Extra large (XL) hybrid deep groove ball bearings from SKF – the basics

Designed and developed especially for large wind turbines, SKF XL hybrid deep groove ball bearings insulate against electric currents while providing high reliability and excellent performance.

Why ceramic rolling elements in bearings?
Silicon nitride, Si$_3$N$_4$, is a ceramic material with properties including high hardness, electrical insulation and low density, which contribute to its suitability as a bearing material.

Why choose SKF?
To ensure optimum quality, SKF has comprehensive material and rolling element specifications for the bearing grade silicon nitride in combination with a thorough quality assurance. The specifications include requirements on material strength, macro- and microstructure, hardness, toughness and rolling contact fatigue behaviour, and on finished rolling element surface appearance.

Furthermore, the components in a hybrid bearing are chosen to correspond to the high performance of the silicon nitride rolling elements.

Comparison of material properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Bearing steel</th>
<th>Bearing grade silicon nitride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength [MPa]</td>
<td>~2 300</td>
<td>3 000</td>
</tr>
<tr>
<td>Tensile strength [MPa]</td>
<td>~1 900</td>
<td>800</td>
</tr>
<tr>
<td>Elastic modulus [GPa]</td>
<td>210</td>
<td>310</td>
</tr>
<tr>
<td>Hardness HV10 [kg/mm$^2$]</td>
<td>700</td>
<td>1 600</td>
</tr>
<tr>
<td>Electr. resistivity [Ωm]</td>
<td>$0.4 \times 10^{-6}$ (conductor)</td>
<td>$10^{12}$ (insulator)</td>
</tr>
<tr>
<td>Density [g/cm$^3$]</td>
<td>7.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Coefficient of thermal elongation [$10^{-6}$/K]</td>
<td>11.7</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Extended service life
SKF hybrid bearings provide superior grease life, especially in situations with difficult operating conditions.

Small to medium sized sealed SKF hybrid deep groove ball bearings are lubricated with SKF electric motor grease. Tests have shown that these bearings provide a longer service life than all-steel bearings (→ diagram 1).

Tolerant to poor lubrication conditions
Hybrid bearings outperform all-steel bearings in terms of wear-resistance when it comes to operating under poor lubrication and contaminated conditions. Tests also have proven the superior behaviour of silicon nitride when contacting metal raceways under pure sliding conditions, thanks to the smoother surface and the higher hardness of the ceramic rolling elements (→ diagram 2).

SKF selection of XL hybrid deep groove ball bearings for generators in wind turbines
SKF manufactures and stocks a wide selection of XL hybrid deep groove ball bearings (→ table above), covering the most commonly used sizes in generators for mainstream wind turbines.

For multi-megawatt wind turbine generators, which require other bearing sizes or other bearing arrangements, SKF can supply customized solutions.

Supplementary designations
HC5 Ceramic rolling elements
C3, C3P Radial clearance
SO Heat stabilization
VA970 Special design for generators in wind turbine applications

Diagram 1
120 °C and n × d_m = 6 700 000

Grease life performance – test result where the grease life in SKF hybrid bearings is four times longer than in the corresponding all-steel bearings

Diagram 2
Inner ring wear (weight loss), [mg]

Wear performance under contaminated lubricant conditions

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