SERVICEINFORMATION

KS PERMAGLIDE® PLAIN BEARINGS
THE IMPACT OF MICRO-MOVEMENTS ON PLAIN BEARINGS

Plain bearings define the position between moving components and determine how accurately the components are guided. Thanks to their sufficient load bearing capacity, plain bearings transfer any forces to the adjacent housing components – ideally with little friction and wear.

Durability of and wear on the bearing position
The operating behaviour of dry-running compound plain bearings is defined by the pattern of movement and the load variables *surface pressure p* and *sliding speed v*. These main characteristics provide an approximate guideline for the design of dry-running plain bearings. The *pv value* (the product of *p* and *v*) represents the specific energy input that the bearing surface of the plain bearing has to absorb on a continual basis. To be able to make a more accurate statement about the durability of the bearing position, the friction behaviour and the heat transfer conditions must also be taken into account.

When it comes to very small patterns of movement, e.g. in the case of vibrating systems, the bearing must fulfil additional requirements. This mainly relates to how materials behave when subjected to different kinds of wear.

Mechanical wear
Any force that impacts on an object causes inner stress, depending on the elasticity of the material. At a microscopic level, the roughness peaks of the touching surfaces of two allegedly smooth objects come into contact at certain points. Stress is distributed in each contact zone, and initially the material reacts through elastic deformation. This is similar to a spring that can bounce back to its original position.


Gearbox with surface damage due to micro-friction

Oscillating friction and roughness peaks that rub against each other in the contact zones are also subject to alternating strain. That is why materials with high bending fatigue strength are required. At each contact point where there is friction, excessive alternating shear stresses will lead to gradual fatigue.

Very high localised stresses lead to plastic deformation if the material is subjected to more pressure than it can resist. When this happens, the material suffers irreversible compression in the contact zones and the structure of the material stiffens. This makes it more and more likely for the material to suffer a brittle fracture in these areas. This can lead to micro-fractures, surface ruin and damage to the structures below the surface. Only the sum of load-carrying contact zones will bring the specific surface pressure to an acceptable level.

Thermal strain

Frictional forces that are always directed against the direction of movement also cause heat conversion. That is why it is essential that frictional heat is conducted away, so as to minimise any impact on the mechanical properties of the material. When it comes to dry-running plain bearings, it is vital that any frictional heat is continually conducted away to the shaft and housing. In the event of liquid friction, heat is also transported away via the lubricant.

A stable tribological system must always have a thermal balance between friction heat introduction and heat dissipation. Otherwise high localised temperature peaks could gradually cause the entire bearing position to overheat. This, in turn, would result in thermal failure and melted material on the sliding surface.

When it comes to high-frequency micro-movements, there are also limited transfer options for heat to be conducted away, as on a macroscopic level the interacting sliding parts actually stay put.

Adhesive wear

In addition to mechanical and thermal signs of wear, other types of wear may occur at an atomic level. Adhesion is a form of interaction between areas in contact. If surfaces come into extremely close contact at local points and there are similarities in the materials, this could result in interaction at an atomic level. An example of this is when a soft material is pressed against a hard material, which causes the objects to bond due to deformation.

In adjacent boundary layers there is an exchange of electrons. Metals can become cold-welded together between the surfaces. If an additional force is applied which causes the surfaces to slide apart, the cold-welded points will be sheared off. Adhesive wear typically takes the form of scoring marks, humps and dells.

Other causes of micro-movements

Micro-movements often occur in vibrating systems as well, or arise when components keep changing form, e.g. bending of strained shafts.

Proposed solution:
Using tribological materials to minimise wear

To curb the impact of wear, tribological materials are designed specifically for oscillating patterns of movement. Hard additives like boron nitride and carbon fibres help to smooth the roughness peaks of the interacting sliding partner. Soft metallic additives like lead and tin, and metallic sulphur compounds like zinc sulphide, molybdenum disulphide and barium sulphate help to fill in roughness grooves in surfaces. The lattice structures of these additives allow surfaces to slide against each other with little friction and wear, and prevent excessive bending interaction. As a matrix, PTFE has very high anti-adhesive and friction-reducing properties, making it an effective solution for reducing the effects of adhesion.

KS Permaglide® P180 material

KS Gleitlager unites these properties in special KS Permaglide® material formulas. The composite material P180 is a new material that has been developed for oscillating applications, and provides effective resistance against the loads arising in components like dual mass flywheels and belt tensioner lever bearings.