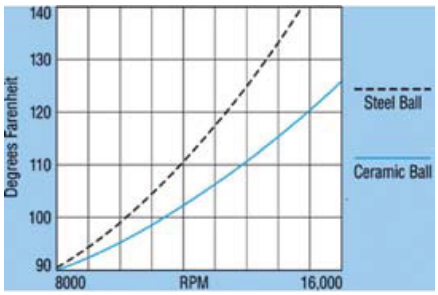
Hybrid Ceramic Ball Bearings

The term “hybrid ceramic ball bearing” normally refers to a bearing assembly consisting of inner and outer rings of standard bearing steel, with silicon nitride (Si3N4) ceramic balls. For some applications, the properties of the bearing with ceramic balls offer functional improvements in several different areas over a conventional all-steel bearing. There is a very significant cost penalty for the hybrid ceramic design that largely limits its present-day use to certain high-end applications. However, this cost gap is expected to shrink over time with advances in ceramic ball manufacturing technology.

Bearings for Machine Tool Spindles

One of the predominant present-day applications for hybrid bearings is angular contact sets for high-speed machine tool spindles. This application utilizes some of the key properties of the ceramic balls compared to steel:

• Lower mass. The mass of a ceramic ball is about 40% of that of a steel ball of the same size. This means the hybrid ceramic bearing operates with less friction, less ball skidding, lower moment from gyro-spin, and therefore, lower operating temperature for a given speed, and higher limiting speed for a given size – by a margin of 20% or more.
• Higher stiffness. A hybrid ceramic design typically increases bearing stiffness by 15 to 20% compared to all-steel. This allows increased cutting accuracy, as the spindle deflects less under load. Overall vibration is also reduced.

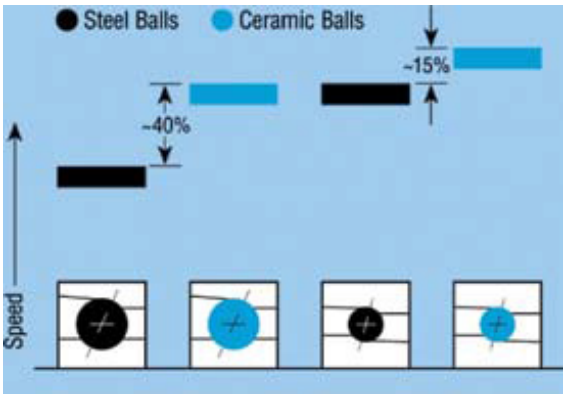


As running speed increases, ceramic balls run cooler than conventional steel balls. The reduced heat build-up prolongs lubricant life.

Beyond Spindle Bearings

There are other properties of hybrid ceramics that hold potential benefits for a variety of bearing applications:

- Smooth surface finish / high hardness. Bearing-grade ceramic balls are harder than bearing steel and have very good surface finish. Wear between the surfaces is reduced, and there is no cold welding between the ceramic ball and steel raceways under poor lube conditions. Therefore, the hybrid design generally requires less lubricant and is more forgiving of marginal lubrication than the all-steel design. The high hardness of the ceramic balls also makes them more resistant to surface-initiated damage from contaminant particles.
- Corrosion resistance. The chemically inert ceramic balls will not corrode – a potentially important issue for bearingapplications such as food machinery and medical tools. (Special anti-corrosion treatments of the steel inner and outer rings may be needed in these cases.)
- Electrical resistance. Ceramic balls are nonconductive, and therefore would prevent electrical pitting damage to bearings in electric motors or related equipment.



The running speed of a large diameter ceramic ball exceeds the same size steel ball by 40%. Converting to a small diameter ceramic ball will boost running speeds by an additional 15%.

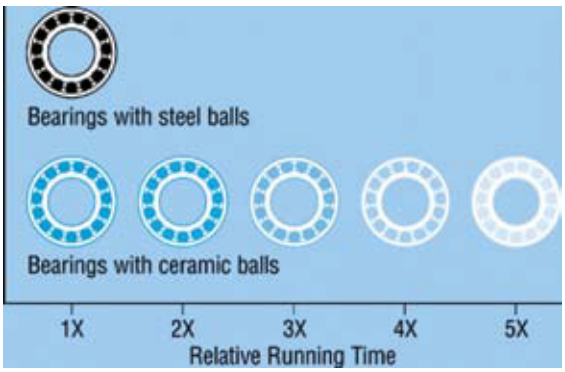
Identification Marking Methods

Hybrid ceramic bearings are identified according to each manufacturers system of numbers and/or letters detailing size, style, etc. Ceramics are often further identified with a prefix or suffix.

Limitations

In some applications, we can see that the properties of the hybrid ceramic bearing would lead to an increased life compared to an all-steel bearing. However, this is not true of all cases. In normal-speed applications where true fatigue spalling of a raceway tends to be the failure mode, the hybrid ceramic design would not be expected to increase bearing life – rather, a significant decrease in the life would be expected. (The higher stiffness of the ceramic balls reduces the size of the ball/raceway contact patch under load, thus raising the contact stress compared to the all-steel design.)

Therefore, potential applications for hybrid bearings need to be carefully weighed on a case-by-case basis.



The service life of ceramic hybrid bearings is at least twice that of conventional ball bearings and could be as much as five times the service life of conventional bearings, depending on operating conditions.