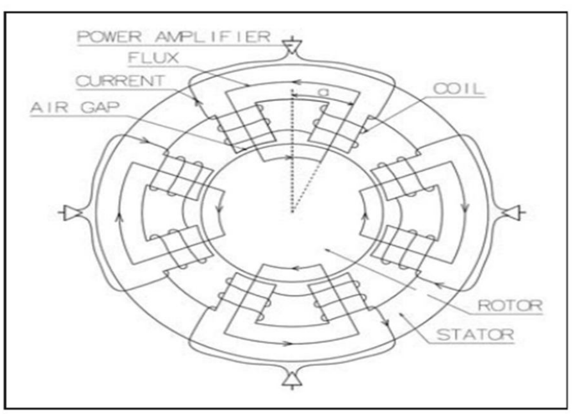


Fig N0. 2- Active magnetic journal bearing

©IJRASET: All Rights Reserved

E. Active Magnetic Journal Bearing

1) *Selection of Flux Density:* For electroplated FeCuNbCrSiB film flux density of 1.6T – 1.7T. for design of model took average of value is,

Where,

B = flux density(Tesla)

Why:

a) The thickness of the as-deposited electroplate FeCuNbCrSiB film is 4 µm.
b) due to eddy current effect the skin effect become stronger in thicker magnetic thin film at high frequencies .

Estimate the flux density in air gap Bg and also assuming 10% leakage.

Bg = 0.9

2) *For The Known Load Capacity Calculate The Force Per Pole*

For the design we take a three active pole,

Pole pitch = α = (360/p)

=(360/8)

= 45°

Hence,

F = F1 + 2(F1*cos 45°)

= 2.41*F1

Using the expression for force in terms of flux in the gap is,

F1 = (Bg^2 * A) / (2μ0)

Where,

Bg = magnetic flux density in air gap

μ0 = magnetic permeability of the vacuum

A = cross-sectional area of the stator pole

To find required cross-sectional area of the stator pole expression is interchange,

A = (2*μ0*F1) / (Bg^2)

3) *Determine no. of Winding Per Pole*

F1 = (μ0*Nw^2*I^2*A) / (8*g)

Where,

μ0 = magnetic permeability of the vacuum

Nw = No. of winding per pole

I = current (5A)

g = Air gap (1 mm)

4) *Calculations of Width of Pole, Length of pole, back iorn(Radial Width)*

Width of pole (Wp) = A/Lb

Length of the pole (Lp) = (1 – 1.5) Wp

Used 1.25 it average between 1 to 1.5.

Calculate back iron (radial width)

Wbi = 0.5 Wp

©IJRASET: All Rights Reserved

5) Calculate outer Diameter of Stator

Dst = Di + 2(Wpi + 1.15hw) …….{research paper_ radial active magnetic bearing design optimization }

Where,

Dst = stator outer diameter
Di (internal diameter) = journal diameter + air gap
Lp (pole length)
Lp = hw + 0.15 hw

6) Wire Diameter (dw)

((N*dw) / Lp) ≥ 1 …….(research paper optimization of 8 pole active magnetic bearing)

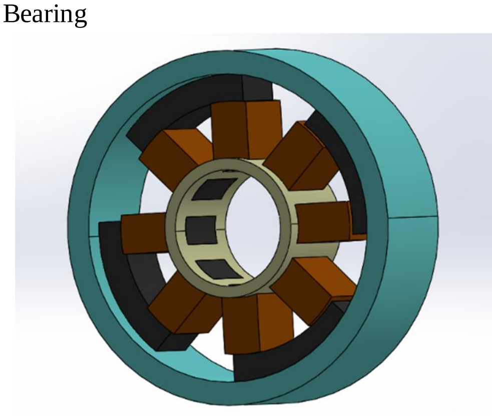
Where,

N = number of turns
dw = wire diameter
Lp = length of pole

Total coil thickness (t)

t = (2 * dw) + Wp
where,
dw = wire diameter
Wp = wodth of pole

Design of Active Hydromagnetic Journal Bearing



III. RESULT

Sr.No	Revolution	Total deformation	Equivalent stress	Equivalent elastic strain	Maximum principal stress	Maximum principal elastic strain
	rpm	m (10^-7)	Pa (10^6)	10^-5	Pa (10^6)	10^-5
1	500	3.0321	1.8517	1.3506	1.2100	1.3104
2	1000	3.0391	1.8539	1.3536	1.2128	1.3134
3	1500	3.0507	1.8577	1.3587	1.2173	1.3185
4	2000	3.06699	1.8629	1.3658	1.2237	1.3255

©IJRASET: All Rights Reserved

IV. CONCLUSION

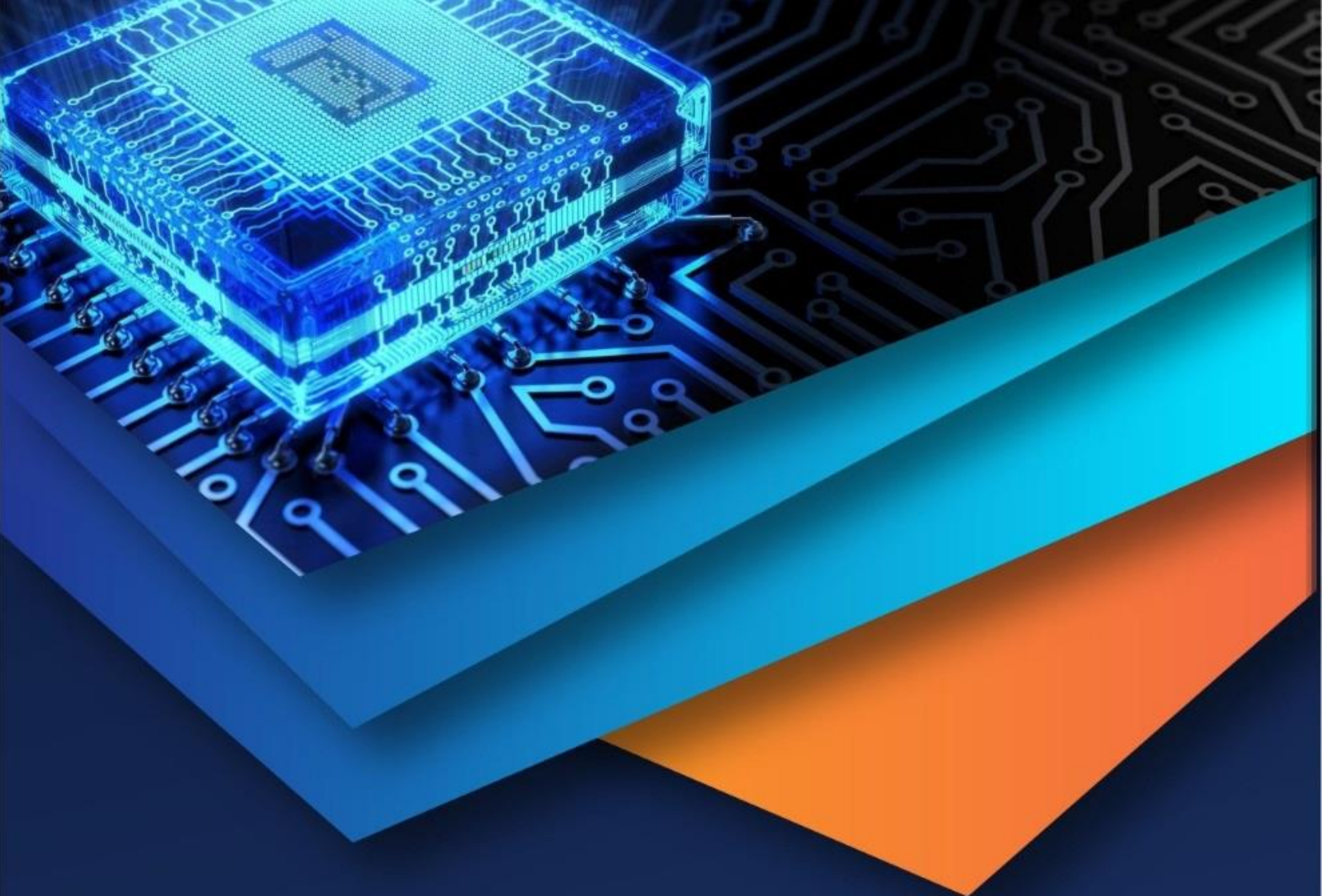
From the static structural analysis results,

A. Total deformation for 500, 1000, 1500, 2000 rpm revolution is permissible so designed active hydromagnetic bearing is safe.
B. Equivalent stress for 500, 1000, 1500, 2000 rpm revolution is permissible so designed active hydromagnetic bearing is safe.
C. Equivalent elastic strain for 500, 1000, 1500, 2000 rpm revolution is permissible so designed active hydromagnetic bearing is safe.
D. Maximum principal stress for 500, 1000, 1500, 2000 rpm revolution is permissible so designed active hydromagnetic bearing is safe.
E. Maximum principal elastic strain for 500, 1000, 1500, 2000 rpm revolution is permissible so designed active hydromagnetic bearing is safe.

REFERENCES

[1] Arjun panthi, prof. Jai balwanshi, prof. Ajay chandravanshi, prof. Gourav gupta, "Design and analysis of hydrodynamic journal bearing using raimond and boyd chart" International journal of core engineering & Management (ijcem), volume 2, issue 3, June 2015, page 109-120.
[2] Shubham Naikawad, "study of active magnetic bearing", International journal of engineering and technical research (ijetr), volume 4, issue 4, April 2016, page 36-39.
[3] Swapnil m. pawar, s.g.jadhav, v.m.phalle "CFD analysis of two lobe hydrodynamic journal bearing", international journal of engineering development and research (ijedr), volume 2, issue 3,2014, pages 2974-2979.
[4] S.M.Muzakkir, k.p.Lijesh " studies on control aspects of active magnetic bearings", international journal of current engineering and technology, vol 15,no 4, Aug 2015,pages 2465-2471.
[5] D.y.Dhande, d.w.pande, "multiphase flow analysis of hydrodynamic journal bearing using CFD coupled fluid structure interaction considering caviation", journal of king saud university-engineering sciences, 26 september 2016,pages 1-10.
[6] Janardhan chander matlapudi, prudhvi kanth gunti, datta sriiam sigatapu, niranjanabehera, "evalution of static and dynamic characteristics of hydrodynamic spiral-grooved journal bearings using CFD", engineering review, vol.39, issue 2, 2019, pages 197-204.
[7] Dr. P. srinivasulu, Mr. P. Raju, muralimohan muthyala," design and analysis of thermo hydro dynamic plain journal bearing by using fsi tool", international journal of innovative technology and research, volume no.5, issue no.6, octomber-november 2017, pages 7475-7479.
[8] MG Farmakopolus,PG Nikolakopoulos,CA Papadopoulos, "Design of an active hydromagnetic journal bearing", archive proceedings of the institution of mechanical engineers part j journal of engineering tribology, 9 octomber 2012,pages 673-694.

©IJRASET: All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)