Success Story
COMET

metallurgical competence center

K1 Met 3.5
Combustion Reaction Modelling of Burners for Industrial Kilns
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K1-Centres
COMET single project, duration and type of project:
K1 Met 3.5, 07/2009-07/2015, multi-firm

Computer models for industrial furnace plants

In this project models and approaches for computer modelling of industrial furnaces have been developed. Based on these models three aggregates have been considered, a tunnel kiln of RHI AG, a radiant tube burner of Ebner Industrieofenbau and the furnace for preheating the submerged nozzle of voestalpine Stahl.

Motivation

By steadily increasing requirements on product quality, energy efficiency and pollutant emissions great demands are placed on industrial furnaces. Therefore it is important to improve the established furnaces steadily. Here, Computational Fluid Dynamics (CFD) methods represent a productive tool to analyze and improve existing furnace plants.

Development of models

Before starting with the calculation of a furnace or burner, individual models have to be developed, tested and evaluated against measurements. Here, not only the quality of the results but also the computing time in which they are achieved is crucial. Within this project a NOx postprocessor for a Flamelet combustion model has been developed, which is able to predict trends of nitrogen oxide concentration with very low resource requirements with the result that this model can be applied to industrial furnaces with reasonable computational effort.

Considered aggregates

Within this project three aggregates have been considered, a tunnel kiln of RHI AG, a radiant tube burner of Ebner Industrieofenbau and the furnace for preheating the emerged nozzle of voestalpine Stahl.

Concerning the tunnel kiln transient through heating of the mattes in the firing zone is interesting. Since the size scales between the burner nozzles in the millimeter range and the total length of the combustion zone vary greatly a technique was developed to calculate the burner in advance and forward the data to the furnace. Similarly, an algorithm have been developed which will forward the temperatures at certain intervals from one car to the other in order to image the shove. This model was evaluated based on temperature measurements and showed a very good agreement in this connection.

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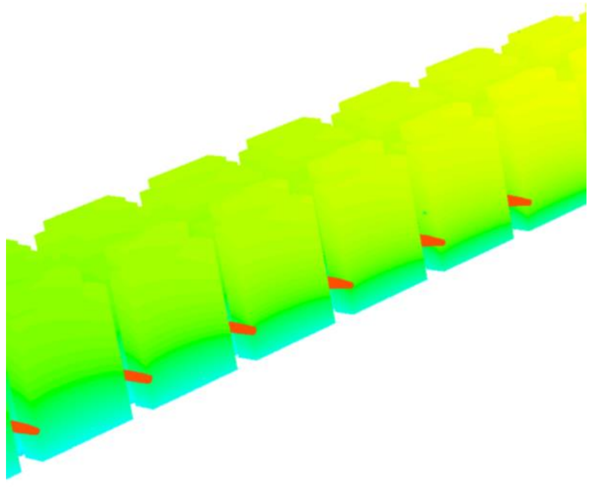

Fig. 1: Extract of temperature field in the firing zone of the tunnel kiln

As a second aggregate a steel tube burner of the company Ebner Industrieofenbau have been considered. Here, the focus is on combustion processes in the interior of the steel pipe in order to make uniform the distribution of the surface temperature by their targeted change. This model was also evaluated with measurement data.

Concerning the third aggregate, the furnace for preheating the emerged nozzle for continuous casting, the furnace geometry was adapted in five steps, so that a desired temperature profile is achieved by targeted flow guidance. The adaptation of the geometry was based on a stationary model and final calculations were performed transient. The evaluation of the model was based on the heating behavior of a emerged nozzle fitted with several thermocouples.

Fig. 2: Achieved temperature profile of the dip tube.

Follow-up project

Currently, it is being worked on the follow-up project within the K1-Met project 3.4 Energy Systems. Here, a walking beam furnace of voestalpine Stahl, the burner technology Ebner Industrieofenbau and a shaft furnace of RHI AG is considered.

Impact and effects

In addition to the gain in knowledge for modelling and behavior of industrial kilns a continuous process improvement takes place. This can be done depending on the task in the field of product quality, energy efficiency and minimization of emissions. Thus, the impact and effects are diversified.

Contact and information

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