VDEh-Betriebsforschungsinstitut GmbH

Iron Ore Sintering Process Model to Study Local Permeability Control

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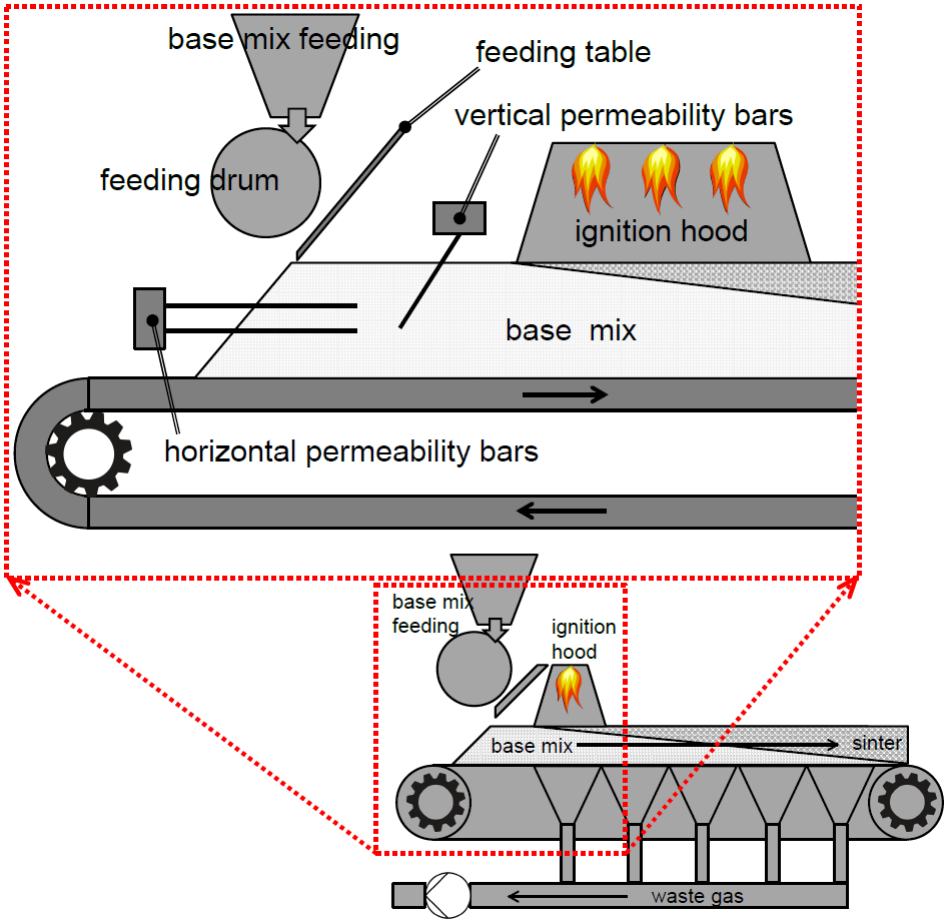
Introduction



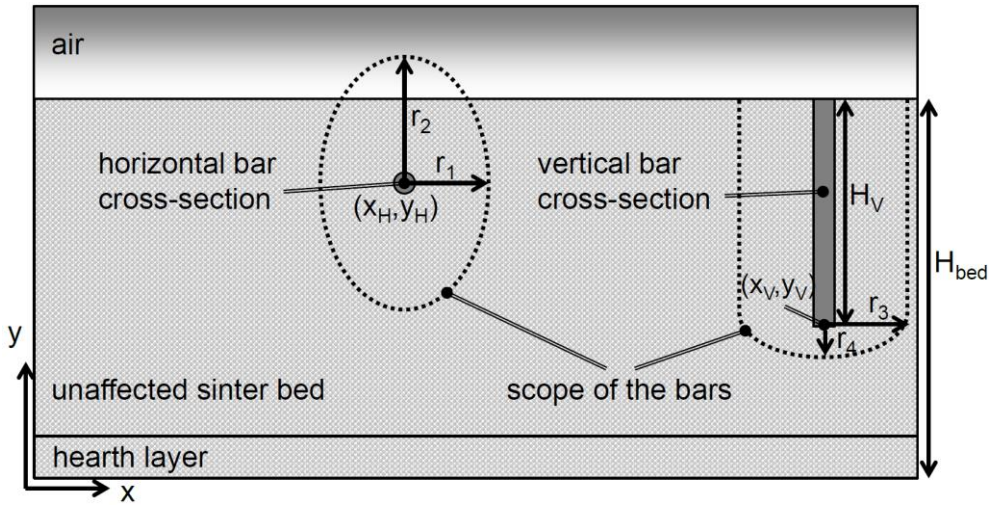
Sinter process prepares the fine iron ores for the blast furnace process by agglomeration at high temperatures. It also allows recycling of waste products from other sections of the steel making process.

The efficiency of the process can be improved by permeability bars, which locally increase the porosity of the bed and thus influence the speed of coke burnout.

A transient 2D sinter process model was developed to investigate the influence of various permeability bar configurations on the process.

Computational Methods:
Reacting Flow through Porous Bed

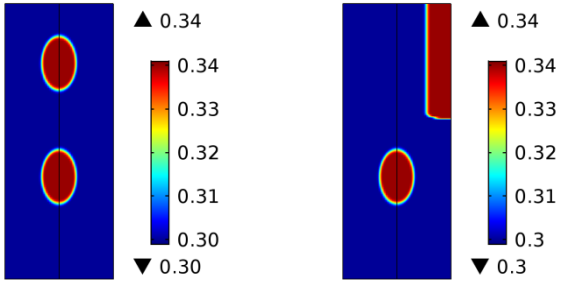
1. heat transfer in gas and solids
2. heat exchange between gas and solids,
3. melting and solidification enthalpies.
4. gas flow through the porous bed,
5. ***local porosity variation***,
6. mass exchange between gas and solids,
7. transport of concentrated species in gas,
8. drying and condensation,
9. coke burn-out, calcination, and sulfation



$$\varepsilon_s(x,y) = \varepsilon_{s0} + \Delta\varepsilon \cdot \left(\text{step}(\hat{r}_H^2) + \text{step}(\hat{r}_V^2)\right) \quad \text{where}$$

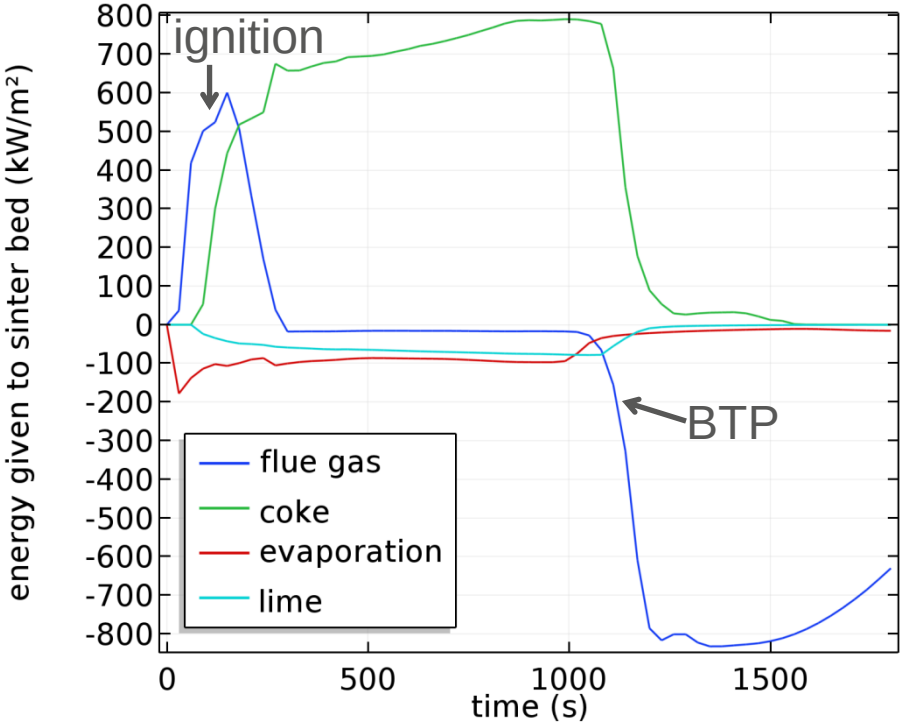
$$\hat{r}_H^2 = \frac{(x-x_H)^2}{r_1^2} + \frac{(y-y_H)^2}{r_2^2}$$

$$\hat{r}_V^2 = \begin{cases} \frac{(x-x_V)^2}{r_3^2} + \frac{(y-y_V)^2}{r_4^2} & \text{if } y < y_V \\ \frac{(x-x_V)^2}{r_3^2} & \text{otherwise} \end{cases}$$

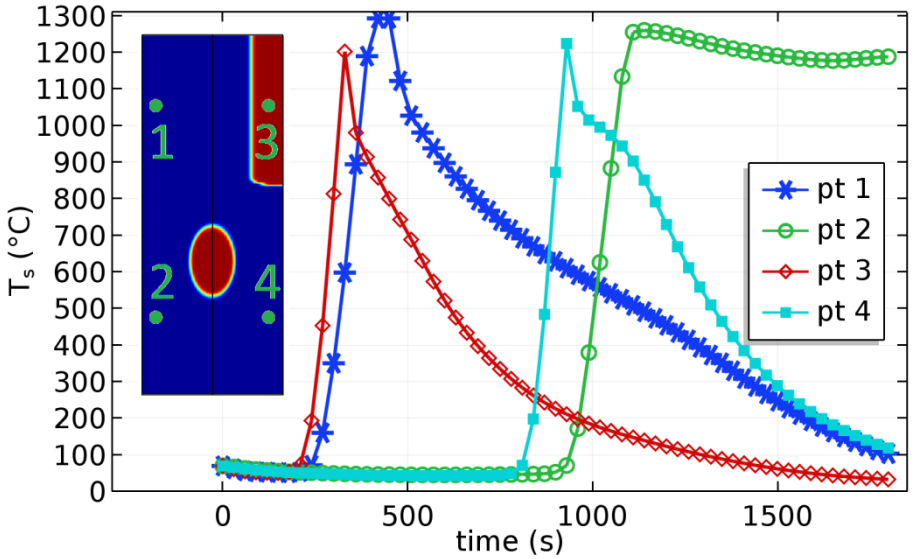


Results:
Energy Exchange & Temperature & Quality

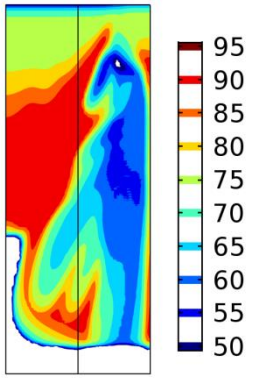
Specific energies introduced into sinter bed



Time-temperature curves

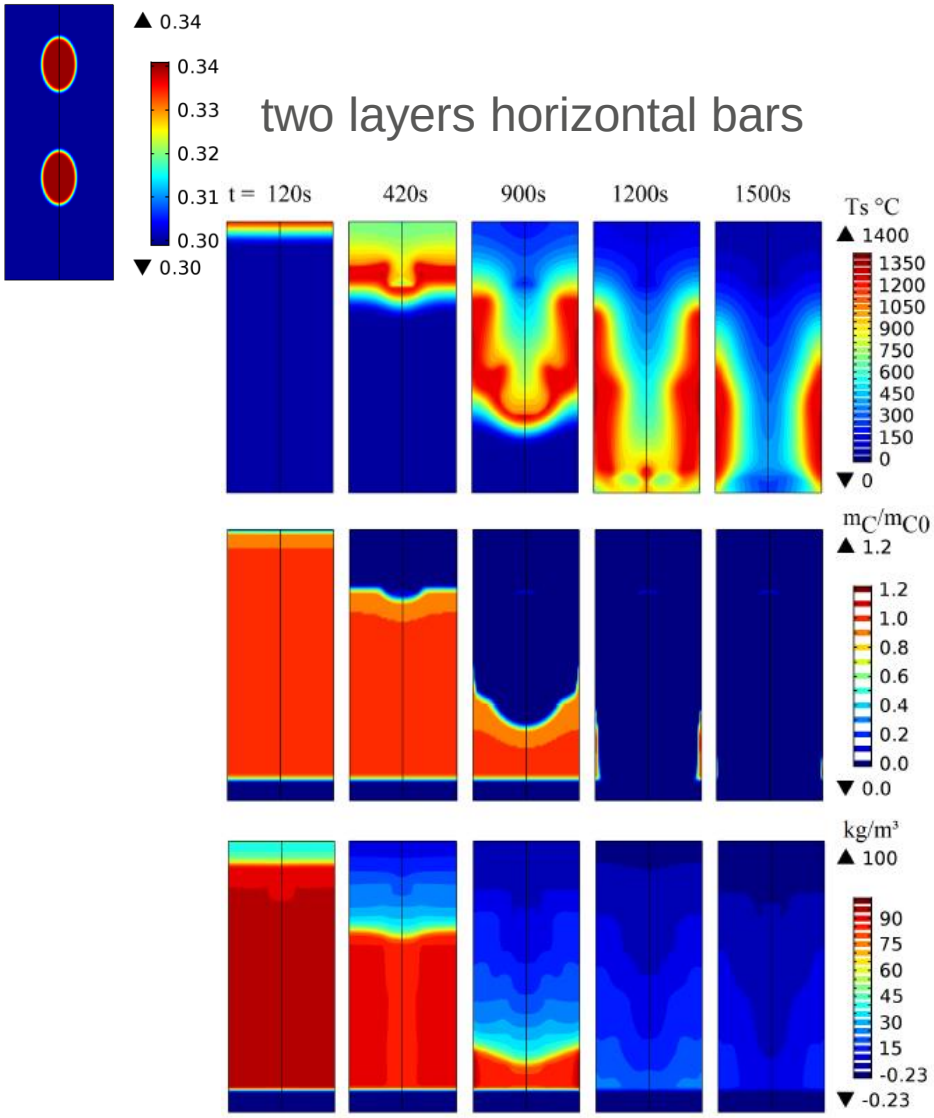


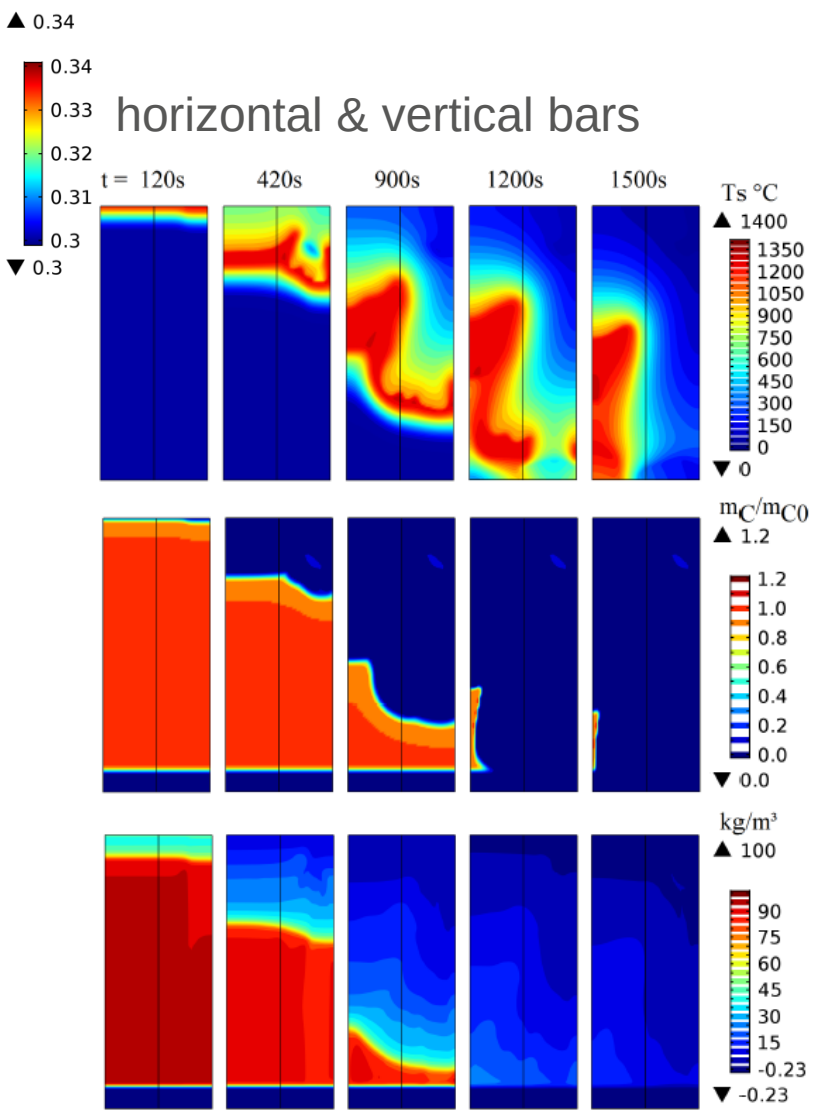
Quality distribution estimation (% material above a threshold size after a tumble test)



BTP (burn-through-point) indicates the completion of the sintering process

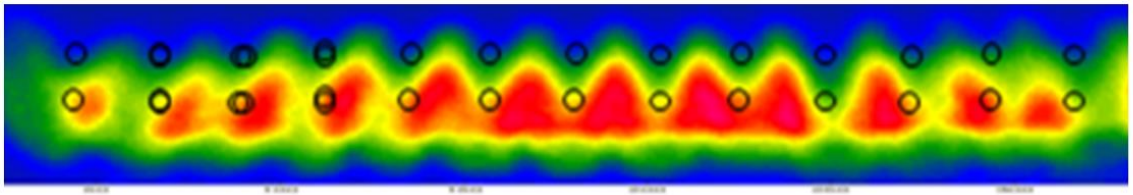
Results:
Progress of the Sintering Process



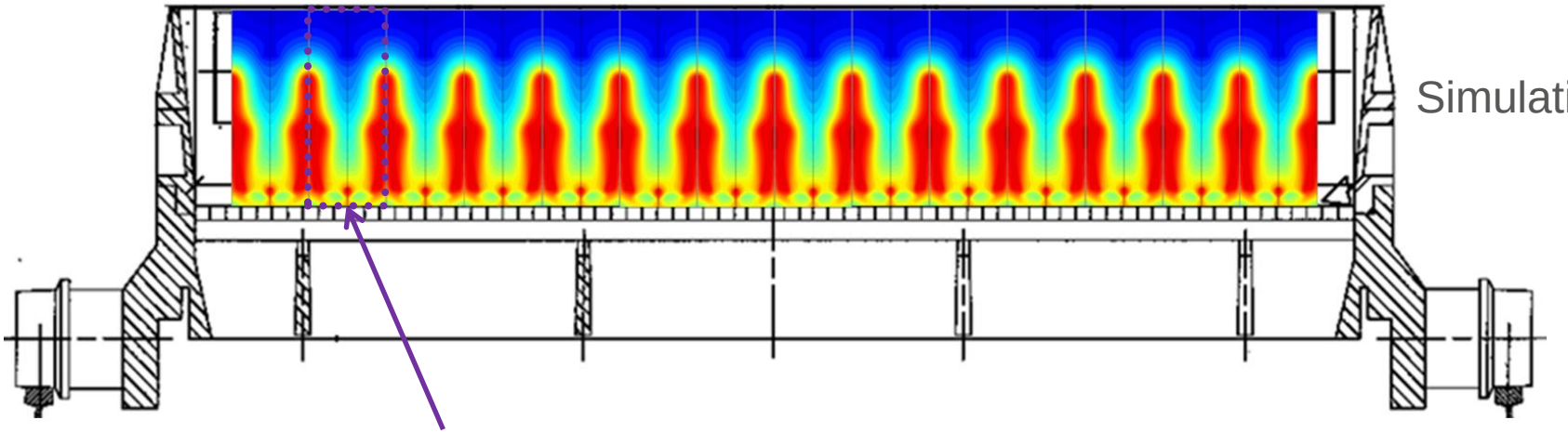


Results:
Verification by Thermography at Discharge

Comparison of simulated and measured high temperature zone at discharge



Thermographic image at discharge



Simulation

Conclusions

- A transient 2D sinter process model was developed to investigate the influence of the local permeability variations via permeability bars on the sintering process
- Process speed can be raised by up to 40% with optimum permeability bar configuration.
- Optimum results were obtained either with two stacked rows of horizontal bars or with vertical bars & horizontal bars in-between.
- The bar design should be supported by the statistical analysis of the thermal profiles at discharge.
- The average sinter strength (quality) usually decreases slightly.

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