

SCHAEFFLER



Proven to be better

Development trends in industrial rolling bearings



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1. General trends in power transmission and in machine construction and plant engineering

Rolling bearings are used throughout the machine construction and plant engineering sectors and are therefore subject to – and also help to shape – the “megatrends” taking place in these fields of application.

The “total cost of ownership” – not the purchase price – is the decisive factor

Rolling bearing users are becoming increasingly aware that the purchase price of a bearing is by no means an accurate representation of the bearing’s actual costs.

On the contrary, it is also necessary to take the rating life and the service outlay, as well as bearing failures, into account when making these calculations.

For practical application, this means that users more often choose a higher-quality rolling bearing with a longer rating and operating life as well as longer maintenance cycles and a higher level of reliability.

Machines that are equipped with durable rolling bearings offer competitive advantages in this regard.

Higher power density – compact design

On a technical level, space requirements are a factor that many machine users today are taking into ever-greater consideration when making investment decisions. From a manufacturer’s point of view, a compact design therefore improves machines’ competitiveness. Because an identical or higher level of performance is required, new generations of machines display a higher power density. The result of this is that the (drive) components, and therefore the rolling bearings, are subjected to greater loads. At the same time, factors such as space requirements and costs mean that these machine components are being designed with greater and greater precision.

Reserves in terms of performance capability are therefore reduced, which makes it all the more important to use sophisticated and high-performance drive components.

Higher precision and higher speeds

In many areas of application – including machine tools and plastics machinery – the machines’ degree of precision increases with each new generation. The machining sector sets the standard here. This development also has an effect on the selection of the rolling bearings, which have to fulfill very high requirements in terms of running accuracy. In many areas of application, such as turning and milling machines, this requirement also goes hand in hand with increasingly high speeds.

Energy efficiency

One of the leading development trends is users’ demand for greater energy efficiency, and machines’ energy consumption is an issue on the agenda of numerous companies.

Many areas in which machines and plants are used (e.g. the plastic injection molding machine sector) are also seeing compensation between different drive technologies, which to a large extent is driven by energy consumption but also by the desire for greater precision. A large number of manufacturing companies also have targets in place with regard to the reduction of energy consumption in production. The increasing consideration of efficiency classes for electric motors (“IE”) and other classifications and labels for energy efficiency contribute to this factor’s growing importance.

By affecting the level of friction, rolling bearings influence the energy consumption and efficiency of drive applications, so the users’ desire to employ low-friction rolling bearings is clear.

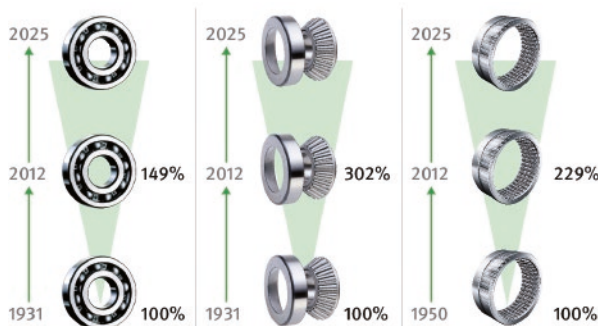
2. General trends in rolling bearing technology

Further developments that are decisively (though to be fair, not exclusively) pushed forward by Schaeffler are continuously taking place in the rolling bearing technology sector.

Increased load ratings

The continuous improvement of dynamic load ratings is a central long-term trend in the development of rolling bearings from one generation to the next. This measurement value specifies the rating life that can be expected from a rolling bearing at a given load. To put it more precisely: In the case of radial bearings, the dynamic load rating is the radial load of unchanging size and direction at which a sufficiently high number of identical bearings achieve a nominal rating life of one million revolutions. For axial bearings, the centrally-acting axial load is the reference value.

If the load rating of a ball bearing from back in 1931 is assumed to be 100%, the value achieved by a Schaeffler ball bearing manufactured in 2012 is 49% higher. In the case of tapered roller bearings, the load rating was increased more than threefold to 302% over the same period, while that of needle roller bearings has more than doubled since 1950 (to 229%).



Load rating development

New materials, improved manufacturing possibilities

The development of new steels that are optimized to suit specific operating conditions and, for example, display smaller quantities of non-metallic inclusions, is one of the things that have made this development possible. However, the ways in which rolling bearings can be machined have also improved, which means that today, significantly smoother and more low-friction surfaces can be achieved, to name just one example. What is more, the complex processes that take place inside rolling bearings are better understood, which makes it easier to optimize the bearings' characteristics in a targeted manner.



A further optimization of the performance of rolling bearings is the result of the complex calculation and design tools that Schaeffler employs in the development and further development of its individual bearing types and series.

3. The time has come for a development leap

Combining these two development paths – the general trends in the drive technology found in machine construction and plant engineering and the trends in rolling bearing technology – paints a clear picture: Rolling bearings have to fulfill requirements that are getting higher all the time. They are able to do this because their further development improves precisely the characteristics that need to be improved in order

to fulfill these requirements: Rating life, load carrying capacity, and efficiency. Because this trend applies to virtually every area of machine building, plant engineering, and vehicle manufacture and not just to “high-end” applications, adapting the basic catalog rolling bearing series to match the new requirements and defining a new standard is an obvious step. This is exactly what Schaeffler has done with its X-life series.

4. A new standard

X-life is the seal of quality for Schaeffler rolling bearings that are characterized by a longer rating and operating life while supporting the same loads and maintaining the same design envelope, i.e. through higher dynamic load ratings. If the existing load ratings are sufficient for the user, he or she can optimize the design of the application by using smaller bearing types and thus saving space and reducing weight.

Standard bearings with top performance values

The positioning of the X-life bearings in the overall product portfolio is of decisive importance. X-life is not an additional premium series but the standard in each case; from the manufacturer’s perspective, “standard” means that the respective bearing series with their performance and rating life values are positioned at the top compared to the competition.

The first X-life bearings – smaller FAG spherical roller bearings and INA cylindrical roller bearings – were

unveiled in 2003. A short time later, in 2004, the first INA needle roller bearings, FAG cylindrical roller bearings, and single-row FAG angular contact ball bearings followed.

Since then, virtually all bearing types have been further developed in such a way that their increased dynamic load ratings have made them suitable for inclusion in the X-life range. Different design-related measures are necessary to achieve these improvements, such as changes to heat treatment processes and/or optimization of the raceway geometry; however, these all lead to similar results – an increase in the dynamic load rating.



Proven series



Spherical roller bearings are a part of the X-life series that have proven themselves again and again. They are used wherever high loads have to be supported and where shaft deflections or bearing seat misalignments have to be compensated.



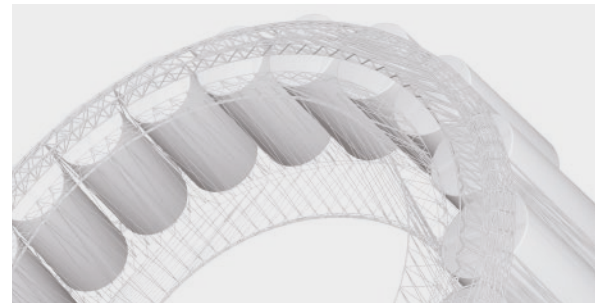
INA's X-life axial angular contact ball bearings have also proven themselves to be a high-quality standard solution in practice. Their main area of application is in bearing supports for ball screw drives, where they allow both a longer operating life and increased limiting speeds.

New to the X-life range: Tapered roller bearings



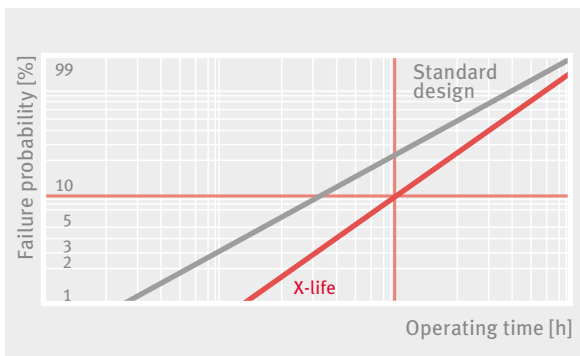
Tapered roller bearings with increased dynamic load ratings – the latest addition to the X-life range – are now available. They are also characterized by significantly smoother running and lower levels of noise generation.

Significantly reduced dimensional and running tolerances compared with DIN 620 / ISO 492 (tolerance class PN) ensure optimum load distribution.

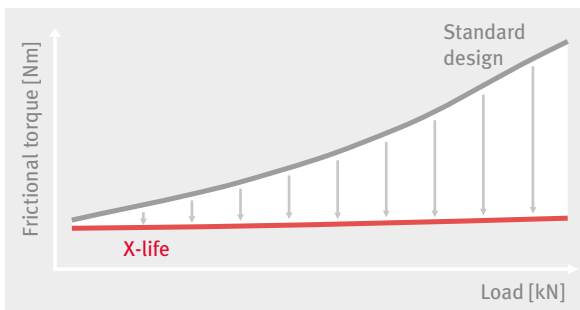


These improvements were achieved through the use of a premium material in combination with an optimized heat treatment process, among other things. This makes the surface of the inner and outer rings more resistant to both solid particles and mixed friction conditions.

Tapered roller bearings in X-life quality are also characterized by a smoother and more uniform surface on the rings and rollers. This reduces the stress placed on the raceway and the rib of the inner ring as well as the roller material and roller end faces. The more even surfaces and contact surfaces allow an optimized load distribution in the bearing. The result of this is that, even at low speeds, an elastohydrodynamic lubricant film can form, which means that the bearings can support high loads immediately after initial operation.

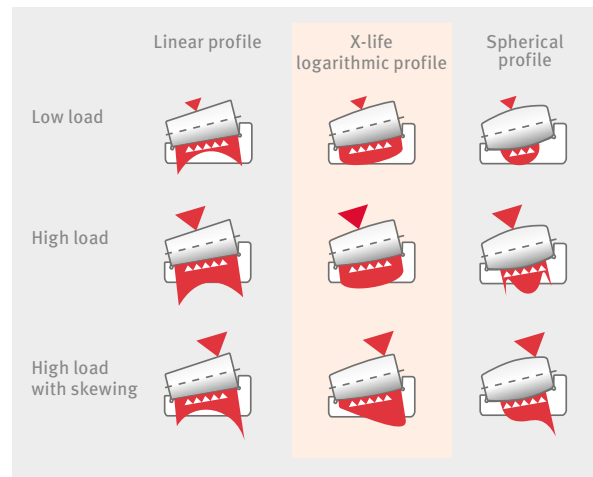


Together with the increased geometrical and running accuracy of the X-life design, the improved surface topography also reduces the generation of friction and heat.



Furthermore, the logarithmic profile of the raceways and the outside surfaces of the rollers was further optimized. The bearing can now better compensate stress peaks that occur at very high loads and during skewing. What is more, the contact geometry of inner

ring ribs and roller end faces has been even better matched. This design measure also minimizes friction and therefore heat generation.



The result of these improvements is that the new X-life tapered roller bearings achieve up to 20% higher dynamic load ratings than the previous design, as well as a nominal rating life increase of up to 70% under identical operating conditions.

Increased performance as an ongoing process

The changeover of standard rolling bearing series is an ongoing process. The market launch of each X-life bearing design takes place only after extensive development work as well as endurance tests in Schaeffler's testing laboratories.

The fact that these bearings are used in the heavy-duty sector is what makes this task so time consuming. This sector brings with it demanding requirements and high standards that are in need of further improvement. Implementing the special design features of X-life rolling bearings in manufacturing also requires extensive preparatory work.

5. Benefits for the user

Design engineers can utilize the advantages that X-life bearings deliver thanks to their increased load ratings in a variety of ways. When an existing standard bearing is replaced with an X-life rolling bearing, the drive operator firstly benefits from an increased bearing rating life and extended maintenance intervals. This improves the “total cost of ownership” and provides increased protection against failure for the drive or machine in question.

The increased load rating also means that the bearing can support higher loads while maintaining the same rating life or, alternatively, the user can install a smaller bearing while maintaining the same rating life and the same loads (“downsizing”). This allows machines to be made more compact and weight to be saved. Their reduced friction and noise generation are also important arguments in favor of using X-life products.

6. The new standard in practice

X-life bearings are used in widely varying applications and sectors, though “heavy-duty” applications are by far the predominant area of application. For example, a renowned manufacturer of hydraulic drives for construction machinery decided to equip its axial piston pumps and motors with X-life rolling bearings and refitted a range of other bearing positions with rolling bearings from the X-life range. This allowed the efficiency of the drive components to be increased by 2%, which has a direct effect on the performance of the construction machinery: A wheel loader with a total power of 140 kW thus saves 9 kW – or has this additional power at its disposal. For 1,000 wheel loaders operated for eight hours per day, this therefore means an annual saving potential of around 26,000 MWh.

This corresponds to a CO₂ emissions reduction of around 16,000 tons and an energy cost saving of approximately five million euros per year.

In another application – vibratory machines – X-life cylindrical roller bearings ensure smooth, low-friction drive operation despite the adverse ambient conditions and very high loads due to factors such as centrifugal acceleration rates of up to 550 m/s².

The new X-life tapered roller bearings are now also being used in agricultural machinery gearboxes, where they contribute to reducing the machines’ fuel consumption.



7. Conclusion

Thanks to all the features described here – higher dynamic load ratings, reduced friction, more compact design – the X-life range provides answers to central trends in power transmission and in machine construction and plant engineering.

The new standard helps design engineers as they strive to create efficient drives with a long operating life.

Rating life is an immensely important factor, especially when it comes to rolling bearings, because these are drive components that are subjected to high loads and are permanently in motion, and that have to be replaced regularly in many applications.

X-life bearings thus contribute to increasing the productivity and availability of machines and vehicles by extending their service intervals. Improving efficiency is also a factor that must not be underestimated:

Energy efficiency is becoming a key argument for more and more machine operators when making investment decisions. The use of X-life rolling bearings can produce measurable improvements here.

► schaeffler.de/X-life

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