Achieve longer lasting plain bearings

in just four steps

Introduction

For when you want the perfect plain bearing, instead of just an “almost-perfect” one! The service life of plain bearings depends upon many factors, making maximizing service life a complicated prospect. Many parameters must be taken into account, especially when special circumstances that can cause rapid wear are present.

In this white paper, we have compiled the most important considerations for the design of a bearing point in a checklist and examined their significance for the selection of plain bearings. The checklist also places the criteria in a sensible order so that you can quickly and easily analyze your plain bearing applications and find the ideal plain bearing.

Excavator with various plastic plain bearing components in a pulley module.

Automated guided vehicle system with plain bearings in the transverse control arm

Photovoltaic tracking system with plastic plain bearings

Rotary knob for household appliance with maintenance-free plain bearing

If the wrong plain bearing is selected, damage and bearing failure can occur during a wear test.

The four core issues of bearing selection

Bearing points basically consist of at least three components: the plain bearing, the running partner — usually a pin or shaft — and the bearing housing, i.e. the component in which the plain bearing is fitted. Applications in which the bearing is fitted onto a pin to move on the outer diameter in a hole are the exception.

The essential factors for the functionality of a bearing point can be well derived from its mode of operation. In bearing positions, a frictional relative movement takes place, e.g. a movement of the shaft related to the plain bearing. This usually generates heat and wear. If a bearing is to last a long time, it is important to minimize both. But what do heat and wear depend on?

Heat is generated in bearing points by friction. This depends on the surface quality of the surfaces moving against each other and on the force with which they are pressed together. In addition, the speed and duration of the movement play a major role. Finally, heat reduction through dissipative materials is another way to influence this.

Wear also depends on various factors. First of all, it depends on the plain bearing-shaft combination, since each combination leads to different wear behavior. In addition, the load plays a role. Increasing radial load or surface pressure also causes increased wear of the plain bearings. The speed also influences not only the heat generation, but also the wear. The higher the speed, the higher the wear. In addition, the movement type (oscillating, rotating or linear) has a decisive influence on the wear rate. Coming into contact with chemicals or dirt can also increase wear.

! Tip: find the right plain bearing with the pv value

In order to assess whether a plain bearing is fundamentally suitable for use in a particular application, the pv value is used. The pv value is the product of the surface pressure (p) and the velocity (v) in a plain bearing application. This must not exceed the maximum permissible pv value of the bearing position. The maximum permissible pv value is determined by the thermal conductivity and the shape of the components, as well as the ambient temperature, and is usually approximated in practice.

From these interrelationships, **the key questions for bearing selection can be derived**

First Question	What should move?
Second Question	How should it move?
Third Question	Where should it move?
Fourth Question	How long should it move?

The first question: what should move

The running partner

What is used as a running partner? Often disregarded, it nevertheless plays an important role: the shaft. In practice, these are often pins or other components. The surface finish and hardness of the material used affect the choice of the appropriate plain bearing. Surfaces that are too rough increase friction or damage the surface of the bearing. But it should not be too smooth either. If the surface is too smooth, adhesion forces can promote the stick-slip effect and thus cause vibrations and squeaking noises and, in the worst case, damage the sliding surface of the bearing. Manufacturers of plain bearings provide corresponding recommendations for the surface roughness of the shafts.

The hardness of the running partners is also important. Since wear in a bearing point should take place on the plain bearing and not on the often significantly more expensive shaft, it is advisable to use shafts whose surface hardness is higher than that of the used plain bearings. Bearings made of material composites reinforced with glass or carbon fibers can also damage the shaft surface if it is too soft.

Fitting the plain bearing

Plain bearings are generally press fit. This requires appropriately toleranced holes into which the bearings can then be pressed. The desired bearing clearance is achieved after being pressed in. This bearing clearance takes into account any dimensional changes that may occur due to moisture absorption or thermal expansion. If the press fit is impaired by the material or the shape of the housing component, the attachment of the bearing should be secured, for example, by positive location.

Which forces occur?

The forces that occur influence two things: the necessary mechanical strength of the bearing and the other components, and the frictional heat that is generated in combination with movements. The decisive factor here is surface pressure, i.e. the ratio between the force and the size of the load-bearing surface. Other stresses, such as edge pressure or shocks and impacts, can also play a role.

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The second question: **how should it move**

Motion is the most important aspect of bearing design. Without movement, bearings would not be necessary. The speed and duration of the movement determines the heat generation in the bearing point. The faster and more continuous the movement and the shorter the downtimes between the movement intervals, the higher the heat generation. Wear also increases due to the greater stress on the surfaces as the intervals between movements are increased.

However, it is not only the intensity of the movements that plays a role, but also the type of movement. Is it a pivoting movement? Does the shaft rotate in the bearing? Or is there a linear movement in strokes? Are the strokes long or short? Many plain bearings reduce wear by the application of lubrication. This varies depending on the type of movement and applied lubricant and the surface. Depending on the type of movement, different liner materials are suitable to different degrees.

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The third question: where should it move

Ambient temperature

The ambient temperature influences the temperature in the bearing point. In addition, the temperature also changes the mechanical strength of the materials. Very low temperatures cause materials to become brittle, which can lead to fractures. High temperatures make materials softer and, in some cases, more flexible. In addition, the temperatures also affect the dimensions of the components. Depending on the material, these expand to varying degrees at high temperatures or shrink at low temperatures. This mainly affects the bearing clearance and the press fit.

Dirt & dust

As a general rule, dirt and dust should be kept out of bearing points. If dirt particles get between the running partners of a bearing point, they can impair the surfaces of the components and thus the function of the bearing point. Appropriate seals are often used to protect the bearing points. Also, permanent lubrication can help keep dirt out of the bearing point.

Humidity & moisture

Moisture leads to corrosion depending on the material. This can lead to a reduction in bearing clearance in the housing and thus cause premature failure of the bearings. Corroded running partners in turn have a negative effect on the running properties and damage not only the shaft but also the bearing surface. Accordingly, corrosion-resistant materials should be used when in contact with moisture or corrosive liquids.

Contact with chemicals may also require appropriate resistance so that the mechanical strength and surface quality of the used components are not impaired.

As with temperature effects, dimensional changes must be taken into account. Materials with high moisture absorption, which include some plastics, can absorb moisture in amounts sufficient to cause dimensional changes, which can in turn affect bearing clearance.

Continuous operation under water or in liquids also affects lubrication and lubricant transmission. Accordingly, not all plain bearings function equally well under water.

Weather effects

This point includes weather effects such as rain and snow, but also solar radiation. While corrosion protection is important for the first two, UV resistance of the bearing materials is crucial for the latter. If larger surfaces are permanently exposed to ultraviolet radiation (or radiation in general), this can affect the mechanical strength. UV-resistant materials solve this problem.

Other standards & specifications

In addition to direct environmental influences, the location of the bearing points results in further requirements. For example, contact with foodstuffs can result in certain specifications regarding the ingredients of the bearings. In potentially explosive atmospheres, the conductivity of the components used is again important, as static charges can lead to arcing.

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The fourth question: how long should it move

Definition of service life

How long is the operating time that the plain bearing should undergo? Is the bearing point permanently in motion? The service life of the bearing is determined by the time during which movement also takes place. The decisive factor is therefore the service life in operating hours.

It is difficult to determine the potential service life of bearings solely on the basis of theoretical values. Representative tests provide certainty here. Only with tests that are very similar to the real application and sufficiently represent the mentioned influencing factors can a reliable forecast be made of the durability of the plain bearing in the application.

checklist

The four criteria for bearing selection

1 First question: What should move?

- Running partner
- Fitting the plain bearing
- Occurring forces

2 Second question: How should it move?

- Type of movement
- Speed
- Interval or continuous operation

3 Third question: Where should it move?

- Ambient temperature
- Humidity and moisture
- Dirt and dust
- Weather effects
- Other standards and specifications

4 Fourth question: How long should it move?

- Actual running performance
- Expected service life

Confused? We will be happy to assist
in the bearing selection

For most applications, many of the above questions can be answered with “does not apply”. The majority of plain bearing applications do not take place in the high-temperature range, nor in permanent contact with concentrated acids or under constant UV radiation. Many plain bearings are simply used at room temperature, without any environmental influences worth mentioning. And yet, the diversity of factors — and the damage they can do if ignored — is great.

At the same time, the precise analysis of the application allows the respective application scenario to be precisely mapped and thus the optimal plain bearing to be selected in advance.

We do more than advise you on the analysis and design of your bearing points. We carry out over 15,000 tribological tests per year to examine the wear of our plain bearings in a wide range of application scenarios. As a result, we know exactly which factors affect the service life of plain bearings and how. With the wear data obtained in this way, we are able to calculate the service life for a wide range of applications in advance. Service life data is provided in the online iglide® bearings shop.