

CASTING TECHNOLOGY FOR BEARING RINGS

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Abstract: This article explores the casting technologies used in the production of bearing rings, focusing on their precision and material properties. Modern advancements, challenges, and quality control measures in casting processes are discussed. A detailed examination of process steps, including melting, mold preparation, and cooling, is provided. Figures and tables illustrate critical aspects of the technology.

Keywords: bearing rings, casting technology, mold preparation, quality control, material properties.

Introduction

Bearing rings play a critical role in reducing friction and enhancing the efficiency of rotating machinery. The casting process is fundamental to producing high-quality bearing rings, ensuring their durability, dimensional accuracy, and performance under varying loads. This paper investigates the casting technologies for bearing rings, emphasizing the precision required to meet industrial standards.

Objectives

- To provide an overview of the casting technologies used for bearing rings.
- To analyze the process parameters and their effects on product quality.
- To discuss advancements and challenges in the casting of bearing rings.

Methods

Materials

The materials commonly used in the production of bearing rings include:

- High-carbon steel
- Chromium steel

- Alloy steels with specific properties

Casting Process

The casting process for bearing rings involves the following steps:

Melting: High-quality steel is melted in an induction furnace to achieve the desired composition. Alloying elements are added to enhance properties such as hardness and wear resistance.

Mold Preparation: Sand molds are typically used for their cost-effectiveness and flexibility. Molds are coated with refractory materials to withstand high temperatures and ensure smooth surfaces.

Pouring: Molten steel is poured into the prepared molds under controlled conditions to prevent defects such as porosity and inclusions.

Cooling and Solidification: The casting is allowed to cool at a controlled rate to minimize residual stresses and ensure uniform microstructure.

Heat Treatment: Post-casting, the bearing rings undergo heat treatment processes such as quenching and tempering to achieve the required mechanical properties.

Machining and Finishing: The cast rings are machined to precise dimensions and subjected to surface treatments to enhance their performance.

Quality Control

- Non-destructive testing (NDT) methods such as ultrasonic and radiographic inspections are used to detect internal defects.
- Dimensional accuracy is verified using coordinate measuring machines (CMM).

Results

Process Efficiency

Table 1 highlights the typical production parameters and outcomes for casting bearing rings.

Table 1. Production Parameters for Bearing Rings

Parameter	Value/Range
Pouring Temperature	1500–1550 °C
Cooling Rate	10–15 °C/min
Surface Roughness	1.6–2.4 μm
Defect Rate	<2%

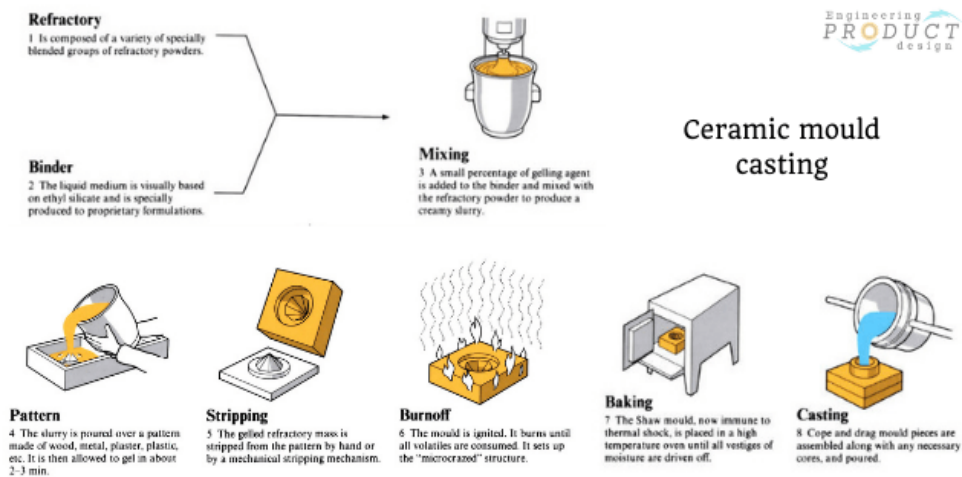


Figure 1 illustrates the casting process flow: Melting. Mold Preparation. Pouring. Cooling. Heat Treatment. Finishing

The term 'casting' also refers to the part made by the casting process, which dates back 6000 years. Historically it is used to make complex and large parts, which would have been difficult or expensive to manufacture using other manufacturing processes.

Primarily, casting produces ingots and shapes. An ingot is a casting produced into a simple shape intended for further processing, such as metal extrusion and forging. Shape casting is for near or net shape castings to produce complex geometries closer to the final part.

Some casting processes can produce Net-shape parts. No additional manufacturing operations are required to achieve the required geometry and dimensions for the parts. Other casting processes are Near-Net-Shape, which requires some other shaping processes, typically machining, to achieve accurate features such as threads, o-ring grooves, bearing seating and pilot holes of self-tapping screws.

Types of Metal Casting

Metal casting falls into two groups by the fundamental nature of the mould design. i.e. expendable mould and permanent mould castings. It can be further subdivided into groups depending on its pattern material.

- Expendable mould
- Permanent mould
- Composite mould

Metal casting steps

1. **Patternmaking** – A replica of the part to be cast is made using a suitable material such as wood, metal, plastic or plaster.
2. **Mould making** – Mould making is a multi-step process in which patterns and cores are used to create a mould. The type and how the moulds are made would vary depending on the type of metal casting. For example, sand casting uses sand inside a flask to create moulds and die casting uses hardened tool steel moulds.
3. **Metal melting & pouring** – Liquid is then melted and poured into the mould cavity either by gravity or high pressure. Then the cast is allowed to solidify before the cast parts are removed from the mould. Again, the cast part removal varies depending on the type of metal casting.
4. **Post-processing** – The cast metal object is removed from the mould and fettled in this final step. The object is cleaned of any moulding material during the fettling, and rough edges are removed.

Material suitability

Although almost all metals can be used, the most common ones are iron, steel, aluminium, magnesium and copper-based alloys such as bronze.

Zinc, aluminium, magnesium and brass are widely used in die casting, whereas aluminium alloy, brass alloy, cast iron, and cast steel are popular sand-casting materials.

Advantages and disadvantages of metal casting

Because of the above reasons, metal casting is a crucial net-shape manufacturing technology. Others include net-shape forging, sheet metal stamping, additive

manufacturing and metal injection moulding. As with any other manufacturing process, a basic understanding of the process, its underlying science, and its pros and cons are essential for manufacturing low-cost quality engineer products.

Advantages of metal casting

- Metal casting can produce complex shapes
- Features like internal cavities or hollow sections can be easily cast
- Significant components can be produced in a one-piece cast
- Materials that are difficult or expensive to manufacture using other manufacturing processes can be cast
- Compared to other manufacturing processes, casting is cheaper for medium to large quantities
- Almost all metals can be cast
- Near net shape often without or minor post-processing

Disadvantages of metal casting

- Relatively coarse surface finish and hence wider tolerance has to be allowed and is not suitable for mating interfaces
- Metal casting, such as shell moulding, has a limit in terms of size and the pattern
- Patterns are time-consuming and expensive to make, although additive manufacturing processes such as binder jetting are being used lately to make a mould
- Die casting can be very expensive for smaller to medium quantities due to the high die cost
- Part size and material choices depend on the casting process chosen. For instance, only nonferrous metal can be used for permanent mould castings

Discussion

The casting process for bearing rings is highly dependent on precise control of parameters. Modern advancements, such as automated pouring systems and advanced

mold materials, have significantly reduced defect rates. However, challenges such as thermal cracking and residual stresses remain areas of concern. Continuous monitoring and process optimization are essential for achieving consistent quality.

Limitations

- Variability in material properties due to inconsistencies in raw materials.
- High initial setup costs for automated systems.

Conclusion

Casting technology for bearing rings has evolved to meet stringent industrial requirements. Through advancements in materials, process control, and quality assurance, manufacturers can produce high-performance bearing rings with minimal defects. Further research into alternative materials and innovative techniques will enhance the sustainability and efficiency of the casting process.

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