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Speaker: Sabrine Khadhraoui, R&D/ Melting and Casting Technology, SMS group GmbH, Düsseldorf, Germany.

Talk: Deep learning of thermodynamic equilibria for optimized process control

Authors: Ali Akouch, Prof. Dr. Markus A. Reuter, Dr. Christoph Kirmse, Michael Bruns, Dr. Sabrine Khadhraoui, Dr. Rolf Degel, Erik Hecker, Nikolaus Borowski

SMS group GmbH, Germany

Abstract:

The use of artificial intelligence (AI) methods has played a game-changing role in process metallurgy as discussed by Reuter et al. [1]. At that time it was already recognized that the use of fundamental physics physics-based data is important to ensure that the integrity of the models is maintained with respect to mass- and heat transfer, process kinetics, and thermodynamics, to mention a few as discussed by Aldrich et al. [2].
In this paper, we discuss further developments in the creation of thermodynamic-based dynamic process models, which:

- optimize the feed mix for various batch batch-type recycling processes
- calculate different operating times for different processing stages, flux additions, gas flow rates, temperature, etc. the final metal quality e.g. copper anode composition,
- determine the off-gas composition and amount, and
- metal production as well as slag creation tonnages etc…

The BlueControlApp has two versions:

- an offline version that can be used for the training of operators and for calculating different operating conditions (linked directly to the thermochemical equilibrium software library ChemApp)
- a real-time version that captures various data generated by the off-line version as base data and deep learns the data, which then can be used as a surrogate model within a real-time environment as a robust calculation engine

In this paper, the functionality and benefits of the BlueControl application for operators will be described based on the example of a tilting refining furnace (TRF).

[1] REUTER, M.A., VAN DER WALT, T.J., VAN DEVENTER, J.S.J. (1992): Modelling of metal-slag equilibrium processes using neural nets. Metallurgical Transactions B, 23: S. 641-650.

[2] ALDRICH, C., VAN DEVENTER, J.S.J., REUTER, M.A. (1994): The application of neural nets in the metallurgical industry. Minerals Engineering, 7: S. 793-809.