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Future slags in electric-based ironmaking and steelmaking

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Ironmaking and steelmaking decarbonization involves significant transformations in existing production processes, and electric-based melting units are acquiring even more importance. Both Electric Arc Furnace (EAF) and Electric Smelting Furnace (ESF) are indeed considered at the bases of future steel and hot metal production, respectively. EAF is a well-known technology deeply used in scrap-based steelmaking and that, in future, will be included in novel integrated steelmaking route coupled with shaft furnaces for iron direct reduction. ESF is a technology used also in other metallurgical sectors, while it is now receiving ever increasing attention also in the steelmaking field.
Since the availability and quality of raw materials (e.g. scraps) is affected by emerging countries and markets, Direct Reduced Iron (DRI) and Hot Briquetted Iron (HBI) are expected to be exploited more in both processes. DRI and HBI availability and quality will be affected by the pellet, strongly linked to the raw material quality, and gas mixture used in related production. Besides process changes and adaptations requirements, to achieve product specifications and sustainable processes, also slag modifications have to be explored for ensuring one of the pillars of ironmaking and steelmaking: its role in circular economy thanks to its main byproduct (i.e. the slags).
The contribution focuses on scenarios investigations carried out with two flowsheet models (i.e. for EAF and ESF) and during the European project entitled "Investigations of Slags from Next Generation Steel Making Processes"(Ref. InSGeP), Grant Agreement No. 101112665. The EAF flowsheet model is a part of a complex stationary model covering the whole scrap-based electric steelmaking. It was firstly developed for making energy and environmental impact evaluations, was then adapted to carry out different types of investigations, and it was validated for different steelworks and steel families. The ESF stationary model has been recently developed based on literature results. It considers ESF in a modular way by reproducing main ESF phenomena and reactions. Different zones are considered to this aim, namely charge zone, top ESF zone, bottom ESF zone and discharge zone. Simulations have been performed via the mentioned models under certain product and process specifications. They allowed exploring, among other aspects, the amount and chemical composition of slags produced with different iron bearing materials fed alone or in mixture. The results show interesting behaviors. The effect severity reflects the quality of used material, and process adaptations are sometimes required to make the slags suitable for correct industrial operations.

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