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# Analysis of erosion morphology characteristics and mechanism of carbon brick in blast furnace hearth

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ABSTRACT

The macro and micro morphology, phase, and chemical composition of carbon bricks in a large blast furnace (BF) hearth after service were analyzed. The results show that the blast furnace hearth presents "elephant foot" erosion as a whole, the ceramic pad at the bottom of the BF is completely eroded, and the erosion in the taphole area is the most serious. The erosion of carbon bricks above the taphole is mainly affected by the harmful element zinc. The erosion at the taphole is mainly caused by zinc erosion, potassium erosion, and slag-iron alternating erosion. The "elephant foot" erosion morphology is mainly caused by the circumferential flow of molten iron. The erosion morphology of the BF bottom is mainly affected by the gas blowby, resulting in the uplift of the foundation of BF and the crushing of the ceramic pad. The serious erosion of the hearth taphole area of the BF is mainly affected by the flow of molten iron. The essence of carbon brick erosion by molten iron is that carbon atoms are separated from the carbon brick, enter the interstitial position of iron atoms, and may form a solid solution.

## 1. Introduction

Blast furnaces are currently the leading ironmaking equipment with high efficiency, low consumption, and environmental friendliness [1]. Extreme energy efficiency, green and low carbon have brought new challenges to the safe operation of BF [2,3]. Therefore, ensuring the safe operation of blast furnaces is an important measure to support the sustainable and high-quality development of China's iron and steel industry [4,5]. The safety of the blast furnace hearth area has become a key part of improving the safe operation of the BF [6,7]. At present, carbon bricks often improve the compressive and flexural strength of carbon bricks by adding nanoparticles or suitable curing conditions, and reduce porosity [8,9]. Therefore, it is beneficial to study the erosion morphological characteristics of the blast furnace hearth and the erosion mechanism to maintain the long campaign life of the BF.

At present, there are four main types of hearth erosion morphology, mushroom type, elephant foot type, wide face type, and pot bottom type [10]. The carbon bricks used in the hearth are prone to oxidation reaction, which causes cracking so that the molten iron penetrates the inside of the carbon bricks and accelerates the erosion of the carbon bricks [11]. The decrease of carbon content in the molten iron of BF will further deepen the erosion of refractory materials [12]. Zinc and potassium erosion in the blast furnace hearth will lead to the formation of cracks in the carbon bricks, which will eventually form a brittle layer and destroy the carbon bricks [13]. The flow of molten iron in the hearth area of the blast furnace will lead to significant erosion of refractory materials and lead to the

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