NSK’s newly developed Water TF (WTF®) bearings are the result of combining special steel-melting technology used for aircraft bearing material, and our original, heat treatment technology. Our WTF (water-tough) bearings successfully resist premature flaking under severely contaminated conditions of water-infiltrated grease lubrication and powder debris (iron-oxide) contamination. Furthermore, our WTF bearings have a bearing life that is three times longer than our conventional bearings.
A new product that responds to customer needs for longer life in harsh environments.

Using NSK technology, we created WTF bearings to overcome premature flaking that results from conditions of water-infiltrated grease lubrication and powder debris or particulate contamination. WTF bearings achieve a service life three times longer under severe operating conditions.
1. Technology

Premature flaking is initiated by dents that are generated on bearing rolling surface areas, which are caused by particulate contamination. When the bearings are operated under such conditions with water-infiltrated grease lubrication, the strength of bearing steel is significantly weakened. This ultimately leads to a phenomenon called corrosion fatigue (Photo 1). By combining material and heat treatment technologies into what NSK calls Water TF (water-tough) technology, we can drastically prevent the onset of corrosion fatigue.

NSK’s Water TF technology includes many proprietary technologies that have been patented (below) with many more pending approval.

USP6165289, GB2311998, USP5256213, USP5298323, JP2128328, USP4904094, GB2209058

Cracks lead to flaking and ultimately corrosion fatigue

Photo 1. Water TF technology consists of an ultra-high clean-material technology for inhibiting the generation of cracks, and a chemical component design technology for restricting infiltration of water into any cracks that developed.

Nonmetallic inclusions (Photo 2) develop cracks below the bearing surface (Photo 3). Water in the grease lubricant infiltrates the cracks, and weakens the bearing material. Using a special steel-melting technology used for aircraft engine bearing material, we were able to restrict crack occurrence by reducing the amount of non-metallic inclusions in the raceway surface.

In order to inhibit the initial development of cracks along grain boundaries, we worked to achieve stronger grain boundaries (Photo 4) by developing an optimum alloy balance for bearing material.

Bearsings used under contaminated lubrication conditions suffer from indentations that are generated on the raceways by foreign particles, which initiate surface originated flaking.

Stress concentration points around the edges of the surface indentations create cracks around the indentations, which progress into larger cracks that lead to flaking. Contact stress concentrations at the edges of an indentation (Figure 2) can be expressed by \( \frac{P}{P_0} \propto \left( \frac{r}{c} \right)^{-0.24} \), which is a function of \( r/c \). This suggests that the larger the \( r/c \), the smaller the stress concentrations, which means an ultimately longer life. NSK’s research on bearing material confirms that as the amount of retained austenite increases, the \( r/c \) value becomes larger, and the reduction of stress concentrations is enhanced.

Our patented TF technology incorporates this principle for achieving longer life under contaminated lubrication conditions by maintaining optimum levels of retained austenite.

NSK developed its Water TF technology by incorporating components of TF technology for enhanced service life under contaminated lubrication conditions.
2. WTF technology among other NSK long life technologies

Purpose

Long Life

Challenge

Subsurface originated flaking
(for clean environments)

Surface originated flaking
(for water-infiltrated environments)

Surface originated flaking
(for particulate contaminated lubrication environments)

Measures

Material

Heat treatment

Bearing seal

High cleanliness
(mass-produced melting)

Ultra-high cleanliness
(special melting)

Chemical component
design technology

Control of retained austenite

Special heat treatment

Z steel

EP steel

Aircraft engine bearings

Water TF bearing

Super TF bearing

Measures against particulate contamination

Improvement of foreign particle resistance

Resistance to crack generation caused by corrosion fatigue due to water infiltration

Resistance to crack propagation caused by corrosion fatigue due to water infiltration

Measures against water infiltration

Long Life

Surface originated flaking

Subsurface originated flaking

Hi-TF steel

Water TF bearing

Super TF bearing

Sealed four-row tapered roller bearing (E-CAPA series)

T/M sealed clean bearing

3. Life of WTF bearings

Bearing life test results under contaminated lubrication conditions of grease, water, and fine iron powder simulating the market are described in Figure 3. Trial usage results of actual cold rolling mills are described in Figure 4. Both results show a bearing life three times longer than that of conventional bearings.

Figure 3. Test results of tapered roller bearing life under contaminated lubrication conditions of grease, water, and fine iron powders simulating market conditions

Figure 4. Trial usage results of WTF bearings in an actual cold rolling mill

Figure 5. WTF bearing dimensions (example)
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