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A comparison of simulated and analysed phase compositions of solidified EAF slags

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Transition towards fossil-free iron and steel production increases the role of electric arc furnaces (EAF), whereas the role of blast furnaces (BF) decreases. This has drawn an increasing attention towards the valorisation of EAF slags with the target in the high value applications such as supplementary cementitious materials (SCM). This is supported not only by the declining production of the granulated blast furnace slag (GBFS) currently widely used as a SCM, but also common targets for both cement and steel industry to reduce carbon dioxide emissions.

Due to their different chemical and mineralogical composition, structure and properties in comparison to GBFS, the EAF slags cannot be used as SCMs as such (Kallio et al. 2025). It is widely considered that usage as SCM requires treatments such as modification of the composition towards lower basicity, removal of certain components (e.g. via reduction), controlled and sufficiently fast cooling as well as a feasible way to even out the potential differences due to use of different kind of raw materials in the EAF (steel scrap, DRI reduced with either hydrogen or other reductants, Fe-containing secondary materials such as briquetted dusts, etc.).

The properties and potential applicability of EAF slags are affected by several variables:

- Used raw materials (steel scrap, DRI) and their composition.
- Aimed basicity of modified slags.
- Amount and nature of materials used to modify the basicity (e.g. quartz, silica-containing tailings).
- Aimed reduction degree of reduced metals (e.g. iron), when recovering metals by reduction.
- Amount and nature of materials used as reductants (e.g. coal, biochar, aluminium, ferrosilicon).

The purpose of this study has been to supplement the experimental studies (Merenluoto 2024; Merenluoto et al. 2026) with thermodynamic simulations in which both equilibrium and Scheil-Gulliver calculations were made for different slag systems with varying compositions. Although not being able to simulate the formation of amorphous glass phase obtained with fast cooling of low basicity slags, computational thermodynamics nevertheless offer a tool to quickly estimate the effect of different slag treatments on the stabilities, amounts, compositions and solidification orders of solid crystalline phases as well as solidus and liquidus temperatures.

Kallio, R., Cantaluppi, M., Louhisalmi, J., & Visuri, V. V. (2025). Mineralogical characteristics of fossil-free steel slags. Minerals Engineering, 230(April), 109396. https://doi.org/10.1016/j.mineng.2025.109396

Merenluoto, A. (2024). Effects of Modification and Granulation on Properties of Dri-Based Eaf Slag (Issue July). University of Oulu.

Merenluoto, A. et al., to be submitted 2026.

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