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Thermodynamic Assessment of Metallurgical Processes Using Thermo-Calc and MATLAB Integration

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Accurate prediction of thermodynamic behavior in metallurgical melting processes is essential for optimizing industrial operations and reducing experimental costs. This work introduces a computational tool that integrates the Process Metallurgy module of Thermo-Calc with MATLAB to enable automated, scalable evaluations of multiple process scenarios. Traditionally, performing sequential calculations in Thermo-Calc requires manual input, which is time-consuming and limits efficiency when exploring large parameter spaces. To overcome these limitations, the Thermo-Calc Toolbox for MATLAB was implemented, allowing the development of a custom script capable of processing diverse parameter sets for various thermodynamic conditions.
The initial script was designed to execute multiple calculations in sequence, significantly reducing manual effort. Building upon this foundation, the script was further enhanced and transformed into a MATLAB-based application featuring a graphical user interface (GUI). This application provides an intuitive platform for configuring input parameters, initiating calculations, and visualizing results through customizable plots. The visualization capabilities allow users to quickly interpret trends and compare outcomes across different parameter sets, offering a clear overview of complex thermodynamic relationships.
A key advantage of the developed tool lies in its ability to perform extensive parameter sweeps, enabling rapid recognition of improved conditions for metallurgical processes. Additionally, the application supports preliminary estimations under fixed conditions, which can be benchmarked against experimental data. This functionality assists process engineers in validating theoretical predictions and refining operational strategies prior to costly experimental trials, thereby improving efficiency and sustainability.
The integration of Thermo-Calc with MATLAB through a custom-built application demonstrates how traditional thermodynamic assessments can be transformed into an automated, user-friendly, and highly visual process. By combining automated computation, interactive visualization, and flexible parameter management, this approach provides a robust platform for systematic evaluation of smelting processes. Ultimately, the tool contributes to faster decision-making, reduced development time, and enhanced process reliability in modern metallurgical operations.

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