For New Technology Network

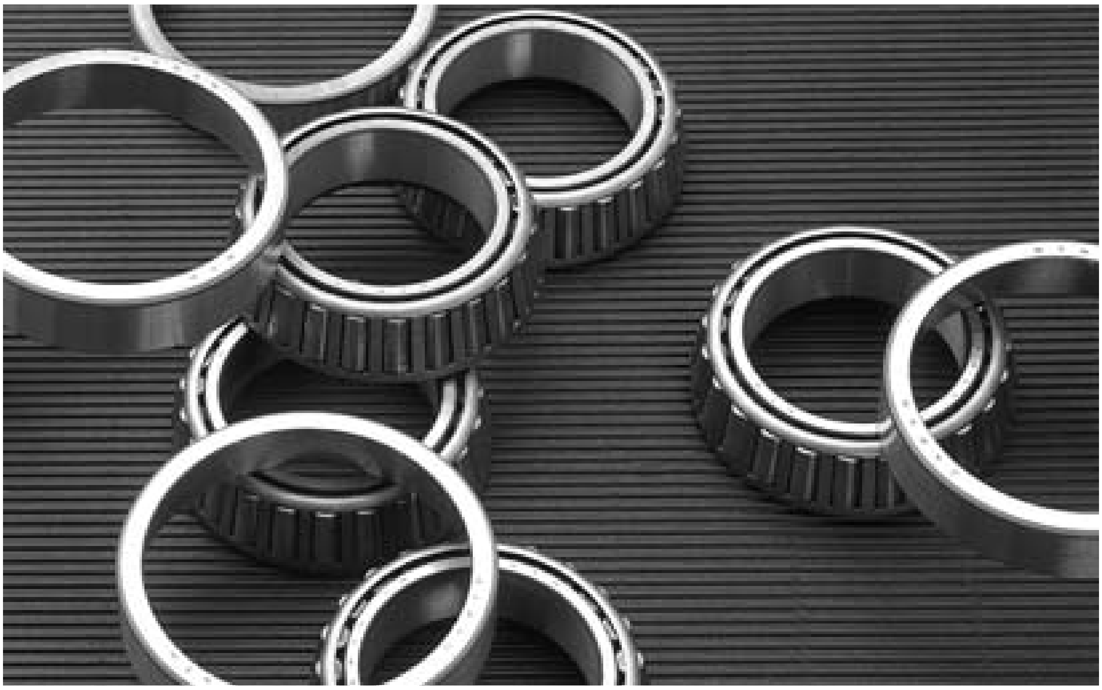
NTN corporation

Large Size, Long Operating Life Bearing - EA type

CAT. No. 3024／E

NTN Large Size, Long Life Bearings - EA type

A newly developed special heat treatment allows these bearings to ensure longer operating life under severe operating conditions!!



EA bearings have a particularly strong advantage by providing longer operating life due to their improved crack fatigue strength, wear strength and peeling resistance characteristics, especially when the lubricant is contaminated and also when the lubricant is clean. Accordingly, these bearings can be used at steel rolling mills and casting facilities where poor lubrication, vibrations and impact loads often exist. The EA bearings provide advantages due to their compact design, longer operating life, and longer intervals between maintenance and inspections. They can be used also for other applications with heavy loads and severe lubricating conditions such as construction and industrial machines.

1 Performance

(Operating life and strength comparison of EA bearings against standard carburized bearings)

(1) Operating life using lubricant mixed with foreign matter is: More than 5 times.
(2) Operating life using clean lubricant is: More than 2 times.
(3) Peeling strength: 3 times. (Rate of incidence is 1/3.)
(4) Wear strength: 2 times. (Wear rate is 1/2.)
(5) Fret strength: 1.3 times.(Wear rate is about 80%.)
(6) Operating life when fitting stress is high is: 3 times.
(7) Operating life against crack fatigue is: 1.5 times.

2 EA bearings

The analysis of bearing damage over many years confirms that most damages to large size bearings are caused by flaking, which starts from indentations made by foreign particles, from peeling caused by insufficient lubrication, from smearing and from cracks originating from those spots on the surface.

EA bearings are produced by a special heat treating process of carburized steel. This process is especially used for larger size bearings. The heat treatment combines carburization and nitriding. This process is an important achievement which strengthens the surface layer and provides a longer operating life when the damage originates on the surface. (Refer to **Fig.1**) The special heat treatment is applied to tapered roller bearings, cylindrical roller bearings and self-aligning spherical roller bearings. Consult **NTN** Corporation for available bearings. Large bearings are identified by the prefix EA. Small size tapered roller bearings use the prefix ETA.

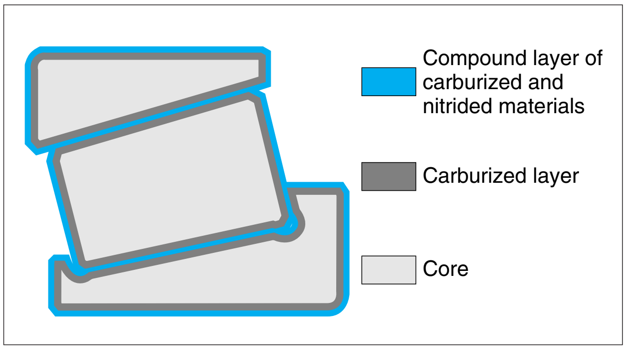


Fig. 1

3 Long Operating Life Theory

EA bearings are designed to form the dispersion of proper amounts of residual austenite and carbides in the surface layer through the special heat treating process. This also improves the thermal stability of the structure. Heat is usually generated on the raceway surface due to rolling friction and sheering stress. For standard bearings this may often change the characteristics of the material (i.e. its sheering stress, hardness and microstructure) and cracks may occur due to re-tempering and fatigue. Consequently, the peculiar characteristics of the EA bearing, namely the temper resistance which will not change the material quality due to tempering, and the surface toughness which will resist cracks and elongation, are effective against the types of damage which start from points on the surface. Adequate amounts of residual austenite, obtained by standard carburization, prevent cracks and their growth when through the manufacturing operations the bearing material strengthens and the surface layer becomes tougher, but this material on the surface is unstable when heated. Because of this fact, compounding nitrogen under suitable conditions and by permeating nitrogen, the residual austenite and martensite matrix of EA bearings is heat stabilized. This maintains the material quality while extracting the appropriate amount of carbide to increase the fatigue strength without lowering the crack strength.

Fig.2 shows the change of hardness of the standard carburized bearing and the carburized EA bearing by tempering, the change of residual austenite by tempering and the relation of matrix strength at high temperature measured by X-ray diffraction half-value width. Compared with the standard process, the special heat treatment provides high resistance to re-tempering and stability of residual austenite.

Fig.3 shows the change of the material quality on the bearing race surface when a lubricant mixed with foreign matter is used in the rolling fatigue test. The EA bearings show a longer operating life since their X-ray diffraction half value width (martensite hardness) and the residual austenite on the surface are resistant to change.

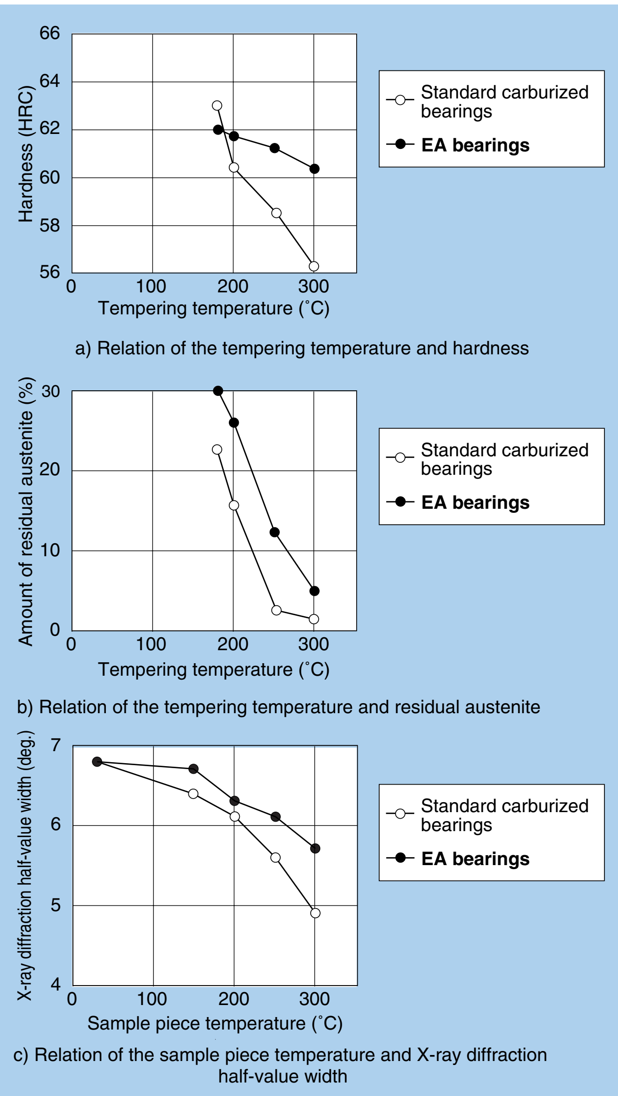


Fig.2 Material stability comparison for standard carburized bearings with EA bearings

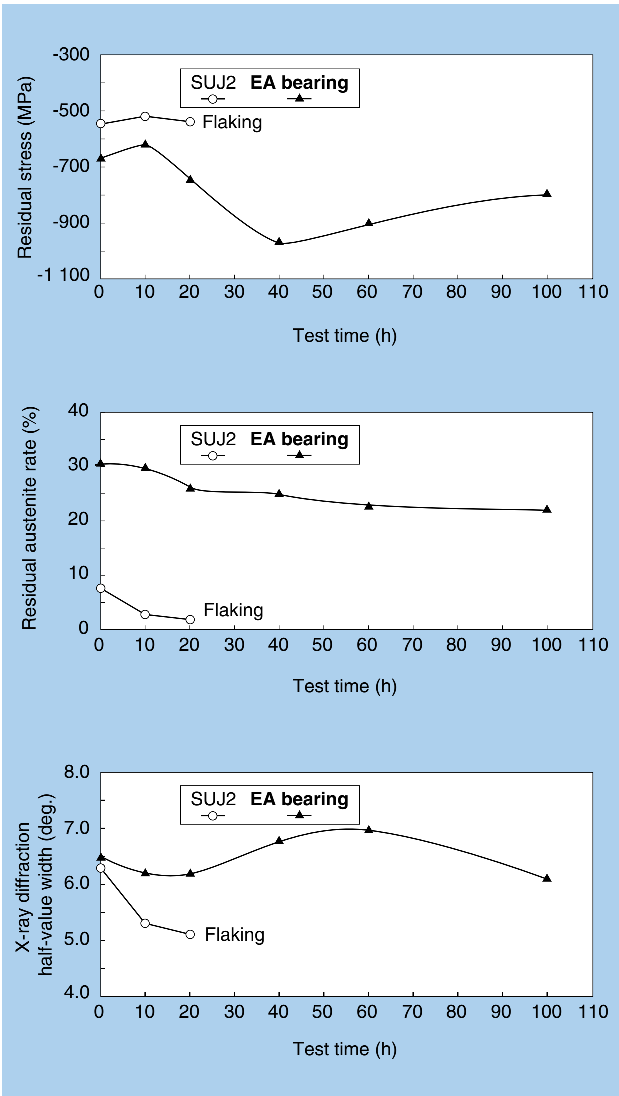


Fig.3 Material quality change on the surface when lubricant mixed with foreign material is used in the rolling fatigue test

4 Various Strength Characteristics

(1) Operating life when lubricant mixed with foreign matter is used.

Fig.4,5 show the durability results of comparison tests with small tapered roller bearings when lubricant mixed with foreign matter is used.
EA bearings display a life span of more than 5 times compared to standard carburized bearings regardless of test conditions.

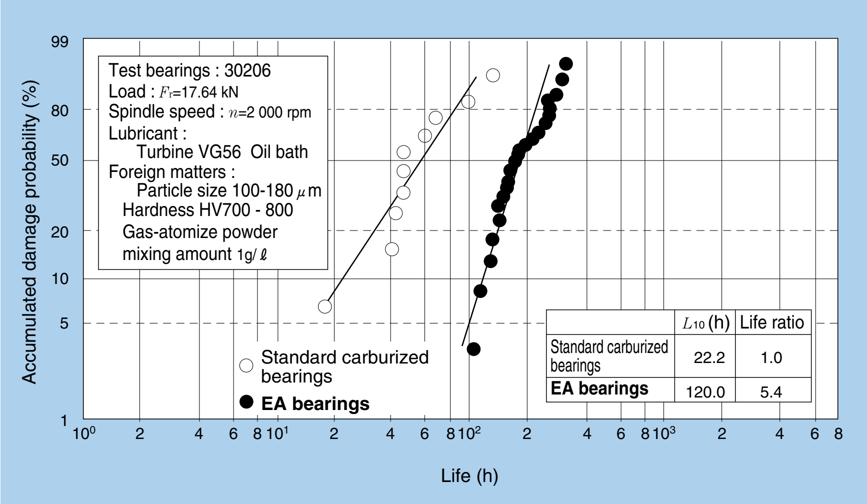


Fig.4 (Test conditions #1) Operating life results when lubricant mixed with foreign matter is used.

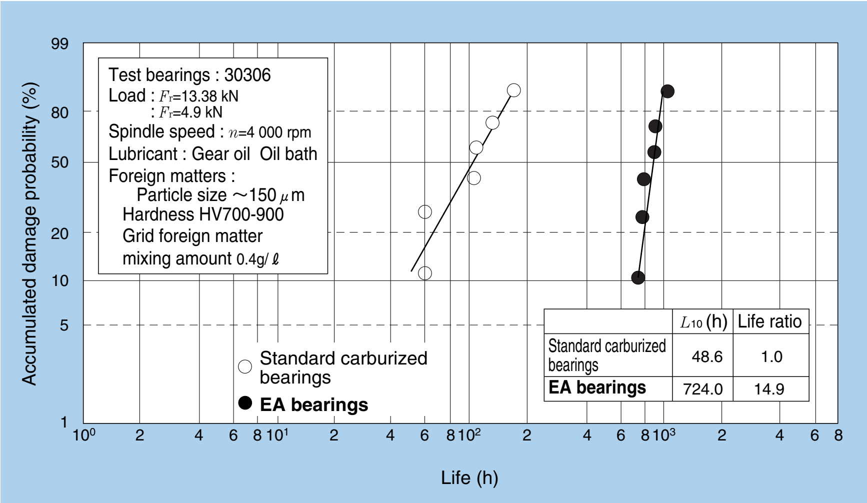


Fig.5 (Test conditions #2) Operating life results when lubricant mixed with foreign matter is used.

(2) Operating life when clean lubricant is used.

To compare the rolling fatigue strength under severe contact stress conditions, the operating life test between the standard carburized bearings and EA bearings was performed. **Fig.6** shows the result. The tests show that the EA bearings have a longer operating life than standard carburized bearings.

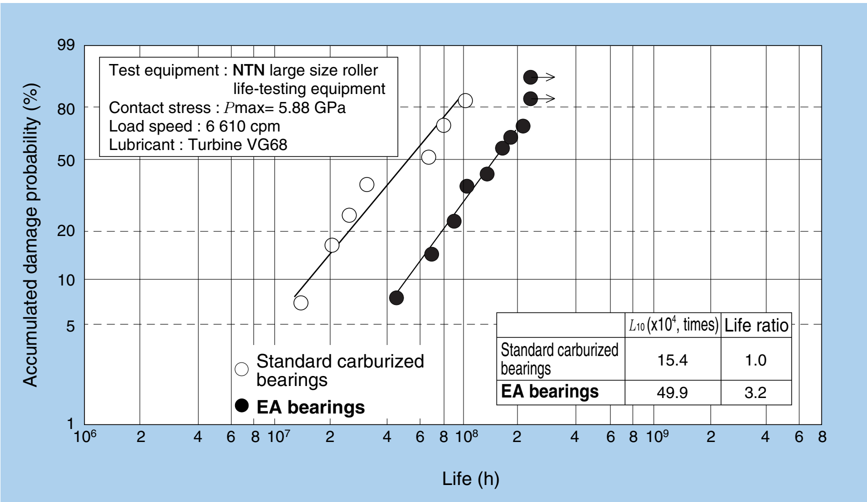


Fig.6 Operating life test results under severe stress condition with clean lubricant.

(3) Peeling Strength

Peeling damage occurs when lubrication film formation on rolling elements is insufficient and metal to metal contact takes place. It often occurs due to slippage and due to deterioration of the lubricating oil when infiltration of a sludge, water and foreign matter exists. **Fig.7** shows the strength comparison in relation to the damage. EA bearings have an incidence rate of about 1/3 compared with standard carburized bearings.

(4) Wear Resistant Strength

The sliding contact areas such as roller bearing ribs are subject to metal to metal abrasive wear in harsh lubricating conditions. The wear resistant strength has been measured using the **NTN** wear test unit. As indicated in **fig.8**, the wear trace depth of the special heat treated EA bearing has been roughly halved compared to that of the standard carburized bearings. Also as **fig.9** indicates, the EA bearing has superior fretting wear resistant characteristics.

(5) Crack Fatigue Strength

Cracking causes the destruction of the bearing. Under very severe operating conditions it is possible that this type of damage may occur. As shown in **Table 1** and **2**, EA bearings have a longer operating life than the standard carburized bearings when the results from rotation crack fatigue strength tests as well as the rolling crack fatigue strength tests with heavy press fits are compared.

Table 1 Ring test results for rotation crack fatigue strength

Bearing	L_{10}(h)×10^4 times	L_{10} ratio
Standard carburized bearings	6 670	1.0
EA bearings	9 020	1.4

Test conditions

Test unit :**NTN** Ring rotation crack fatigue test unit
Load :9.8kN
Load speed :8 000 cpm

Table 2 Test results for rolling crack fatigue strength with heavy ring press fit

Bearing	L_{10}(h)×10^4 times	L_{10} ratio
Standard carburized bearings	2 030	1.0
EA bearings	6 240	3.1

Test conditions

Test unit :**NTN** line contact type rolling life test unit
Fitting stress :425 MPa on raceways
Load :4.9 kN
Load speed :6 120 cpm

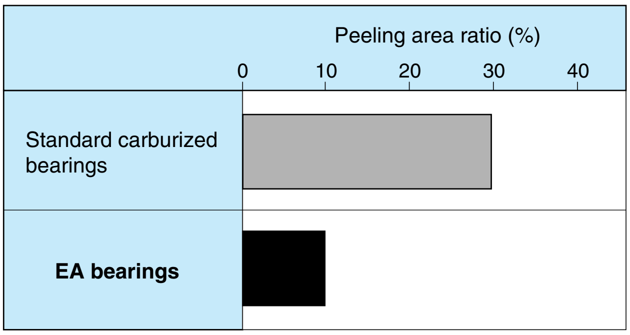


Fig.7 Results of surface strength using peeling strength test

Test conditions
Contact stress :P_{max}=3 GPa
Spindle speed :1 000 rpm
Lubricant :Turbine VG68
Total rotations :5x10^6 times

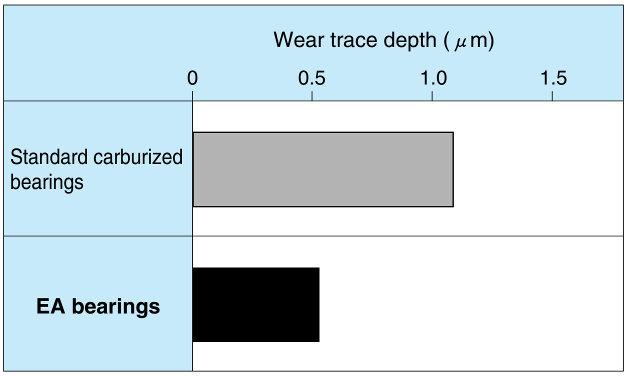


Fig.8 Results of wear test using NTN test unit

Test conditions
Contact stress :210 MPa P_{max}=210 MPa
Spindle speed :2 000 rpm
Lubricant :Turbine VG68
Test time :10 min.

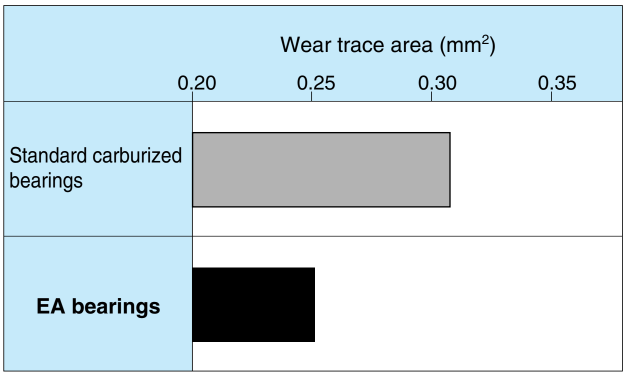


Fig.9 Results of fretting wear test

Test conditions
Contact stress :2.5 GPa
Amplitude :0.48 mm
Number of vibrations :30 Hz
Lubricant :Turbine VG68
Test time :8 hours