Flow Sheet based modeling approach to control iron and steel making supply chain

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Introduction

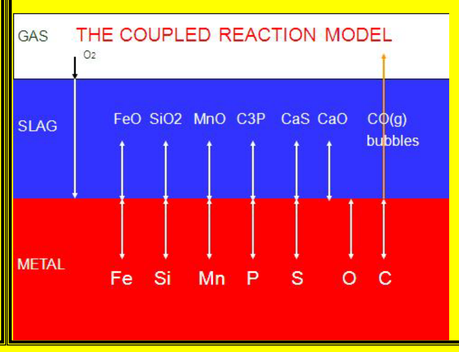
Iron and steel making processes consume enormous amount of materials in a large scale production unit. The overall process consists of the flow of material as well as heat across large number of interconnected unit process reactors. Almost all reactors have deviations from thermodynamic equilibrium in overall sense but they can be classified as large number of interconnected localized equilibrium reactors with restricted interactions among them. Therefore the role of thermodynamic package like FactSage and sequential modular based package like METSIM becomes very important for process design and control as well as for studying the parameters to achieve minimum cost and CO_2 emissions. In the paper flow sheet modeling based approach with coupled application of FactSage and METSIM is demonstrated for modeling of iron making process (blast furnace as well as Midrex) and steelmaking process (like BOF).

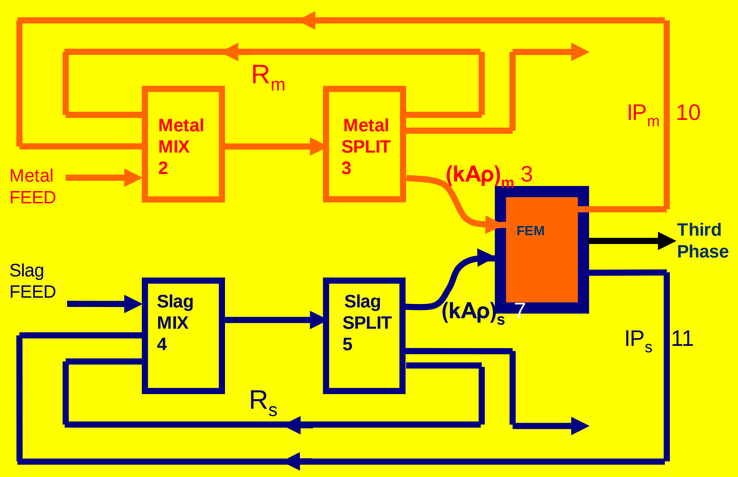
Flow Sheet based modeling as an innovative approach to model iron and steelmaking supply chain

- The basis for analysis of all chemical and metallurgical processes is the mass and energy balance. Plant design, capital costs, and technical evaluations are all dependent on such calculations. Flowsheet modeling approach (using METSIM, FactSage-ChemSheet etc.) assist the steel plant engineer in performing mass and energy balances of complex processes.

- The kinetics of metal-slag-gas reactions can be adequately defined as a flowsheet including free energy minimization at reaction interfaces.

Representation of coupled reactions between multiple phases (slag-metal-gas) is a flowsheet based model

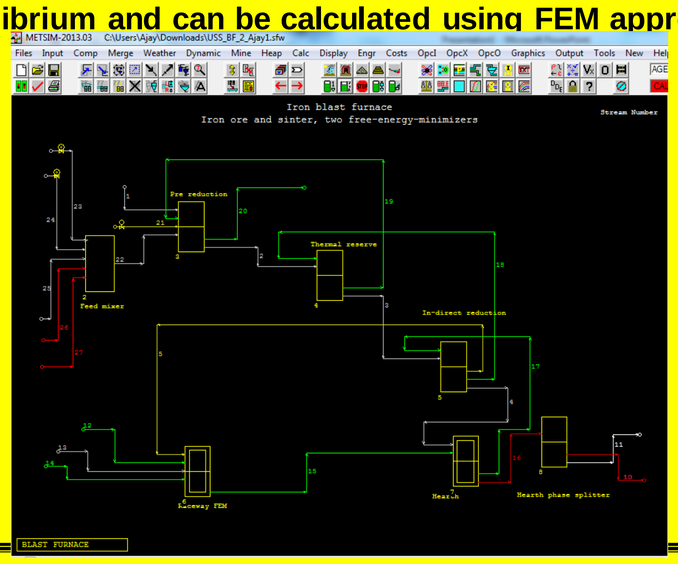




Iron and Steelmaking Processes modeled employing METSIM

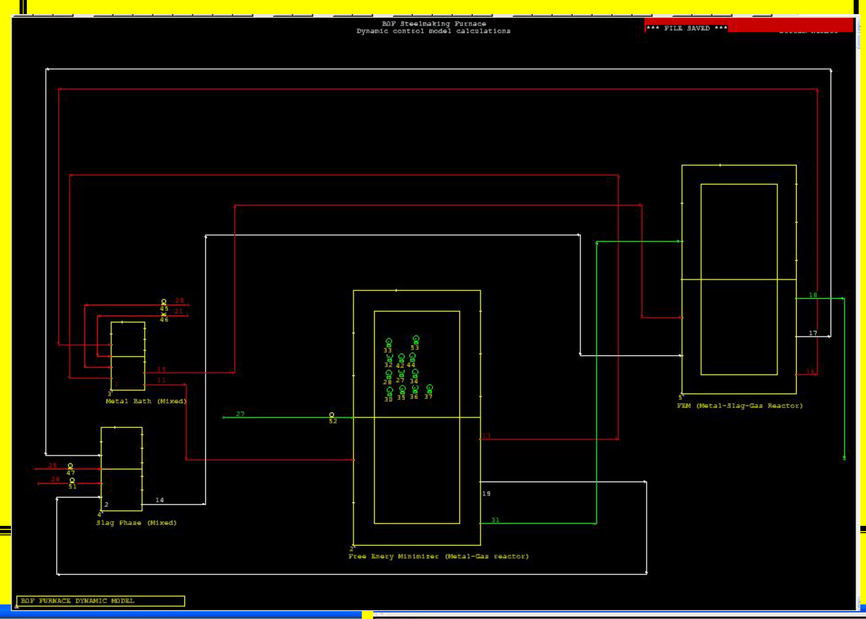
Blast Furnace Iron making

- The entire reactor can be divided into different zones namely preheating zone, thermal reserve zone, indirect reaction zone, Hearth zone and raceway zone.
- The gaseous stream of each zone is recycled in previous zone (counter current reactor).
- Hearth zone and Raceway zones are in thermodynamic equilibrium and can be calculated using FEM approach.



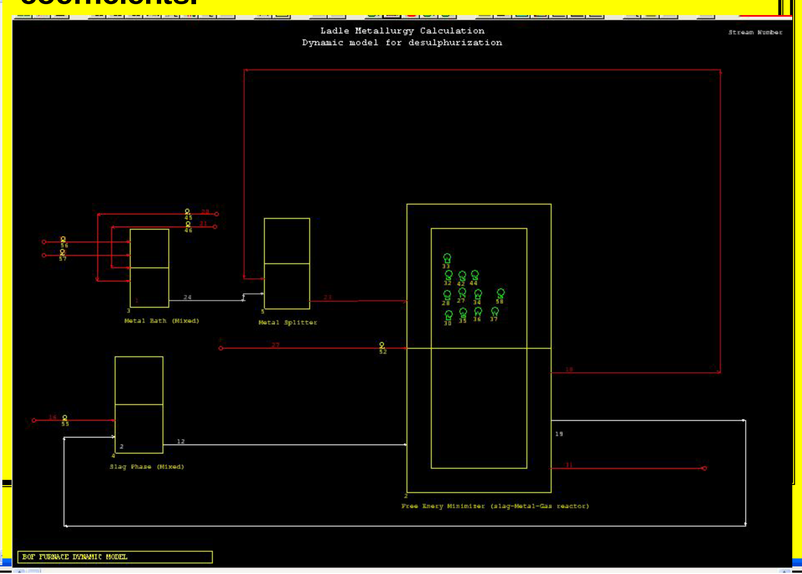
Dynamic Control model of BOF Steelmaking

- Process is divided into FEM based reaction zones connected through recirculation streams.
- Two reaction zones are considered. One under jet impact zone (metal-gas reactor) and another in slag-metal-gas emulsion (slag-metal-gas reactor).



Kinetics of Ladle Metallurgy Process

- Kinetics of deoxidation, desulphurization, inclusion removal, degassing under influence of various other conditions can be modeled very effectively in METSIM.
- The rates of various streams to slag-metal FEM reactor can be adjusted in accordance to the control mechanism and mass transfer coefficients.



Results