

BALL BEARINGS SELF-STABILIZING OIL PRESSURE BEARINGS

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Abstract – A bearing is a machine component which permits relative motion and decreases friction amongst two surfaces. Bearing is a component that supports, guides, and decreases the friction of motion between fixed and moving machine components. The term bearing is derived from the verb “to bear” it means “to support”. In this paper I have compiled and compared generic bearings with SSO bearings from “Noctua”.

Keywords – Hardware, Ball Bearings, SSO bearings.

I. INTRODUCTION

Bearings are used in a lot of industries but this paper is focused on are fan bearings used inside personal Computer fans and servers. So naturally the two most important prerequisites are silent operation and reliability. In here I cover most of the bearings used in personal computer fans and some from other industries.

All type of bearing has mainly 4 parts

- Outer race.
- Inner race.
- Rolling element (i.e., ball, roller, needle)
- Separator (retainer).

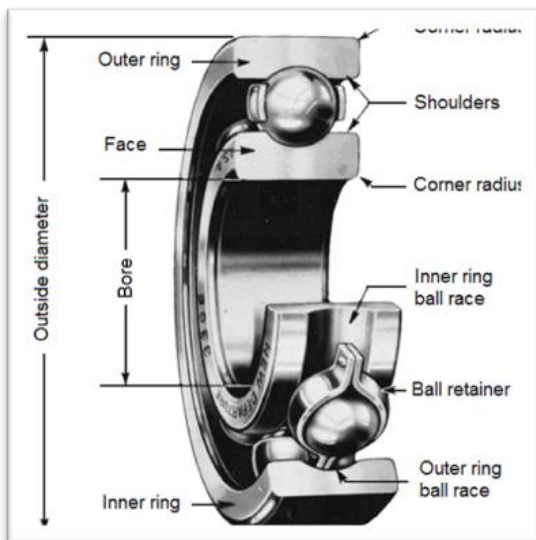


Fig1. Construction of a ball bearing

The main reason why bearings are used is that first they can transfer moment or force; and that they can be

substituted effortlessly and conveniently when they're broken. In a mechanical system, it is also possible to attach the shaft directly with housing.

However, when this system has a problem, the only possibility is to recuperate the function of the system and to displace the enclosure or the shaft.

Through the mechanical engineer perspective, both of these aren't only very costly but also frustrating to manufacture a fresh cover or shaft with the same guidelines.

But then again, if the bearings are being used in between them, the problems also change. Generally, there is undeniably no relative movement between internal ring or the outside ring and the shaft with concealment. So that there is less opportunity for the enclosure or shaft to be exhausted. Generally, the bearing first breaks and then your shaft or property is broken. In the event the above situation happens it is absolutely very easy to find it out. Just buy a fresh bearing from the marketplace with the same parameter and replace it with the old one. That is why bearings are frequently used.

II. HYDRAULIC BEARINGS

“Hydrostatic” and “hydrodynamic bearings” are bearings filled with fluid that depend on this thin film of any fluid like air / oil to make a smooth surface amongst the mobile and stationary elements to reduce friction losses. These Bearings might be comparable in form but “hydrostatic” and “hydrodynamic bearings” have very dissimilar principle of action when compared to regular bearings. Regular bearings have cheaper and elementary design and, in these bearings, the “shaft” is in direct connection with the exterior of the bearing throughout the process and they use a “lubricant” in order to decrease the resistance amongst the shells.

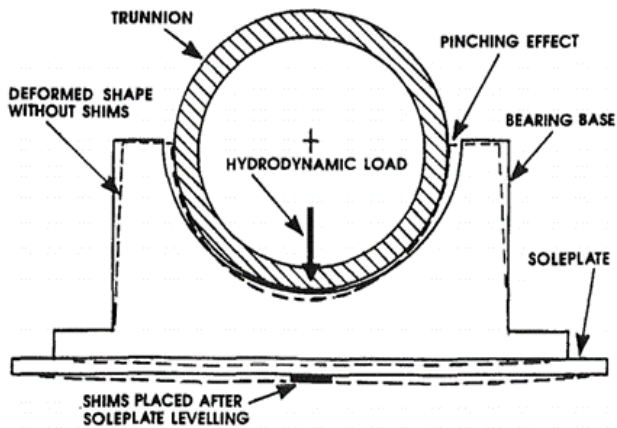


Fig2. Hydrodynamic load on a hydraulic bearing

Contrary to regular bearings, “hydrodynamic” & “hydrostatic bearings” are costly and complicated to fabricate and use.

Usual practice for hydrodynamic & “hydrostatic bearings” are slides and spindles of machines, basically works which need very accurate development and extreme rigidity.

“Hydrodynamic and hydrostatic bearings are both known as categories of fluid bearings and since there is no contact between the moving surface and the bearing directly, the heat generated during mechanism process is due to oil shear”.

“Hydrostatic” & “hydrodynamic bearings” can equally prop any given weight under some limit on a fluid-based film, the only difference between them is how that layer is generated.

III. HYDROSTATIC BEARINGS

These bearings use a “positive pressure supply” that maintain a gap amongst the moving & motionless parts in a machine setup. In hydrostatic bearings, the “lubrication” is present amongst rotating sides under pressure.

These types of bearings offer a very high rigorousness and durability, and are best suited for precise procedures.

“These bearings can accommodate substantial loads at low RPM’s as hydrostatic lubrication does not depend on relative motion to maintain the lubrication film.”

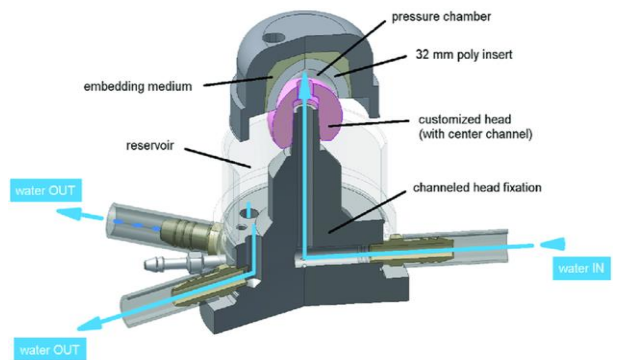


Fig3. Hydrostatic bearing with water supply

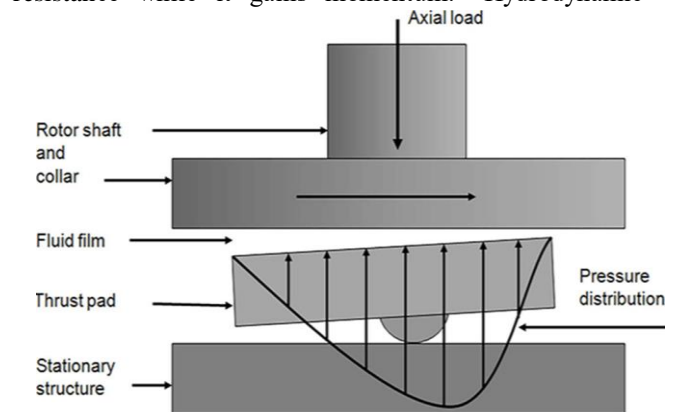
Hydrostatic Bearings are also able to deliver very high toughness in addition to energy degeneracy coefficients.

Depending on the application, hydrostatic bearings can be made to use in linear as well as rotary motion with radial loads. This makes them perfect to support parts in fluid pumps. The design of these bearings can get very complex and may require meticulous pressure and break regulator to operate appropriately.

IV. HYDRODYNAMIC BEARING

In these bearings the gap is created in a dynamic manner with rotation of the bearing. “Hydrodynamic bearings” can

be employed in rotating machines, & they might need exterior compression on any of the paddings or else a subordinate bearing can be used to evade additional resistance while it gains momentum. “Hydrodynamic



bearings” are intended for circular and thrusting weights.

Fig4. General working of a hydrodynamic bearing

A “hydrodynamic bearing” characteristically have a small gap assemblage which depends on some thin fluid film which creates interim when the shaft is revolving. These “bearings” diffuse weight on a “self-renewing film” of fluid (oil or air).

Most elementary “hydrodynamic ball bearing” is the “journal bearing.” It is designed as a cylinder-shaped “bore” usually with “2 axial indentations for lubrication”. Journal Bearings have a very elevated weight capability & its footprint is small, can rotate both sides, and low machining cost. With increase in machining rate, it is clear that these bearings have bottlenecks which requires amendments to the design.

Apparatuses which utilise “hydrodynamic lubricated bearings” must not suffer from extreme load in the starting phase. These “bearings” have several real world uses such as electric motors, gas turbines, refrigerating pumps, & grinders. These can also be used on ships in the various configurations and parts.

V. SPEED LIMITS

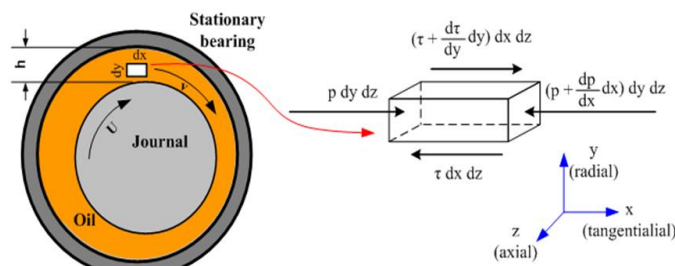


Fig5. Forces acting on a volume element in the hydrodynamic film

Hydrodynamic & hydrostatic bearings” just have viscous friction” linked with “fluid-based film layer of oil or air”, which gets “sheared” through the movement of these bearings. These bearings can also suffer hydrodynamic effects” in excessive velocity state and a considerable increase in temperature can be observed as a result.

The approximate maximum speed is 1,000,000 DN. The DN number describes the bearing diameter in mm (D) and top speed in rpm (N).”

VI. ACCURACY

The pivoted shoe concept was applied to journal bearings and wide-ranging assessments have proved that this is the most effective design.

The pivot surface is sphere-shaped to permit 360° rolling freedom and permits the “shoe” to revolve & develop a wedge. ‘Hydrodynamic pivoted shoe bearings’ deliver significant benefits. They have a smaller footprint, are cheaper, low maintenance, have a long lifetime, and are a lot more effective when compared to older design of bearings.

Accurateness of this type of “hydraulic bearings” can be found out by the precision of apparatuses used.

There are “linear hydraulic motion bearings” that were designed by means of very high accurateness in the range of submicron/meter.

VII. DAMPING AND STIFFNESS

“Hydraulic bearings” don’t share “loss of contact” troubles like “sliding and rolling contact bearings” have. Because of this film of oil (lubricant) in gap of bearings, they have outstanding dampening proficiencies in usual as well as “tangential bearing.”

“When air is used in the bearing gap, the low-viscosity film of air, gives bearings modest to low damping abilities in the normal and tangential bearing path, respectively.”

VIII. LUBRICATION

An appropriate “lubricant” should continuously be available in the moving parts to guarantee safe operation of “hydraulic bearings.”

It must be brought down in temperature to eliminate any heat produced from the “oil shear” & at the same time it should be warm enough to flow easily. To keep the size of particles lower than “minimum film thickness”, lubricant must be filtered before using in the hydraulic bearings.

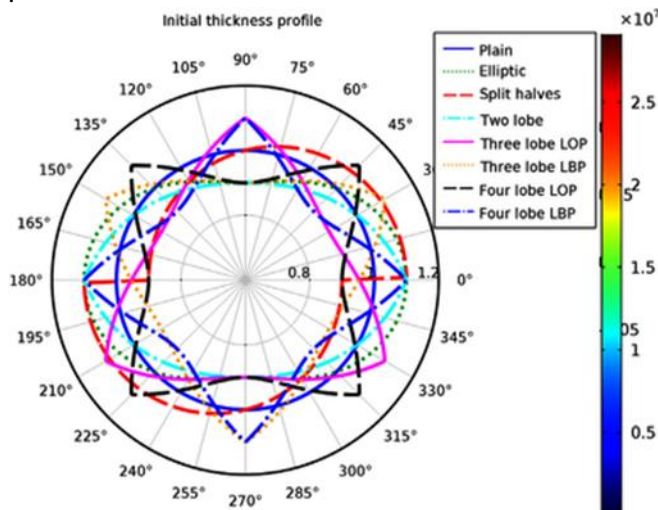


Fig.6. Performance of various Hydrodynamic Bearings

“The few basic categories of hydrodynamic bearings are circumferential groove bearings, pressure bearings, and multiple groove bearings. Hydrodynamic bearing feature high stiffness and long bearing life, and are often used for fine machining and finishing.”

IX. SELECTING A LUBRICANT

To make good usage of efficiency of high precision ball bearings, special attention should be paid to the appropriate bearing lubrication.

Maximum RPM and longest lifespan is established on the quality of “lubricating film” structure which lowers

resistance/friction between sliding & rolling segments.

1.Characteristics of a good lubricant

- Reduction of mechanical vibrations and sounds.
- Heat elimination
- Fastening effect
- Resilient to corrosion

Aptness for elevated velocity of contemporary lubricants permits the increasing usage of user friendly and monetary benefits of “grease lubrication”.

Functioning necessities that surpass the effectiveness of “lubricating greases” offer “oil-lubricated bearings” through supreme longevity at the highest RPM’s & temp varieties.

The compatibility of current high-speed grease at very high speeds allows the user friendly & economic benefits of using lubrication.

Working prerequisites beyond lubricant effectiveness provide “oil-lubrication bearings” at the highest speed and long-lasting service life in the temperature range.

“Oil-air lubrication” provides aimed & volume adaptable oil/air quantity for sliding and spinning of bearing surfaces.

Lubricant should be taken to the “air stream” through staircase of airflow and via the “view tube” & supplied to the lubricant points for the required period.

“Oil-air lubrication” safeguards top-notch efficiency in terms of usage & lubrication effects at highest speeds:

- Minimal rise in temperature
- Negligible resistance
- Low working risk
- Lube supply can be adjusted to the requirements in real time
- Oil wastage is very low
- Negligible “oil mist” is developed
- Eco friendly and highly profitable
- No need to cool and filter oil

X. ADVANTAGES OF HYDROSTATIC BEARINGS

- These bearings have high loading capacity
- Capacity is independent of thickness of thickness of lubricating film & viscosity.
- In theory, the lifespan of these bearing is infinite without surface wear.
- Provides damping and rigidity constants of good scale and is also excellent for precise positioning and control.

XI. DISADVANTAGES OF HYDROSTATIC BEARINGS

- Requires auxiliary equipment which results in increased installation and maintenance costs.

- Very High-power consumption due to pump losses.
- Requirement for purification apparatus. Forfeiture of productivity as a result of pollutants in fluid.
- Probable to display air-filled mallet unpredictability for extremely compressed fluids.
- Possible to induce “hydrodynamic” instability when using hybrid mode procedure.

XII. SELF STABILISING OIL PRESSURE BALL BEARINGS

These bearings have an enhanced operating principle, self-stabilizing oil pressure bearings which outclasses current sleeve, ball or liquid bearings in terms of resilience and long-term stability. These bearings are patented and produced by a small Austrian brand called “Noctua”.

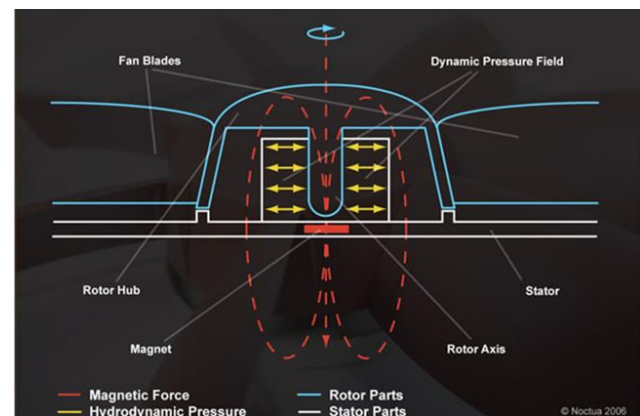


Fig7.SSO bearing Counstruction

1.Operating Principle:

“The rotating movement of the axis produces pressure on the particular oil inside the bearing. This causes the formation of a dynamic pressure field that stabilizes and stabilizes the spindle inside the bearing shell. While conservative liquid bearings also use the hydrodynamic pressure principle, the SSO bearings are fitted with an additional magnet, which supports the self-stabilization of the rotor shaft.”

“This permits for a quicker, reliable and precise center of rotor shaft and thereby increases the long-standing stability and resilience of the bearing: As soon as the fan starts, the dynamic pressure field of the fluid must first be created, whichever is earlier the axis of the so-called gyro effect. This results in increased volume until the spindle is stabilized by the build-up of the dynamic pressure field, which has noise emission and defects. For this reason, the SSO bearing has a built-in magnet whose field instantly determines the self-stabilization of the rotor and therefore reduces the gyro effect. In addition to stabilizing the fan's early stage, the auxiliary magnet allows for a more precise center of the spindle inside the bearing shell and thereby reduces bearing resistance, friction and noise emission.”

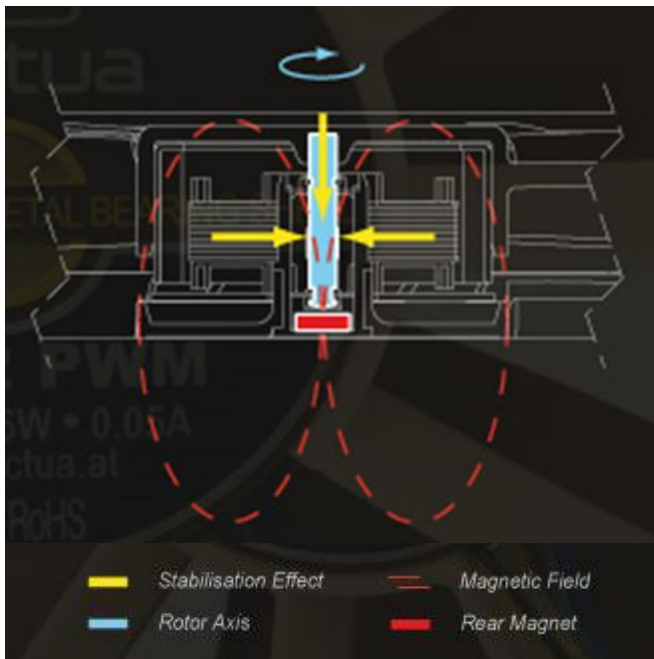


Fig8. Stabilizing forces on a Fan equipped with an SSO bearing

2.SSO compared to traditional sleeve and ball bearings:

Sleeves and ball bearings reflect fan markets that present major shortcomings: Traditional sleeve bearings initially have very low emission, but are largely unsatisfactory for long-term stability, short overall lifetime and increased noise after operating time. On the other hand, high grade ball bearings operate at slightly higher noise levels than long-term stability starters, providing a satisfactory start. SSO bearings not only outperform the splendor of traditional sleeve bearings, but also outperform the long-term stability of current top-of-the-line bearing modules.

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