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On the hunt for fluxes and reducing agents

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Flue dust from pyrometallurgical metal extraction is an important source of secondary raw materials for many metals, including those classified as strategic.

However, in many cases, they remain unused if they cannot be immediately returned to the process. In this case, they are safely deposited or landfilled as hazardous waste. These materials are continuously transformed by various (geo)chemical processes, resulting in heterogeneous, sometimes toxic, and often small-volume residues.

Since processing these materials alone is often uneconomical and can lead to new environmental pollution, we developed the FINEST concept. This concept involves mixing various fine-grained waste streams to create a raw material optimized for efficient pyrometallurgical processes.

We have experimentally implemented and confirmed this concept for processing so-called "Theisenschlamm" mixed with fluxing and reducing agents from secondary raw material sources [1, 2].

"Theisenschlamm" was already established as a raw material, and the choice of the other components of the "recipe" was made more or less by chance when screening possible raw material sources in the surrounding area.

Systematic thermodynamic modeling of various mixture systems is suitable for transitioning from this alchemical approach to a systematic procedure.

To this end, we developed a PostgreSQL database to collect the chemical, phase, and physical parameters of fine-grained secondary raw materials, such as fillers from quarrying operations, residual material from building material recycling, processing residues from tailings piles, and flue dust. We then classified these materials using Shiny Apps and prepared them as input data for thermodynamic modeling. We will discuss this database structure and its potential applications.

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[1] Renno et al. The "Theisenschlamm" challenge: exploring the potential and limits of valorizing a stockpiled flue dust slurry by mixing it with other environmentally toxic waste streams" Goldschmidt 2025 Abstract https://doi.org/10.7185/gold2025.31473

[2] Hossain et al. "Valorization of hazardous legacy waste flue dust of former copper smelting using pyrometallurgical pathways" in revision