

# Starting from the Local Equilibrium or coming from the Fluid Dynamic End: A Comparison of Methodologies in Process Modeling

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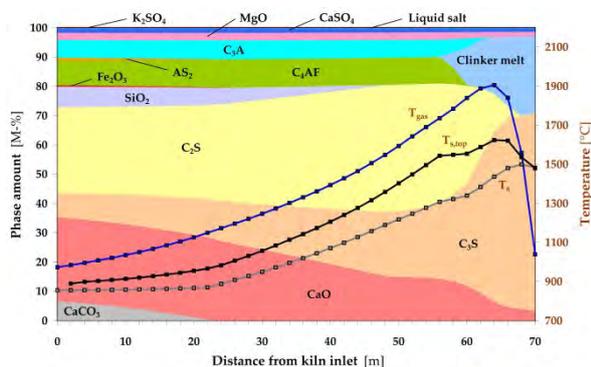
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## ABSTRACT

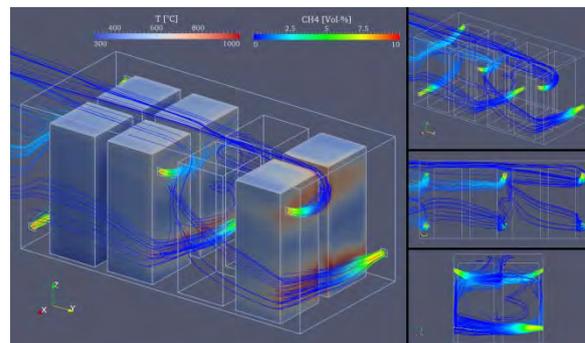
Most industrial high temperature processes are highly complex and difficult to evaluate. Nevertheless process engineers desire simplified and easy to use process models in order to simulate their processes and e.g. depict the influence of various changes onto product quality or productivity. Unfortunately the real life is far more complex and so in most cases simplified process models cannot be used to answer profound questions regarding process conditions. Therefore it is necessary to develop different process models in order to handle different problems and tasks.

Two different projects with different approaches to a total process model will be discussed. On the one hand side a model with localized thermodynamic equilibria is used for the simulation of the cement clinker production process in rotary kilns. The goal was to depict the recirculation of volatiles in within the process and its consequences for process control and stability as well as for the corrosion of refractories in the rotary kiln itself. The model was developed using SimuSage. Figure 1 shows the phase distribution in the rotary kiln for a specific plant.

On the other hand side a CFD model is used to model the firing of refractory bricks in tunnel kilns. The goal of this ongoing project is to identify the influence of various process parameters on process control and product quality. The current model is based on the CFD code OpenFOAM including a CHEMKIN interface in order to model the combustion of natural. Figure 2 shows the resulting fluid flow in the burning area of a model tunnel kiln.



**Figure 1:** Phase distribution of solid material in a cement rotary kiln. Curves show the temperature of the gas phase ( $T_{\text{gas}}$ ), the temperature of the solid at the solid/gas interface ( $T_{\text{s,top}}$ ) and the mean solid temperature ( $T_{\text{s}}$ ) respectively.



**Figure 2:** Fluid flow in a section of a model tunnel kiln. Refractory blocks are colored by temperature, gas stream lines by  $\text{CH}_4$  content respectively. The combustion is modeled by a simplified two step reaction model.