PRODUCTION OF BEARING RINGS FROM FOUNDRY WASTE: ANALYSIS OF CASTING DEFECTS

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Abstract:

This article explores the production process of bearing rings utilizing secondary raw materials and foundry waste. The focus lies on the analysis of casting defects that occur during remelting and shaping processes. By investigating various types of inclusions, shrinkage cavities, and porosity, the study suggests optimal conditions for improving the quality of cast bearing components.

Keywords: Bearing rings, foundry waste, casting defects, inclusions, shrinkage, porosity, remelting, metallurgy

1. Introduction

The global demand for high-performance bearing components has led to the need for sustainable production methods. Recycling metal waste and utilizing foundry by-products has become an efficient solution for producing bearing rings. These methods not only reduce raw material costs but also help minimize environmental pollution. Bearing fault diagnosis is mainly performed in two aspects; on the one hand, the fault information is extracted from the vibration response signal, which is mainly extracted and diagnosed by various learning algorithms. For example, the deep learning approach [**3**,**4**], digital twin-driven approach [**5**], optimized adaptive deep belief network [**6**],

2. Materials and Methods

Bearing rings were produced by melting a mixture of primary and secondary steel in an induction furnace. The molten metal was poured into sand molds and cooled under controlled conditions. Post-casting operations included heat treatment and machining. The metallographic analysis was carried out using an optical microscope, and casting defects were identified using dye penetrant testing and ultrasonic examination[**7**].

3. Results and Discussion

The analysis revealed common casting defects including:

- **Inclusions:** Mostly slag and non-metallic particles introduced during remelting.
- **Shrinkage cavities:** Formed due to improper solidification.
- **Gas porosity:** Resulting from trapped gases during pouring.

Modifying the melting temperature, using effective degassing agents, and improving mold design significantly reduced the frequency of these defects[**8**].

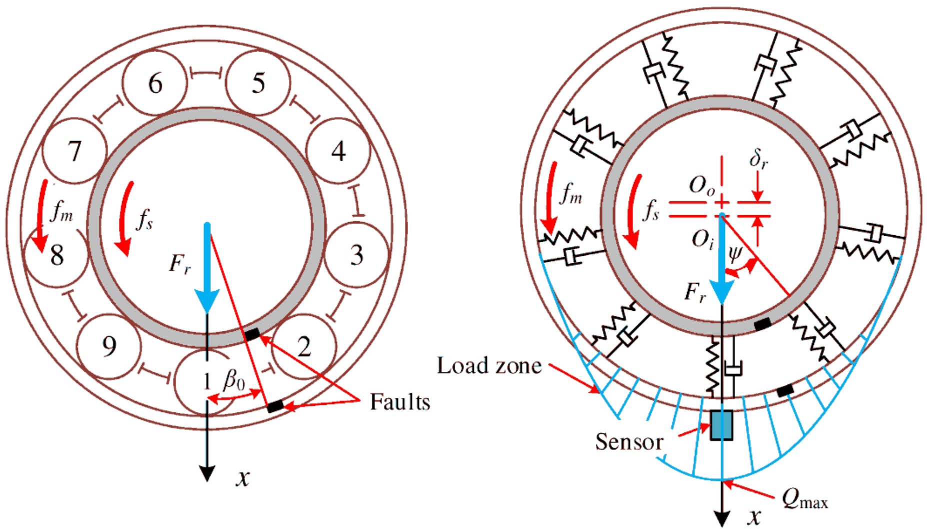

Figure 1. Schematic diagram of bearings under radial load. (a) Schematic diagram of the structure; (b) Simplified spring-damper model.4. Conclusion

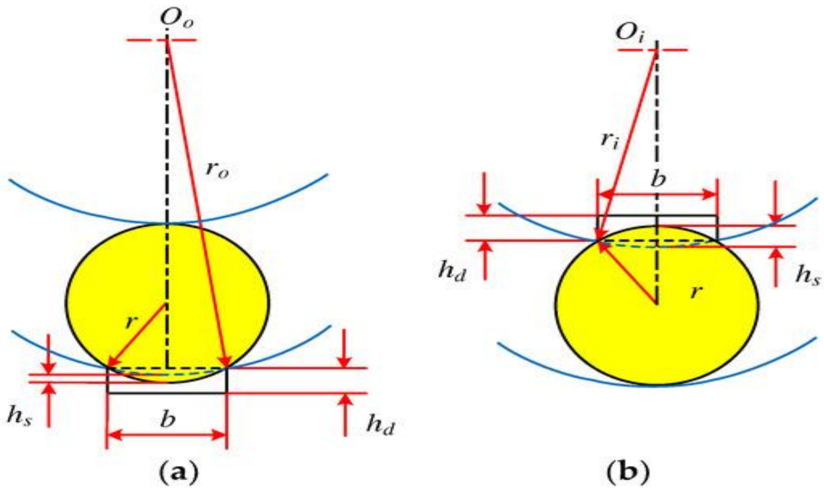

Figure 2. Structural diagram when the rolling element falls into the fault position. (**a**) Outer race fault; (**b**) inner race fault.

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Using foundry waste in the production of bearing rings is a viable and sustainable practice. Proper control of casting parameters and rigorous defect analysis are key to improving quality and mechanical properties. Future work will focus on optimizing alloy composition and further automation of defect detection[**8**].

The contact stiffness of the rolling elements abruptly decreases when the rolling elements fall into the fault position. The contact deformation and contact force of the load-carrying rolling elements in the load zone increases, rebalancing the external radial load while causing a sudden reduction in the total effective stiffness, resulting in the vibration of the system[**9**].

When different rolling elements fall into the outer race fault position, the change in the total effective stiffness and the system response are equal in magnitude. Additionally, there is significant outer race fault characteristic frequency and its frequency multiplication in the fault characteristic spectrums. When different rolling elements fall into the inner race fault position, the total effective stiffness is modulated by the inner race rotation and varies dramatically, resulting in the amplitude of the system time domain vibration response also being modulated by the inner race rotation and varying dramatically. Additionally, there are significant inner race rotational frequencies and their frequency multiplications, inner race fault characteristic frequencies and their frequency multiplication, and side frequency in the fault characteristic spectrums.

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