SUCCESS STORY

K1-MET
Competence center for Advanced Metallurgical and Environmental Process Development

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Programme line: COMET-Centre (K1)

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REACTIVITY OF ALTERNATIVE REDUCING AGENTS UNDER BLAST FURNACE CONDITIONS

IMPROVEMENT OF REACTIVTY IDENTIFICATION OF ALTERNATIVE REDUCING AGENTS VIA COMPUTER-AIDED METHODS BASED ON DIGITAL TWINS.

Motivation

Alternative reducing agents (ARAs) are used to replace metallurgical coke in the blast furnace process. The thermo-chemical reactivity is a crucial property of suitable ARAs. The extraction of reactivities from experiments relies on assuming homogeneous conditions, since local, spatially resolved information is missing. However, spatial variations in temperature, species concentrations, and flow profile might lead to over- or underestimation of the ARAs reactivity.

Computational Fluid Dynamics (CFD) provides a unique possibility to obtain additional insight to the occurring phenomena in lab-scale equipment and identify such spatial variations. Computer-aided approaches can improve the quality of extracted reactivity data and provide additional information on the conversion conditions.

Investigation

A digital twin of Sandia's Pressurized Entrained Flow Reactor (PEFR) was created during an outgoing research stay at Sandia National Laboratories' Combustion Research Facility (CRF, USA). The digital twin was validated using temperature and particle conversion data from experiments. Spatial variations of temperature, species concentrations and velocity were identified in the reaction zone of the PEFR using the digital twin. Lagrangian tracer particles are used to determine realistic residence times and conversion condi-

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tions (temperature, species concentrations) of the coal particles in the reactive zone. Figure 1 and Figure 2 indicate severe inhomogeneities of the temperature and flow field in the first 0.1 m of the PEFR's reactive zone along the particle tracks.

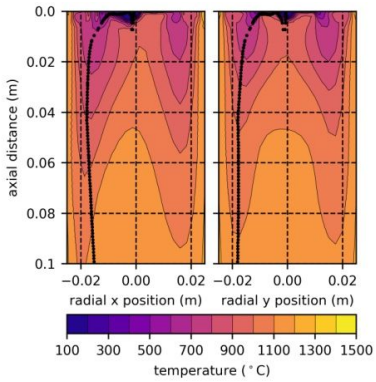

Figure 1: Temperature contours near the coal injection point. Black dots: Coal particle trajectory. (source K1-MET/TU Wien)

These variations falsify the evaluation of experimental data and therefore, the extraction of kinetic parameters. First evaluations showed a reactivity difference of around 15% between the computer-aided and ordinary extraction approach.

Impact and effects

The digital twin concept can be used to gain detailed insight into the occurring process of any experimental setup. Furthermore, re-evaluation of existing experimental results can improve the accuracy of gas-solid reactivity data.

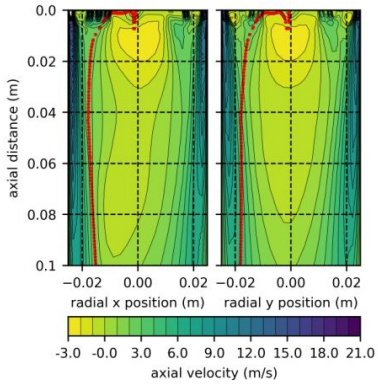

Figure 2: Velocity contours near the coal injection point. Red dots: Coal particle trajectory. (source K1-MET/TU Wien)

The developed computer-aided approach for the extraction of ARA reactivities will be used in the current funding period to evaluate potential ARAs. Identifying sustainable ARAs is a key issue to reduce the environmental impact of the blast furnace process.

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