CFD-Simulation of Natural Gas Combustion and its Application to Tunnel Kiln Firing

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ABSTRACT

The majority of shaped refractory products are fired in industrial tunnel kilns using natural gas burners. Depending on the product type and quality the maximum firing temperatures can reach as high as 1800° *C* and above.

Due to these high temperatures and the big geometry of the tunnel kilns measurements of various process parameters (e.g. temperature profile in the refractories, gas composition, gas flow …) are difficult to perform.

Nevertheless process engineers need reliable data to understand the influence of various changes of process parameters onto product quality or productivity. Simulation models can help to better understand the process itself as well as facilitate the decision making process regarding process- and/or plant-specific changes.

The simulation model of the tunnel kiln is implemented in the CFD-code OpenFOAM. The most challenging zone of the tunnel kiln is the burning zone:

Additionally to fluid flow and heat transfer (free and forced convection plus radiation) the combustion of natural gas has to be treated. In order to properly model the combustion with as little calculation time as possible the flamelet-model is applied.

The present model covers the burning zone extended in both directions and corresponds to roughly ⅓ of the tunnel kiln. A model of the total tunnel kiln will help to answer various questions related to maximum process temperature, dwell time, temperature gradient, kiln car setup, pushing sequence and energy efficiency.

Furthermore modifications of the burner positions and their influence on product quality and energy efficiency can be studied.