Influence of Raceway Shape on Species Concentration

Eva-Maria Wartha[1], Markus Bösenhofer[1,2], Franz Hauzenberger[3], Hugo Stocker[4], Christoph Feilmayr[5], Michael Harasek[1]

[1]TU Wien, Institute of Chemical, Environmental and Bioscience Engineering
Getreidemarkt 9/166, Vienna, Austria, 1060
Phone: +43-1-58801-166 270
Email: eva-maria.wartha@tuwien.ac.at

[2]K1-Met GmbH, Area 4 – Simulation and Analyses
Stahlstrasse 14, BG 88, Linz, Austria, 4020

[3]Primetals Technologies Austria GmbH
Turmstraße 44, Linz, Austria, 4031

[4]voestalpine Stahl Donawitz GmbH
Kerpelystraße 199, Leoben, Austria, 8700

[5]voestalpine Stahl GmbH
voestalpine-Straße 3, Postfach 3, Linz, Austria, 4020

Keywords: Blast furnace, Computational fluid dynamics, Raceway shape

INTRODUCTION

The main steel production route is the blast furnace route, which accounts for ~60% of the overall steel production in Europe.[1] Although being used for centuries, the process is still under intensive investigation. The large energy consumption and the high carbon emissions in the blast furnace process increase the need for process optimization and offer possibilities for improvements. The heart of the blast furnace is the raceway zone, where the hot blast enters, forming the raceway cavity. The blast oxidizes the coke and the auxiliary reducing agents providing the necessary heat and creating reducing gases to reduce the iron oxides.

Due to the high temperatures, detailed measurements inside or near the raceway zone are practically impossible. Therefore, computational modeling techniques can be an excellent opportunity to study the processes in the raceway zone and gain insight into the processes occurring.

However, the large scale of the plant, its high temperatures and reactions, and the interaction between solid and gas flow also pose challenges in modeling and computational cost. Therefore, a sensitive choice of models, balancing the computational cost and the needed accuracy, is essential for profound predictions. In the following, we will demonstrate a strategy that can be applied to large-scale applications, i.e., the blast furnace raceway. The model setup is validated based on comparison with experimental data, and we exemplify the importance of the model choice for predicting the raceway shape and consequently the species concentrations.

MODELING THEORY

The discrete-element-method (DEM) is probably the most detailed way to model solid particle movement, and their interaction is the discrete-element-method (DEM). Because the particle-particle interactions are resolved there, the description is very accurate but leads to high computational demand. Therefore, the application of DEM to large-scale applications, such as the blast furnace, is still hindered by its high computational cost.[2,3]

An Eulerian description of the solid flow reduces detail but can describe dense solid flows on large scales. The sub-models used to model solid movement in such a framework need to be carefully chosen to maintain reasonable prediction accuracy. In this paper, we exemplify the influence of such model choices on the prediction of solid's movement and distribution and how it also influences the species concentration prediction in the gas phase.