Comprehensive investigations and simulation study on fractured tenon of compressors X20Cr13 blade used in ironmaking plant

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Abstract

The fracture of compressor blade's tenon is a concrete problem in the operation of ironmaking plant. A systematic research on the fracture failure of the tenon of X20Cr13 blade has been carried out in this paper. Systematic research consists of two parts: comprehensive analysis and simulation analysis. Comprehensive analysis includes macroscopic analysis, metallographic structure analysis, SEM characterization, EDS characterization, mechanical property analysis, chemical composition analysis, hardness analysis and assembly structure analysis. The simulation analysis includes heat treatment simulation analysis, static stress software simulation analysis and resonance damage calculation analysis. The comprehensive analysis shows that the performance, chemical composition and hardness of blade are not the cause of failure. The cracks of blade tenon have the obvious fatigue crack characteristics. The fretting wear can produce the failure source which leads to the occurrence and development of cracks. A large number of M23C6 carbides with large particle size appeared in the metallographic structure and distributed unevenly and intensively along the grain boundary. These carbides not only damage the continuity of matrix structure but also create conditions for the initiation and propagation of fatigue cracks. Improper assembly of blades can also lead to excessive local stress. The simulation analysis further confirmed that the stress at the root of blade tenon is too large and the possibility of failure caused by resonance is eliminated. Improper heat treatment is also one of the causes of fracture. Based on the research conclusion, this paper also puts forward some constructive suggestions for this engineering problem.

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