# Design of a Pressurized Air Bearing

**Prof. S. M. Pimpalgaonkar[1] Iandrajit A. Thakare[2] Harshal N. Mate[3] Akshay D. Harane[4]**
[1,2,3,4]Department of Mechanical Engineering
[1,2,3,4]Priyadarshini Bhagwati College of Engineering Nagpur, India

*Abstract*— High speed applications are common in machine tools, rocket engines, turbo-chargers, dental applications and high power density electric blocks. One of the major problems associated with high speed machines is frequent bearing failures. This is primarily because of the large number of cyclic loading the conventional bearing has to withstand. Gas bearings on the other hand are contact less bearings where the fluid film formed bears all the load and is continuously expelled out the system. This theoretically makes them completely wear free and renders them with a life of more than 15-20 years. In this project we design, simulate, fabricate and experimentally validate a pressurized gas bearing system for high speed flywheel energy storage system.

***Keywords:*** Flywheel, Magnet, Compressor, Potentiometer, Reduce friction, Increase life of bearing

## I. INTRODUCTION

Humans Worldwide, considerable focus is being given to the development of renewable energy technology to mitigate the use of fossil fuels in order to meet the increasing energy demands. For efficient utilization of available renewable energy in the form of solar, wind, geo-thermal, etc. it is imperative that a reliable energy storage system is incorporated, so that fluctuations in supply and demand can be smoothed out. Conventionally, this is achieved by chemical batteries, hydro storage, thermal storage, compressed air storage, hydrogen storage etc. Of these, battery storage has the best energy density, hence the least footprint. Even though conventional batteries like Li ion based systems are reliable, they are ridden with problems of high cost, low depth of discharge, limited number of cycles and temperature dependent efficiency. Flywheel energy storage (FES), which is the storage system proposed in this report, is a viable alternative to battery storage. Flywheel Energy Storage system is an alternative form of energy storage which can directly replace.

Battery storage from various power applications like unaltered power supply (UPS) etc. The concept of Kinetic energy storage via flywheel is not new and can be found in various applications like automobile etc. for smooth power delivery. These applications mostly require high power to energy ratio, i.e. energy is stored and delivered at a very fast rate. For long duration storage it is imperative that there is least amount of power dissipation because of friction. Most mechanical bearings have high losses due to friction and windage. Advance flywheels address this issue by using magnetic bearings. The flywheel in this case is suspended in air/vacuum with the help of an active electromagnet which exactly balance the gravitational force. The flywheel rotor position feedback goes to the controller, which then manipulates the electromagnet current required to balance the rotor mass. On these bearings there is no contact friction between the rotor and the stationary enclosure. To further reduce skin friction drag between the rotor and the ambient air, the enclosure is kept under partial vacuum. In this way, once the flywheel attains its maximum speed while charging, it can store this kinetic energy for very long durations with a loss of a few revolutions per minutes per day.

## II. LITERATURE REVIEW

For initializing this project, we searched different information regarding of pressurized air bearing with literature review of different research paper. In industries widely ball bearing fail due to high friction so this is overcome by pressurized air bearing.

[1]In this paper we found that during working of bearing due to friction small steel particles added in lubricant. In bearing high stresses produced and due to friction heat is generated so we eliminated lubrication. Major task of design is to achieve negligible friction.

[2]From this paper we found that in the foil gas bearing the pressure distribution in the lubricating film causes the flexible surface to deform, which, in turn, alters the pressure distribution. For this reason analogies drawn from rigid bearing theory do not necessarily apply.

[3]From this paper we find pneumatic stability of an externally pressurizes gas bearing was investigated using perturbation testing. Bode plot were used to determine the onset of instability, and full spectrum cascade plots were used to determine the air hammer vibration frequency.

## III. COMPONENTS & WORKING

### *A. Compressor:*

The main function of compressor is suck the air from atmosphere and compress to high pressurized air.

### *B. Neodymium magnet:*

It is use for lifting the weight of flywheel & use for energize coil.

### *C. Solar panel:*

It takes sunlight from the sun and produce electrical energy. These energy use for the purpose of energize copper coil.

### *D. Potentiometer:*

It is use to regulate the compress air flow and it maintain the fluid thickness between flywheel and bottom flywheel.
Dial gauge: It is use for measuring the lifted height of flywheel.

All rights reserved by *www.ijsrd.com* 

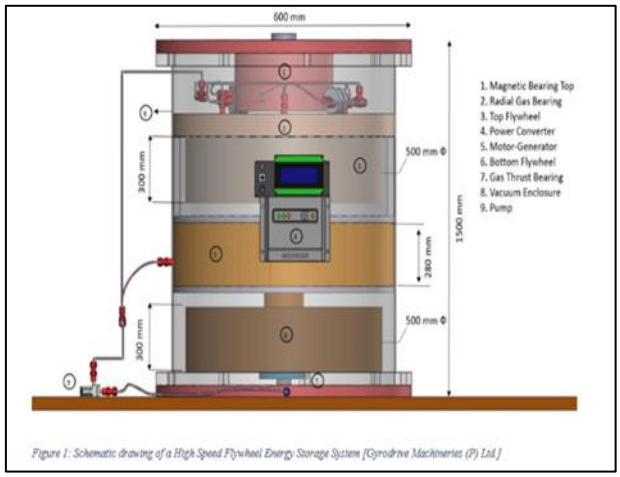


Fig. 1: Design of Pressurized Gas Bearing

## IV. WORKING METHODOLOGY

An air compressor takes air at atmospheric pressure and rises it to a higher pressure. This high pressure send through hose pipe to the pressurized gas bearing. This pressurized air flow maintain by potentiometer. The main application of this bearing flywheel storage system there is seven neodymium magnet. Which help us to near about 70 to 80 % lifted the weight of flywheel so load on compressor is less and flywheel rotate when copper coil is energies. Copper coil energies with the help of solar panel.

## V. VALIDATION

In ball bearing required continues lubrication that require inspector so it is eliminated in pressurized gas bearing there is no lubrication only use air , it is negligible viscosity as compare to other lubrication the life air pressurized gas bearing is 15-20 years more than conventional bearing. It is use in high speed machine like turbo machinery flywheel storage system, dental application , high speed application .it is safely to operator's.

## VI. CONCLUSION

In this project a gas thrust bearing system was designed using first principal micro-fluid equations as described in section 1. The derived equations for pressure assisted flow in a capillary restrictor and a circular pad bearing are used to design a bearing system for a particular load application. A thrust bearing system was designed using these equations and experimental analyses was performed, where the following observations were made

1) The theoretical bearing disc friction coefficient was within 1% of the experimental results.
2) The experimentally obtained bearing clearance is within 2% of the theoretically derived value.
3) The theoretically obtained pressure and velocity profiles match with the CFD analysis.
4) The experimentally obtained bearing stiffness matches with the theoretical values.

The designed gas bearing has a bearing friction coefficient which is 2 orders less than the conventional hydraulic bearings and three orders lower than the conventional ball bearings. The system compressed air requirement is very low (<1% of the system power) and hence it is advantageous for high efficiency applications. Since there is no contact between the bearing surfaces, this system has a very low wear and a very high life (> 15 years).

## REFERENCE

[1] The adverse effect of steel particle contaminants on fatigue of grease lubricated ball bearing, ISSN 1546-9239
[2] Externally pressurized foil gas bearing, E. J. BARLOW Member of the research staff, Ampex carporation, redwood city, calif.
[3] S.Jacob, J. (1997). Air-Hammer Instability of Externally Pressurized Compressible Fluid. Nevada: Bently Rotor Dynamics Research Corporation.
[4] Mohite, SS, Haneesh, K, Sonti, VR. Analytical solutions for the stiffness and damping coefficients of squeeze films in MEMS devices with perforated back plates. J Micromech Microeng 2005; 15: 2083–2092.
[5] Wei Ma, Jiwen Cui, Yongmeng Liu, Jiubin Tan, Improving the pneumatic hammer stability of aerostatic thrust bearing with recess using damping orifices, In Tribology International, Volume 103, 2016, Pages 281-288, ISSN 0301-679X, https://doi.org/10.1016/j.triboint.2016.06.009.
[6] Dhar E, Srivatsa S, Kumar P. Feasibility of a Direct Coupled Turbine-Compressor Power Block for S-CO2 Brayton Cycles. ASME. Turbo Expo: Power for Land, Sea, and Air, Volume 9: Oil and Gas Applications; Supercritical CO2 Power Cycles; Wind Energy ():V009T36A009. doi:10.1115/GT2016-56847.
[7] Abderafi Charki, K. D. (2013). Numerical simulation and experimental study of thrust air bearings with multiple orifices. International Journal of Mechanical Sciences, 28-38.
[8] D. Gerada et al., "High-Speed Electrical Machines: Technologies, Trends, and Developments," IEEE Trans. Ind. Electron., vol. 61(6), pp. 2946-2959, June 2014.
[9] A. Tenconi et al., "Electrical Machines for High-Speed Applications: Design Considerations and Tradeoffs," IEEE Trans. Ind. Electron., vol. 61(6), pp. 3022-3029, June 2014.
[10] E. Swanson et al., "A practical review of rotating machinery critical speeds and modes," Sound Vib. vol. 39, pp. 10–17, May, 2005.
[11] D. J. Ewins, "Modal Testing: Theory and Practice," vol. 359. 1984.

All rights reserved by *www.ijsrd.com* 