The Thermal Stability of Rotary Kilns for the Production of Cement Clinker

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Introduction

The process for the production of cement clinker is energy demanding. The most important steps of the process are calcination, heating up to 1450 ºC, sintering of partly melted material and cooling of the final product. A strong thermal interaction between the clinker cooler and hot side of the rotary kiln causes instability of the overall production process. In practice, large fluctuations of the production level occur with negative impact on throughput, emissions, energy consumption and durability.

Project content

In order to understand the dynamics of the process a full-scale process identification was performed. As a result, it is possible to predict the free lime content of the clinker, an important key parameter of the final product. However, strong non-linear effects have large negative impact on the performance of these sensors.

The non-linear effects are assumed to be caused by the transportation of the clinker in the kiln, which is heavily influenced by the amount of melt formed. It is believed that variation of the solid phase velocity is the main reason for the process instabilities. Therefore, composition calculations have been performed on a thermodynamic basis These results will be used in a slurry transport model for the solid phase.

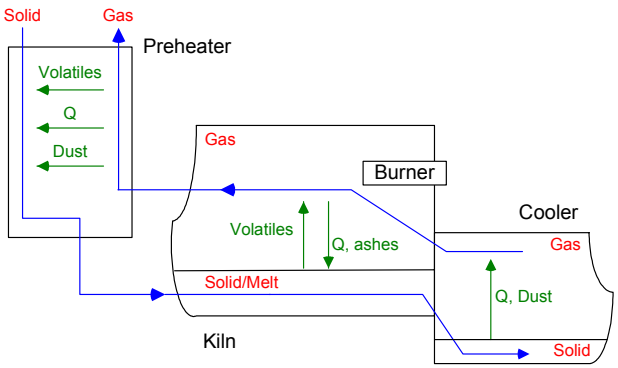

Figure 1. *Mechanism of the kiln-cooler interaction.*

A CFD approach of the clinkering process will reveal the effects of the dust load of the combustion air, coming from the clinker cooler, on the heat transfer mechanisms within the kiln, which effects the temperature and thus melt content of the clinker.

The interaction between cooler and kiln is analyzed and described thoroughly, because this interaction dominates the system response, mainly in the low frequency domain (1 hour cycle). From a mathematical view its characteristics are revealed. The results obtained from research are implemented in linear transfer functions between the key input and output parameters. Thus a model can be developed that describes and gives insight in the dynamic behaviour of the cement clinker process.

Research prospects

With the outcome of this project it is possible to maintain constant product quality, decrease energy consumption and increase the deployment of secondary fuels and raw materials by adapting the current process control strategies with the aid of software sensors. In Figure 2. the first results for the online free lime sensor are shown. This sensor is improved by implementation of the dynamic description of the cement clinker production process.

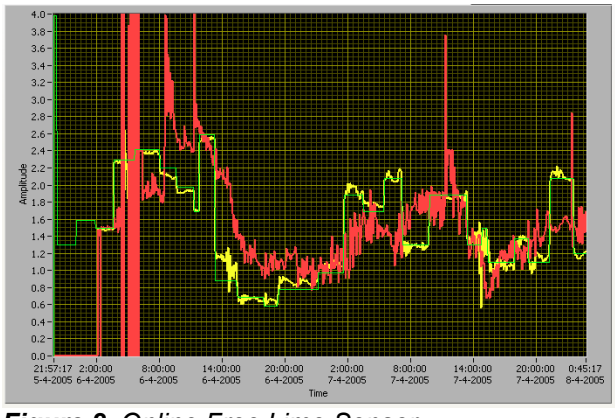

Figure 2. *Online Free Lime Sensor.*

Acknowledgement

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