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Selecting the Right Rolling Bearings

Rolling bearings are critical components in rotating machinery, production systems and vehicles. Here, Schaeffler provides some useful tips and guidance for engineers on how to select the most appropriate bearing for the application.

Mechanical design engineers often have to specify and select suitable rolling bearings. Even simple shaft systems subjected to radial and axial loads running at defined speeds can still place huge demands on the rolling bearings. The adjacent housing, for example, influences the shaft and the design of the bearings. Other factors such as temperature or sealing requirements are also important. The designer therefore has to find an appropriate method of supporting the shaft by using rolling bearings in such a way that the loads involved, the speeds required, the adjacent construction and environmental conditions, are all taken into account in order to ensure a reliably functioning shaft system.

In some cases, the designer may be able to use his or her experience and knowledge to design the shaft bearing arrangement. However, this could result in a bearing arrangement that is over-engineered and therefore not cost effective. Or worse still, the bearings may simply fail to fulfil the functions required of the shaft.

In order to determine the correct shaft bearing arrangement, several factors need to be considered. First, engineers need to consider how precisely the shaft needs to be guided. Are there any external constraints or forces that could be eliminated by the correct shaft bearing arrangement using appropriate degrees of freedom? Is shaft deflection likely or is the shaft sufficiently rigid? Will there be significant thermal elongation when the operating temperature is reached? Is the shaft itself driven or does it drive another component? Will the shaft be affected by vibration or oscillation caused by these other components? Can the shaft be aligned accurately or should allowances be made for any misalignments?

For example, a different bearing arrangement with two tapered roller or angular contact ball bearings will offer precise shaft guidance but can also exert constraining forces on the shaft and bearing system due to internal axial forces caused by inaccuracies in the adjacent construction. The designer can solve this by using cylindrical roller bearings with a defined axial clearance rather than changing the bearing arrangement. The classic locating/non-locating bearing arrangement, on the other hand, compensates for factors arising from the adjacent construction as well as any thermal expansion.

The bearing arrangement determines the types of rolling bearings that are selected. If a different bearing arrangement with tapered roller or angular contact ball bearings suitable for unilateral loads, or even cylindrical roller bearings is sufficient, the locating/non-locating bearing arrangement requires a bearing on the locating side that can support axial loads in both directions. In this case, the designer can select radial ball bearings, spherical roller bearings or cylindrical roller bearings. The function of the non-locating bearing is then fulfilled by radial ball bearings or spherical roller bearings with a moveable outer ring (sliding seat) or classic non-locating bearings such as cylindrical roller bearings, needle roller and drawn cup bearings.

For any application, the design envelope and load direction are not sufficient as a means of selecting a suitable rolling bearing. The required life and operating conditions raise numerous questions that can either confirm or reject the bearing selected. If the factors that influence the rating life of the bearing are known or need to be optimised, in most cases the adjusted rating life can be used for life calculations, which often enables the system to be downsized.

Once the designer has calculated and defined the forces, speeds and other conditions for the bearing arrangements, the most appropriate rolling bearings need to be incorporated.

This method of selecting the right rolling bearing is, however, “distorted” by the wide variety of bearing types and series. Many of the characteristics of rolling bearings are present to a greater or lesser extent in numerous bearing types, while other required characteristics are absent in certain rolling bearings.

In typical rolling bearing catalogues, several bearing types may appear to fulfil the requirements of the shaft bearing arrangement. In addition to the dimensions of the bearings, there will also be various statements relating to basic load ratings, speeds and mounting. This technical data should help to narrow down the different types of rolling bearing that can be used.

However, other important questions then need to be asked such as: "How long must the bearing last? Will it support the necessary speeds? Do the lubricants used for the shaft system fulfil the requirements of the rolling bearings? What lubrication does the rolling bearing require?

This is where a good bearings supplier can advise and guide the customer into selecting the best bearings for the application. The designer can learn how the various factors – load, speed, internal stresses in the bearing material, the viscosity and cleanliness of the lubricant, as well as the size and hardness of the contaminant particles, the additives and the environmental conditions – affect the expected life of the bearings.

The type of lubricant can have a considerable effect on the rating life, and contaminants in the lubricant cause increased wear in the bearing. If the operating viscosity is above the nominal viscosity required for the rolling bearing, this supports lubricant film formation and therefore the expected life of the bearing. In contrast, an inadequate operating viscosity does not permit lubricant film formation, which impairs the rating life of the bearing.

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CONTACT:

Schaeffler (UK) Ltd, Forge Lane
Minworth
Sutton Coldfield West Midlands B76 1AP
Tel. +44 121 313 5881
Fax +44 121 313 0080
E-Mail: Karen.Preston@schaeffler.com