# THERMOCHEMICAL TREATMENT METHODS FOR INCREASING THE HARDNESS OF BEARING RINGS

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**Annotation:** Thermochemical treatment methods are widely used to improve the wear resistance and extend the service life of bearing rings. Processes such as carburizing, nitrocarburizing, and boronizing enhance the hardness of the surface layer, ensuring resistance to mechanical and chemical influences. This article examines the effects of various thermochemical treatment technologies on the microstructure, hardness, and strength of bearing rings. The research results contribute to optimizing these processes and improving their efficiency.

**Keywords:** bearing, ring, hardness, thermochemical treatment, carburizing, nitrocarburizing, boronizing, microstructure, wear, strength, coating, diffusion, surface layer, durability, mechanical properties, heat treatment, chemical influence, optimization, metallurgy, efficiency.

## *1.Introduction*

In the mechanical engineering industry, bearings are an integral part of moving mechanisms. They are widely used in automobiles, aviation, railway transport, industrial equipment, and other critical systems. For bearings to function efficiently, they must possess high strength, wear resistance, and long service life. Various heat and chemical treatment methods are applied to achieve these properties. In particular, thermochemical treatment significantly improves the surface hardness of bearing rings, enhancing their wear resistance. This study focuses on examining thermochemical treatment methods aimed at increasing the durability of bearings, determining their effectiveness, and identifying optimal technological parameters. The research results are expected to contribute to improving the quality of bearings in the mechanical engineering industry.

### *2.Research and methods*

Carburizing.Carburizing is a method of increasing the hardness of metal surfaces by introducing carbon. In this process, bearing rings are heated to high temperatures and exposed to a carbon-rich atmosphere. As a result, carbon atoms penetrate the metal, enhancing its strength. This method yields rings with high hardness and improved wear resistance (resistance to friction-induced wear). Nitriding.Nitriding is a process of increasing the hardness of steel surfaces by introducing nitrogen. This method also improves the metal's corrosion resistance. Nitriding is typically performed at low temperatures, which reduces deformation. This process significantly enhances wear resistance and extends the service life of the components[1].

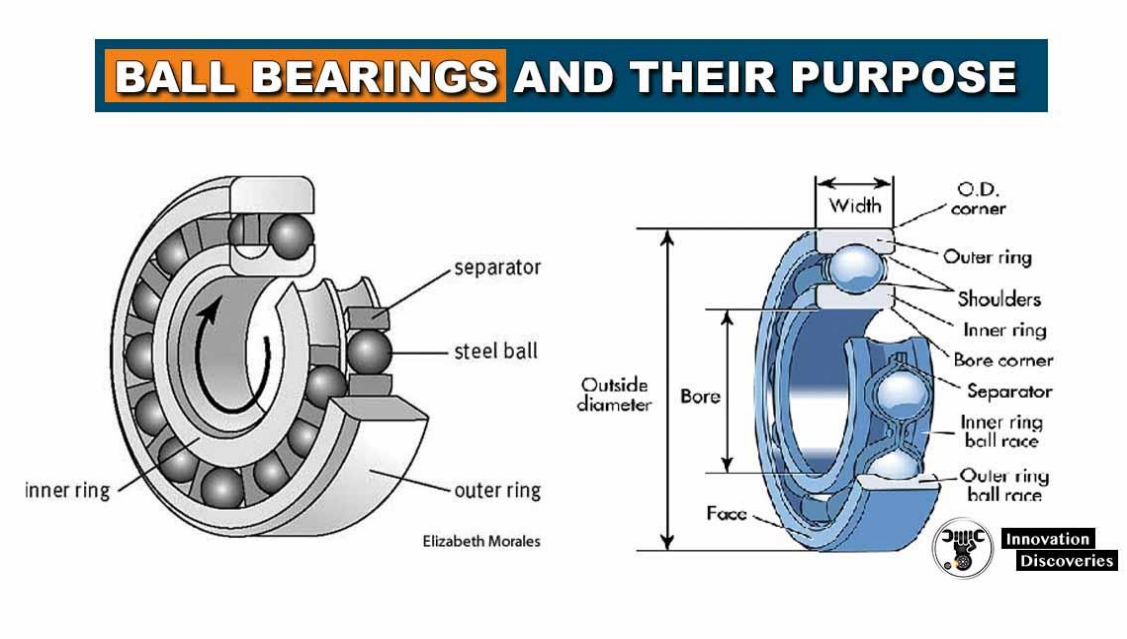


**Figure 1. Engine Bearings Structure**

Carbonitriding. Carbonitriding is a process in which both carbon and nitrogen are introduced into the metal surface. This process increases the strength and wear resistance of steel, making it highly effective for bearings as it strengthens the internal structure of the rings and enhances their hardness[2-3].

### *3.Results and analysis*

Experimental studies have shown that thermochemical treatment methods significantly increase the surface hardness of bearing rings. Comparative analyses

revealed that samples treated at high temperatures in specialized chemical environments exhibited much higher wear resistance and strength than those subjected to conventional heat treatment. In particular, bearings treated using carburizing and nitrocarburizing demonstrated a noticeable improvement in hardness and durability. Furthermore, experiments indicated that the service life of bearings is directly related to the technological parameters of the treatment process[3-4].

When optimal temperature and exposure times were selected, the internal structure of the material strengthened, improving its mechanical properties. This, in turn, enhanced the wear resistance of bearings and ensured their long-term efficient operation. Overall, research findings confirm that thermochemical treatment plays a crucial role in improving the quality of bearings in the mechanical engineering industry, significantly enhancing their performance efficiency[3].

***Table 1***

*Thermochemical Treatment Methods for Bearing Ring Components*

| **Treatment Method** | **Process Description** | **Advantages** | **Disadvantages** | **Application Areas** |
|---|---|---|---|---|
| Carburizing | Introducing carbon in a carbon-rich gas environment at high temperatures | Increases surface hardness and wear resistance | Inner layer may remain soft | Automotive industry, mechanical transmissions |
| Nitriding | Creating a hard surface layer by introducing nitrogen | Low-temperature process, reduces deformation | Time-consuming process | Aviation, energy equipment |
| Carbonitrid | Introducing both | Faster | Requires precise | Mechanical |

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| ing | carbon and nitrogen into the surface layer | process, high hardness and wear resistance | technological control | engineering, bearing manufacturing |
| Boriding | Treatment with boron compounds | High surface hardness and wear resistance | Complex and time-consuming process | High-load components |
| Alitizing | Formation of an aluminum layer to enhance oxidation resistance | High oxidation and corrosion resistance | Requires special conditions | High-temperature components, chemical industry |

### *4.Conclusion*

To enhance the wear resistance and long-term efficiency of bearing rings, thermochemical treatment methods such as carburizing, nitriding, and carbonitriding are employed. These methods increase surface hardness, improve strength, and significantly enhance wear resistance. Research indicates that selecting optimal treatment parameters leads to a significant improvement in bearing quality and service life. Modern technologies allow for these processes to be conducted more efficiently and cost-effectively. Additionally, the adoption of environmentally friendly methods reduces negative environmental impact and improves manufacturing efficiency. In the future, the application of innovative materials and advanced treatment technologies will further enhance the quality of bearings.

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