K1-MET | **Competence Center for Excellent Technologies in „Advanced Metallurgical and Environmental Process Development“**

Research Area 1 Project 3

Formation of Nitrogen Oxides in the Heating System of a Coke Oven

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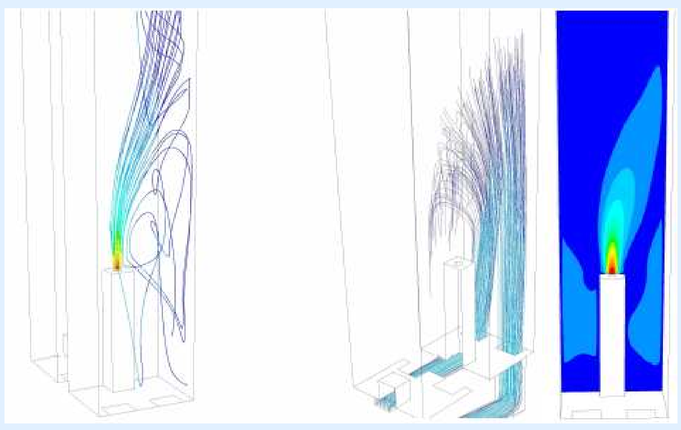
The combustion of coke gas in the heating system of the coke oven batteries at the voestalpine Stahl GmbH in Linz strongly depends on the geometry of the coke gas supply channel. To improve the combustion reaction with regard to a reduction of NO formation the use of a bluff body has been investigated with the mean of CFD.

Project-Partners

Optimization of the coke gas combustion in the coke oven batteries of the voestalpine GmbH in Linz - CFD study about the implementation of a bluff body in the single stage coke gas channel

• **Coke gas combustion**

The present CFD study focused on the improvement of the single stage coke gas combustion of the coke oven batteries at the voestalpine Stahl GmbH in Linz.
The combustion behaviour and as a consequence the NO emissions strongly depend on the geometry of the coke gas supply channel. The single stage coke oven batteries contain coke gas channels of different length. For the longer channel the coke gas flow shows a declination (see Fig. 1a). The two air channels are responsible for this asymmetric gas flow. One air flow is vertical and the other air flow has an inclination (see Fig. 1b). Because of the inclined air channel swirls are formed which deviate the coke gas in the zone above the inclined air channel (see Fig. 1c). Therefore the upstream flue cannot be used completely for the combustion.



(a) (b) (c)

Fig. 1: Pathlines of the long channel single stage coke gas operation for the coke gas supply channel (a); for the air supply channels (b); velocity distribution of the coke gas channel (c).

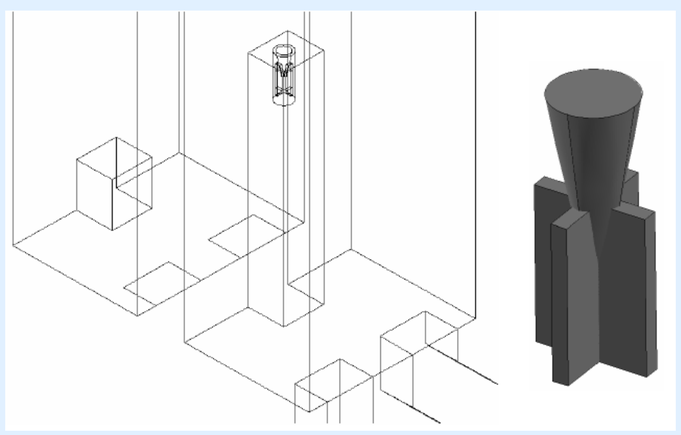
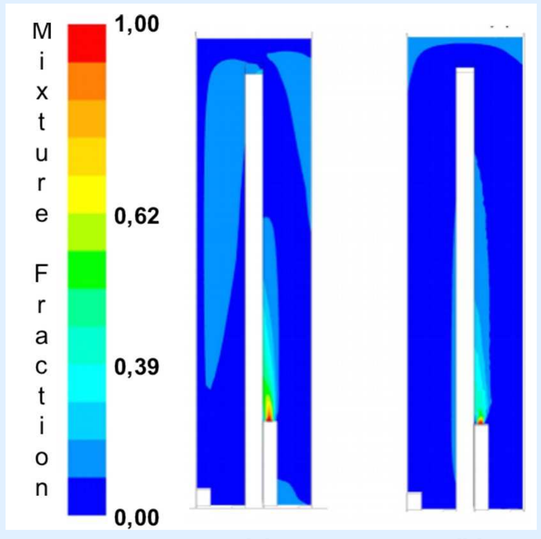


Fig. 2: Conical bluff body.

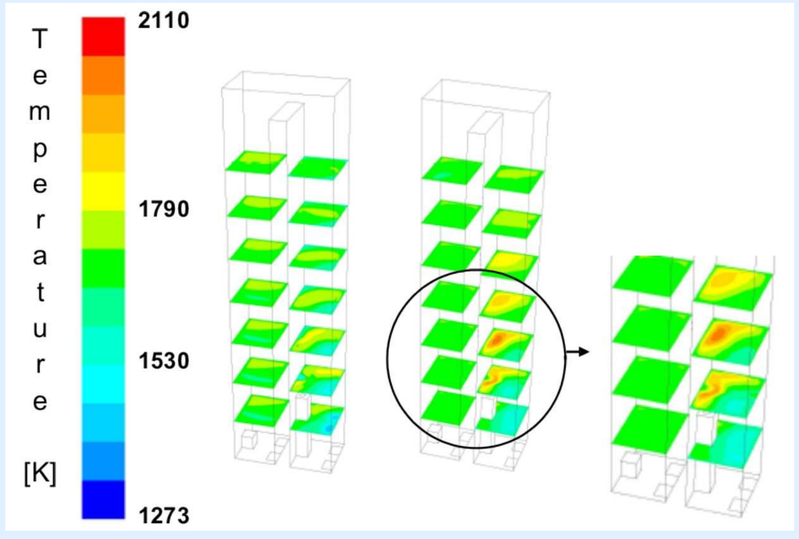
• **Implementation of a bluff body and simulation results**

To improve the combustion and to reduce the NO emissions several types of bluff bodies have been modelled with the software GAMBIT. A matrix of several operating points from the coke plant in Linz has been created to simulate the bluff bodies with the software package FLUENT. The simulation results showed that with the use of a conical bluff body (see Fig. 2) the NO emissions can be reduced.
The bluff body leads to a higher turbulence in the upstream flue which favours the mixing of coke gas and air. Therefore the combustion proceeds faster (see Fig. 3) and more intensive which can be acknowledged with higher temperatures in the upstream flue (see Fig. 4). Furthermore the coke gas is better distributed in the upstream flue so that nearly the entire upstream flue is used for the combustion. During the combustion with a bluff body the higher peak temperatures in the upstream flue lead to locally higher thermal NO emissions (see Fig. 5). In the downstream flue there are lower temperatures compared to the operating points without bluff body. Therefore the overall NO emissions are lower when a bluff body is installed.



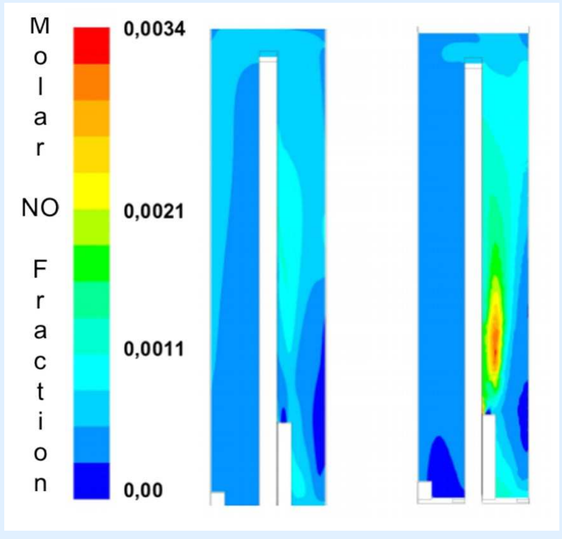
(a) (b)

Fig. 3: Mixture fraction (= distribution coke gas) of the long channel single stage coke gas operation without a bluff body (a); with a conical bluff body (b).



(a) (b)

Fig. 4: Temperature distribution of the long channel single stage coke gas operation without a bluff body (a); with a conical bluff body (b).



(a) (b)

Fig. 5: Molar NO fraction of the long channel single stage coke gas operation without a bluff body (a); with a conical bluff body (b).