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A Novel Test Rig for the Evaluation of Auxiliary Reducing Agents (ARAs)

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ABSTRACT

Injecting auxiliary reducing agents (ARAs) in the raceway zone of a blast furnace increases the efficiency and reduces CO2 emissions in case using bio-based sources. Reliable conversion rates are crucial to identify new ARAs or their mixtures and to optimize the ARA injection process, but they are hardly available in literature. The harsh reaction conditions in blast furnaces require suitable experimental equipment to determine reliable conversion rates. In this work a novel entrained flow reactor for evaluating ARAs will be presented and compared to the reaction conditions in a blast furnace. Furthermore, first experimental results will be presented

Keywords: auxiliary reducing agents (ARAs), blast furnace, raceway zone, test rig, reaction kinetics, coal combustion

INTRODUCTION

Injecting auxiliary reducing agents (ARAs) directly into the raceway zone of a blast furnace is a widely used approach to increase efficiency and reduce greenhouse gas emissions and metallurgic coke consumption. ARAs therefore serve as alternative carbon carriers. A large spectrum of ARAs, such as natural gas, oil, waste plastic, pulverized coal, and biomass, can be used in the blast furnace process.[1] To identify suitable ARAs, sufficient knowledge about their conversion rates in the raceway zone is crucial to estimate the impact on the blast furnace operation. ARAs undergo following thermochemical conversion steps in the blast furnace:

- Drying
- Devolatilization
- Gasification and burnout

The conversion should be completed before the ARAs leave the raceway zone, which forms in the vicinity of the tuyeres.[2] Computation Fluid Dynamics (CFD) can help determining the conversion time, but it relies on kinetic parameters and hence experimental data. The harsh reaction conditions in the blast furnace limit the feasibility of in-situ measurements. Optical access to the raceway zone allows for determining particle sizes and temperature distribution and provides essential information while using ARAs.[3] However, it cannot contribute to extracting kinetic parameters and hence there is additional data needed to specify whether using a specific carbon carrier is beneficial for operating the blast furnace. To obtain reliable kinetic parameters for potential ARAs, experimental equipment must recreate realistic temperature, pressure, velocity, and species profiles. Table 1 gives typical operation conditions of the raceway zone.

