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Reaction behaviour of different carbon sources in FeO containing slags for electric smelting furnaces

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Electric smelting furnaces (ESF) represent a promising ironmaking technology for reducing steel industry's CO2 emissions by utilizing direct reduced iron and a lower need of solid carbon sources compared to blast furnaces. Carbon sources in ESFs serve two primary functions: reduction of FeO from slag and acting as carburizers for the hot metal. Thus, the yield of ESFs is strongly influenced by their reaction behavior and density, with biogenic options (biochar) playing a key role in advancing sustainability. However, carbon carrier performance is influenced by reactivity, which depends on volatile matter, specific surface area (SSA), porosity and fixed carbon content. This study compares biogenic and fossil carbon sources to evaluate if biochars can outperform traditional carbon carriers in reduction behavior. Lab-scale submerging trials in 15 % FeO slag were conducted at 1550 °C to investigate the reaction behavior of biogenic (biochar from wood chips, wood coal pellets) and fossil-based (coke, anthracite) materials. Higher FeO contents can be locally present in the process zone of ESFs. Therefore, the FeO content in the used slag, recalculated from an ESF slag, was increased to ensure a sufficient FeO gradient and better highlight the reaction behavior.
The investigations indicate a faster reaction behavior with increased gas bubble size for biochar. Additional BET N2-SSA measurements revealed an increasing order of wood coal pellets (1.23 m2 g-1) < coke (2.54 m2 g-1) < anthracite (9.07 m2 g-1) < wood chips (273.71 m2 g 1), implying that biochar may have a higher reactivity. Wood pellets showed a lower SSA due to their compacted form compared to the particle form of other tested carriers. Biochars have the potential to maintain or even improve ESF yields. Nevertheless, understanding their behavior in metallurgical processes is essential for their integration into future ironmaking, offering a sustainable alternative to fossil carbon sources

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