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Review on Air Bearings and Its Applications

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Abstract— ***Bearings are machine elements that allow components to move with respect to each other. A little consideration will show that some part of power wasted in overcoming the frictional resistance and due to the contact of surfaces large amount of wear and tear takes place between the contacted surfaces.Hence to avoid wear and tear in sliding contact bearing and to reduce frictional resistance the thin layer of fluid is introduced which is called as lubricant.Air bearing are introduced to reduce such frictional resistance and wear of sliding contact bearings.Air bearings are bearings that uses a thin film of pressurized air to provide low friction load-bearing interface between surfaces. There is small gap between two surfaces i.e. two surfaces do not touch. As these bearings are contact free various problems in traditional bearing like friction, wear, particulates, and lubricant handling are avoided. Also there are advantages like precision positioning, such as lacking backlash and static friction, as well as in high-speed applications.***

Keywords- ***Air bearing,sliding contact bearing***

I. INTRODUCTION

Air bearings are advanced technology in designing of bearing. Air bearings technologies are generally used coordinate measuring machines since two decades. An air bearing is such bearing which provide gas film to avoid the contact between the surfaces during their relative motion. The gas film is of air which provides lubrication between the surfaces. Types of air bearings: there are two major types of air bearing which are aerodynamic bearings and aerostatic bearings. The principle of aerodynamic bearings depends on relative motion between surfaces in contact and usually spiral groove used to draw air between the bearing lands. Aerodynamic bearings require relative motion between the surfaces, so there is problem found when bearing surfaces comes in contact at low speed or when there is no relative motion. Another name of aerodynamic bearings is foil bearings or self-acting bearings. The read-write head flying over a spinning disk, crankshaft journals, camshaft journals, and thrust bearings are examples of this type of bearing..

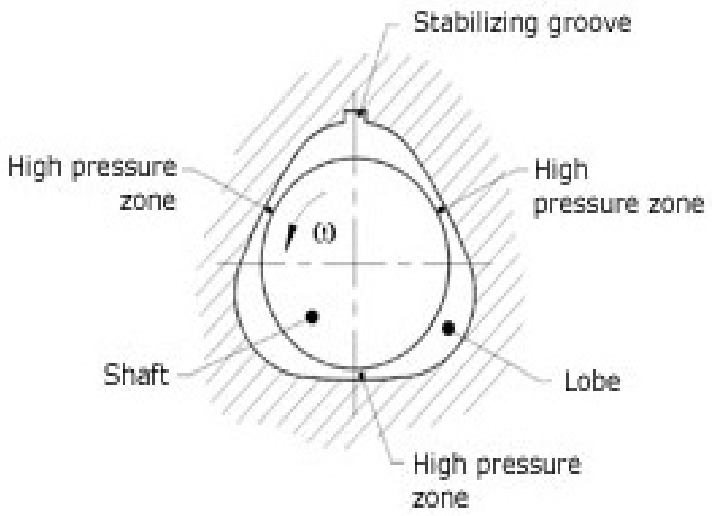

Fig1. Aerodynamic bearings

In aerostatic bearings, pressurized air is supplied between the bearing surface and precision hole, groove. The pressure of this air is maintained by external source. Since air pressure is maintained by external source so at low relative motion between the bearing surfaces or when there is no relative motion between them the air pressure is controlled.

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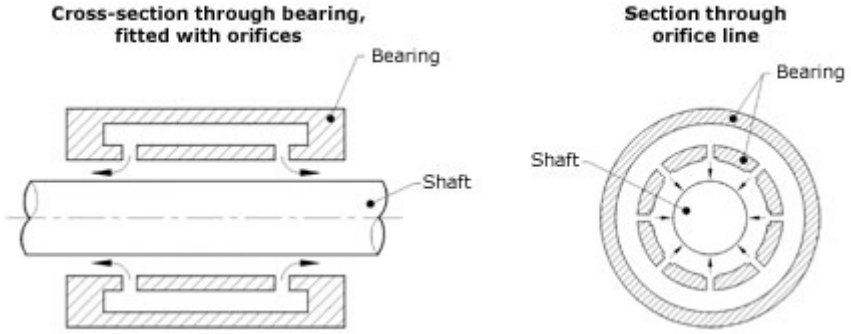

Fig 2.Aerostatic bearings

II. WORKING

The general perception of bearing in individual mind is ball bearing i.e. everybody is familiar to only ball bearing but in air bearing there is no any contact between the bearing surfaces. In Air bearing instead balls, there is cushion of air this mean air film acts as lubrication between surfaces and friction will be reduced .The gap depends upon types of air bearing used i.e. it may be aerodynamic bearings or aerostatic bearings.

III. ADVANTAGES

There are a lot of technical advantages of air bearings such as negligible friction and wear, high speed and high precision capabilities and no oil lubrication requirements. Till now these benefits are not properly utilized due to its manufacturing difficulties. New Technologies were found in manufacturing of air bearings. The porous media technology makes air bearings robust, simple to use, inexpensive, and available off-the-shelf. Some advantages over traditional bearing are:

Greater Precision: Air bearings provide excellent precision in both directions i.e. the rotation may be in axial or radial. Since there is no physical contact, wear is minimal, ensuring accuracy remains constant over time.

High Speed: Low shear forces within the air bearing allow extremely high rotational speeds with minimal loss of power and very low heat generation. Speeds can exceed 300,000 rpm.

Tool Life: By using air bearing the life of the tool increased.

Long Bearing Life: With no mechanical contact and a clean air supply, free from oil and water, bearing life is dramatically increased.

Low Thermal Growth: Low friction, constant air flow and efficient power transmission result in minimal thermal growth.

Lack of Maintenance: Only the very minimum of maintenance is required. A regular check of air supply and coolant systems is all that is necessary to ensure complete reliability.

Large Load Capacity: Air bearings can support heavy loads, allowing them to be applied to many industrial machine tool applications.

Reduced Vibration: Only minimal levels of vibration and audible noise are produced when running an air bearing spindle.

Cleanliness: Air is the only lubrication used; therefore, air-bearing technology is ideal where there must be no contamination of the work piece or working environment

IV. APPLICATIONS

A. High Speed Equipment

Machines are being designed today that have moving elements that may cycle as many times as one billion cycles per year. It is simply not reasonable to try to do accelerated life testing on such machines. Another alternative is to switch the mode of wear by changing the bearing technology from roller bearings to air bearings. In air bearings the speed or distance the bearing travels does not affect wear. The mode of wear in air bearings is erosion, so the amount of particulates in the incoming air is the determining factor in how long a bearing will last. Even assuming relatively dirty is used, the calculated life of an air bearing is measured in centuries regardless of whether it is moving at one billion cycles a year or remaining stationary. The dynamic coefficient of friction increases with speed and will only contribute heat problems at over 20 meters per second and then only in confined rotating applications

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B. Coordinate Measuring Machines

Most coordinate measuring machines (CMMs) are built with air bearings because they allow for infinite resolution. Because air bearings actually float on a pressurized film of air there is no physical contact. This means only the shear of the molecules contributes to friction. The static and dynamic coefficients of friction at startup are identical and there is no stick-slip effect. This minimizes lost motion and reversal errors around the triggering of the probe. And because air bearings are more repeatable and smoother than rolling element bearings error correction is more effective. Mechanically, this allows for infinite motion resolution (putting the controls engineer back on the hot seat.

C. High Speed Equipment

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D. Ultra Accurate Machine Tools

Many of the most accurate machine tools in the world employ air bearing technology. The zero static coefficient of friction allows for unmatched performance during stage reversal in contouring applications. Very accurate velocity control and elimination of perturbations in the stage movement allow for the turning of optical quality surface finishes that are measured on the angstrom level. Errors in geometries on manufactured parts are often on the order of several millionths of an inch. Linear Stages The benefits of air bearings, and porous media air bearing technology in particular, are

	•Oil Journal Bearings	•Air bearing	•Magnetic bearing
Working medium	–Oil	–Air	–Electric current
Shaft supported by	–Oil film	–Air pressure	–Magnetic field
Medium delivered by	–Oil pipes or sump	–Ambient air source	–Wires and cables
Bearing stability and characteristics defined by	–Oil film stiffness	–Air gap stability, foil stiffness and configuration	–MBC algorithms
Bearing stability control	–Passive	–Passive	–Active
Key support component	–Oil pump	–Shaft speed	–Controller amplifier
Support component back up	–None	–None	–Backup rolling element bearings and UPS battery back up
Bearing health monitoring	–Passive temperature sensor	–Passive temperature sensor	–Active position sensors, multiple temperature sensors, remote monitoring
Contacting	–At start up and low speed	–At start up and low speed	–Never
Inherent monitoring	–None	–None	–Temperature, vibration, proximity to surge, system stability
Cost	–Not applicable to wastewater industry	–Low	–High

V. CONCLUSIONS

A lot of studies and research have been done on air bearing. there are lot of advantages of air bearing over sliding contact bearing with large applications air baring concepts are ready to solve the problem of sliding contact bearing.with the comparison with other types bearings the air bearings has been explained

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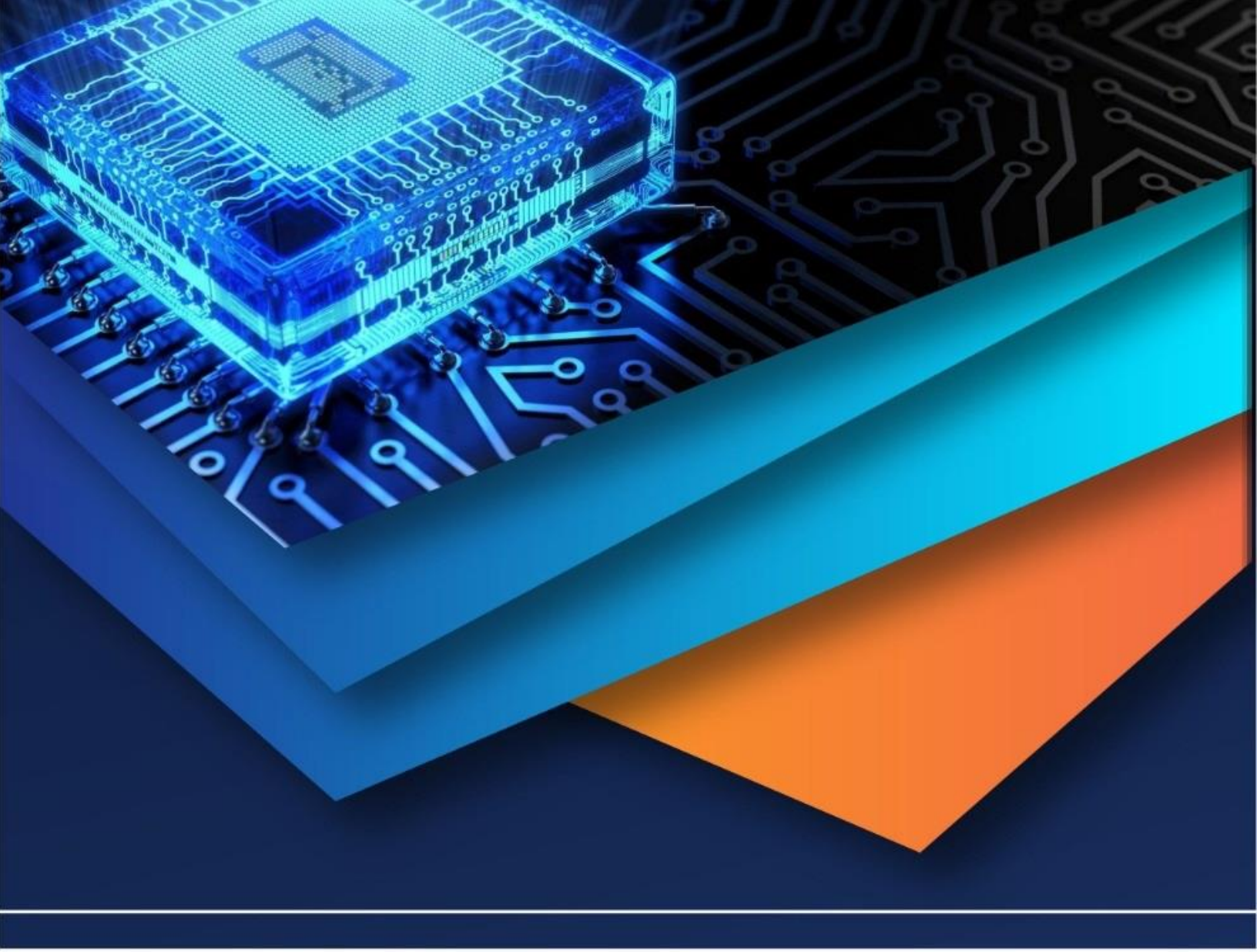

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