AISTech 2021 — Proceedings of the Iron & Steel Technology Conference
29 June–1 July 2021, Nashville, Tenn., USA
DOI 10.33313/382/152

The Influence of Coke Reactivity on the Raceway Size – A Case Study

M. Bösenhofer [1,2], E.M. Wartha[1], F. Hauzenberger[3], C. Feilmayr[4], H. Stocker[5], J. Rieger[2], M. Schatzl[2], M. Harasek[1]

[1]Technische Universität Wien, Institute of Chemical, Environmental and Bioscience Engineering
Getreidemarkt 9/166-2, 1060 Vienna, Austria
Phone: +43 1 58801 166251
Email: markus.boesenhofer@tuwien.ac.at

[2]K1-MET GmbH, Area 4: Simulation and Analyses
Stahlstraße 14, 4020, Linz, Austria

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

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

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

ABSTRACT

The formation of the raceway zone in the blast furnace depends on the momentum introduced by the hot blast and other alternative reducing agents and the coke consumption due to thermo-chemical conversion processes. While the influence of the introduced momentum on the raceway size has been evaluated extensively in literature, the sensitivity to the coke reactivity remains unclear. This work will evaluate the effect of the coke reactivity on the raceway size and shape using a systematic approach based on a down-scaled 2D case. The simulative case study is done with an in-house add-on to OpenFOAM®.

Keywords: OpenFOAM, raceway model, coke reactivity, raceway size, raceway shape,

INTRODUCTION

The raceway zone of blast furnaces or smelting gasifiers is essential for the overall furnace efficiency and melting capacity. The main parameters influencing the raceway size are the momentum introduced by the hot blast and alternative reducing agents (ARAs), the coke rate, and the coke consumption rate. The effect of the momentum changes on the raceway size has been extensively studied by Gupta et al. [1–3] and others [4–7]. In contrast, the contribution of the coke reactivity to the raceway size remains somewhat unclear in literature. Feng et al. [5] used constant coke removal rates to simulate coke consumption and evaluate its effect on the raceway size using Discrete Element Method (DEM) simulations. However, these coke removal rates fail to reproduce the influence of the local, spatially varying coke consumption on the raceway size and shape. The thermo-chemical conversion processes in the raceway also have an effect on the zones above, e.g., active coke zone, cohesivezone, and direct and indirect reduction zone, and govern the blast furnace operation efficiency. Furthermore, ARA conversionefficiency and the coke consumption correlate with the fluid flow pattern, which depends, among others, on the raceway shape and size. Therefore, optimized raceway conditions are beneficial for the efficiency and productivity of the furnace.

This work focuses on the relationship between the coke consumption rate and the raceway size using a computational fluid dynamics (CFD) model of the raceway zone. The model incorporates multi-phase flow, heat transfer, and thermo-chemical conversion of the coke phase. We vary the coke reaction rate systematically to evaluate its influence on the raceway. The following section introduces the raceway model's governing equations followed by the simulation setup and results.

