NTN INSIDER

TECH TIP

Comparing Common Heat Treatment Options for Tapered Roller Bearings

Originally designed as a longer-lasting bearing for wagon wheels over a century ago, the characteristics of tapered roller bearings make them a versatile bearing that has been adopted in a wide range of applications and industries, including automotive, aerospace, steel, mining, wind energy and more. Tapered roller bearings take advantage of line contact between the rolling elements and raceways, which allows them to carry heavier loads compared to ball bearings. Furthermore, the tapered rolling elements in these bearings make them excellent at supporting combined radial and axial loading. Due to their high load capacity, tapered roller bearings are often used in harsh applications where the bearings are subjected to heavy loading and impacting. Heat treatment of tapered roller bearings is crucial to their longevity in these applications, with the two most common heat treatments being through hardening and case hardening.

Through Hardening

Steel is primarily composed of iron that is mixed with carbon and other alloying elements. Carbon is an important alloying element in defining the metallurgical properties. Higher carbon content increases the hardness and strength of the material, which is important for wear resistance and long life in bearing steel. However, this also makes the steel more brittle. During the production of the molten through-hardened steel, a high level of carbon is dissolved into the iron mixture. The steel later goes through a hardening process, which involves heating the steel to a high temperature, followed by quenching (or cooling) and then tempering. This process equally hardens the material all the way through from the surface to the core. As a result, through-hardened bearings are relatively brittle and susceptible to fracture under impact loading.

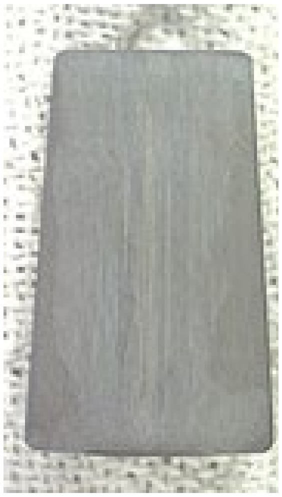

Figure 1: *Through-Hardened Roller*

Case Hardening

Case hardening (also known as carburizing) is a type of heat treatment commonly used for tapered roller bearings, which provides superior resistance to fracture under impact loading. In the case-hardening process, lower carbon steel is heat treated in a furnace with a carbon-controlled atmosphere. It remains in the furnace for a period of time to allow the carbon to be absorbed through the surface of the steel to a predetermined depth. This forms a hard, high-carbon surface layer necessary for the rolling contact surface, while the core remains relatively soft. The softer core is able to better absorb shock loading, making the bearing less prone to fracture under impact.

Figure 2: *Case-Hardened Roller*

In addition to improving impact resistance, the softer core improves performance under misaligned conditions and carburized material generally improves bearing fatigue life by 40%. For these reasons, case-hardened steel is the standard for every NTN-Bower bearing. In the study shown in ***Table 1*** on the back side of this document, a premium NTN-Bower carburized bearing demonstrated its advantage over competitor through-hardened bearings when tested under set radial and axial loading conditions, where the carburized bearing exhibited L10 fatigue life that was 50% higher than Competitor A and 413% higher than low-cost Competitor B.

Please contact your local NTN Sales Representative for more details.

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Table 1: Fatigue Life Comparison of NTN-Bower Carburized Bearing to Competitor Through-Hardened Bearing (Part Number: HM218248/HM218210)	
Life Comparison	**L10 Fatigue Life (hours)**
NTN-Bower Carburized	385
Competitor A Through-Hardened	257
Competitor B* Through-Hardened	75

**Competitor B bearings from this study were produced by a low-cost manufacturer.*

Tapered Roller Bearing Common Failures

In addition to bearing material and heat treatment selection, there are a number of other factors that may cause a bearing to last a shorter time in operation. Proper installation, lubrication and maintenance are all very important to achieving long bearing life. Shown below are a few of the most common failure modes for tapered roller bearings.

Figure 3: Impact Fracture
Fracturing of a through-hardened roller was caused by impact loading in a wheel end application.

Figure 4: Debris Denting
Widespread denting formed across the cup raceway surface due to ingress of particulate contamination into the bearing.

Figure 5: Excessive Axial Preload
Flaking damage was induced on the large end of the rollers due to excessive pressure against the rib face surface from applying too much preload during installation.

Figure 6: Excessive Endplay
Flaking damage was induced on the small end of the rollers due to improper setting during installation that allowed for excessive clearance.

Figure 7: Poor Lubrication
Heat discoloration on the raceway surface and smearing damage on the large end rib face were caused by an insufficient lubrication separating the rolling contact surfaces.

Beyond Bearings

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