Considerations for choosing the correct rolling-element bearing characteristics

Selection of NKE bearings. (Image courtesy of NKE)

Daily experience in application engineering has proven that the selection of the correct bearing type can be successfully achieved by customers, based on the documentation and tools provided by the bearing manufacturer and using comparable applications as a guideline.

This selection process is typically dominated by two complementary factors. First is the required bearing life rating in the application, as a result of the relation between the bearing's dynamic load rating, the magnitude and direction(s) of the forces acting, and the speed of rotation. Second is the build size of the bearing in relation to the available space in the application.

In addition, there are several other critical bearing characteristics which are not always considered with the required diligence. These may later cause questions and issues to arise. These are, amongst others: clearance, cage type, lubrication, standard, pre-installed sealing variants in radial deep-groove ball bearings, etc.

The following aims to address these reoccurring questions.

Clearance

The nominal bearing clearance is the distance between end positions in which the rings of a rolling-element bearing may be moved against each other. For most radial rolling-element bearings, this radial distance of movement, better known as radial clearance, is provided in publications, while paired or double-row angular contact ball bearings and taper roller bearings are listed with an axial clearance. Ranges of clearances are combined in (radial) clearance classes, which are standardised to a large degree, according to DIN 620, and easily identifiable by the suffixes C3, C4, etc.

Bearing clearance has a significant influence on the function and performance of a rolling-element bearing and, with few exceptions in special applications, a bearing always needs a certain amount of clearance for proper operation – the so-called "operating clearance".

This operating clearance results primarily from the chosen clearance class of the rolling-element bearing, in conjunction with the shaft and housing fits required for a specific application. The temperature difference between the shaft and housing during operation potentially includes additional heat being transferred into the application via the shaft. Typically, this causes a "constriction" of the bearing, thereby reducing the nominal clearance often considerably. In a worst-case scenario, this may lead to an unintentional preload.

An unintentional preload typically causes additional friction loss and heating, thereby posing a very real risk for a premature bearing failure. Therefore, it is highly recommended to add an operating clearance evaluation to any bearing selection process. The bearing clearance class that offers sufficient clearance during operations should be chosen.

Cage type

Every bearing is equipped with a standard cage type, which is suitable for use in "standard" applications.

A more detailed check of the cage type to be used in a specific application, typically in cooperation with the bearing manufacturer, is recommended based on the following operating conditions:

- Operating temperature – for example, polyamide cages (PA 6.6.) reach their limit of use at operating temperatures of 120°C. Beyond this temperature, metal cages must be used, or the application of special plastic cages, such as PEAK, evaluated.
- Fast acceleration and/or low loads – in such cases, depending on the bearing type and size, the use of lightweight cages (i.e. polyamide or pressed-steel cages, or ring-guided cages) must be considered to avoid the weight of the cage decelerating or blocking the movement of the rolling

elements. This subsequently causes smearing damage, due to slippage.
The same principle also applies to applications in which rolling-element bearings are subjected to shock loads, vibrations, and high centrifugal forces, e.g. on eccentric shafts.

- Lubrication situation – in general, grease-lubricated applications favour the use of rolling element-guided cages, as the formation of a sufficiently stable lubricant film in the gap between a ring-guided cage and the ring itself often cannot be reliably achieved.
  Oil-lubricated bearings are typically not subject to such restrictions. However, one additional consideration must be the compatibility of high-tech, fully synthetic lubricant oils, with plastics and rubber used for cages and external seals.

Lubrication

The selection of the correct lubricant is one of the most underestimated topics in the use of rolling-element bearings.

On one side, the best possible lubrication to minimise friction and metallic contact under realistic operating conditions must be considered.

On the other side, any lubricant is subject to ageing during operation, depending on the actual operating conditions. Most often, the lubricant's performance is degraded to the extent that it has reached the end of its service life well before the rolling-element bearing itself. The actual operating temperature again plays a significant role in this context.

Evaluating the lubricant is definitely recommended for most applications, in cooperation with the lubricant manufacturer and supported by the bearing manufacturer.

Inner ring guided solid steel window-type cage with DLC coating. (Image courtesy of NKE)

Standard, pre-installed sealing variants in radial deep-groove ball bearings and others

Several misconceptions exist regarding the use of pre-installed bearing seals offered by the manufacturer, which in turn may have an impact on the actual bearing's performance and longevity.

First and foremost, contacting bearing seals should not be considered liquid-tight, due to the very limited space into which they are integrated, and the necessary design compromise between sealing efficiency and minimisation of friction and associated frictional loss.

Depending on the actual application, it is therefore recommended carefully to evaluate pre-installed bearing seals in terms of the required sealing efficiency, and balance it against acceptable frictional loss. If the solutions on hand are insufficient, the use of special bearings (e.g. with integrated radial oil seals) can be considered, or provision must be made for additional, external sealing measures of the bearing position.

A second topic often arising is the build-up of a 'grease collar' at the sealing gap or sealing lip. This results from a small amount of grease being expulsed during the internal grease distribution process, once a bearing starts to operate. Although it may impact the visual perception of a bearing, this grease collar is actually not a defect, but rather an additional protection for the bearing. This is because it captures contamination well outside the bearing and away from the actual sealing gap or sealing lip, thereby helping further to delay an intrusion of contamination into the bearing itself. In certain applications where a grease collar is not desired for practical reasons, it can be minimised by reducing the grease quantity and performing a run-in procedure prior to the installation.

Conclusion

The topics mentioned are naturally only a small – but important – selection from the multitude of aspects to be considered when using rolling-element bearings. For more information, check out the NKE Austria General Catalogue: ***https://bit.ly/3K3KvVx.***