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Performance analysis and substitution potential of biomass charcoal as foaming agent for EAF

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Foamed slag technology is the core process of ultra-high-power electric furnace steelmaking, which is crucial for enhancing thermal efficiency, protecting furnace lining and optimizing molten steel quality. This paper takes biomass charcoal as the research object, systematically analyzes its performance and influencing factors as a blowing agent, and compares it with traditional fossil-based blowing agents (coke, graphite, anthracite). Waste wood block charcoal, corn stover charcoal, waste bamboo charcoal and industrial wood charcoal were used in the experiment, combined with chemically formulated electric furnace slag, and their foaming ability was evaluated by high-temperature foaming experiments with comprehensive foaming index (K). The results showed that the waste wood charcoal showed the best overall performance due to its high fixed carbon content and low ash content; the corn stover charcoal significantly reduced the viscosity of the slag due to its high ash content and high alkali metal content, resulting in the worst foaming area and duration; the waste bamboo charcoal, although with the highest fixed carbon content, had a high potassium content in the ash content that exacerbated the deterioration of the foam stability, and had a second best overall performance than that of the waste wood charcoal. Compared with fossil blowing agents, graphite showed the highest maximum foaming area and comprehensive index, but industrial wood charcoal showed substitution potential by virtue of its longer foaming time and low-carbon environmental protection characteristics. The study further revealed the synergistic effects of slag alkalinity, viscosity and surface tension on foaming performance, indicating that alkali metals (e.g., K, Na) in the ash fraction of biomass char reduced the viscosity by disrupting the silica-oxygen network, but an excessive amount shortened the foam life. This study provides a theoretical basis for the large-scale application of biomass char in electric furnace steelmaking, which is in line with the development needs of green metallurgy under the “dual-carbon”strategy.

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