Master project proposal

Thermal system analysis of a heat conduction calorimeter to be used in cement plant automation

Background

Cement plants are large industrial complexes to produce a finely ground powder called cement. Cement can be mixed with water to form a strong mineral binder that is the adhesive holding concrete, the worlds most used construction material, together.

A problem with cement production is that process conditions, raw materials (limestone, clay) and the fuels (tires, plastic waste, coal) also affect cement reactivity by minor changes in composition. So there is need for continuous monitoring of both the reactants and the cement. Today this is done by automated laboratories that work 24-7 all year round generating data to control processes in the plant. The most common analyzers supply elemental composition and mineralogy. Until now it has not been possible to quantify the most important property of cement – reactivity – close to production. Reactivity is today measured by casting samples for strength testing that have to react for at least 24 h before they are measured; and the results that one will get then come far too late to be used to control the production.

Thyssenkrupp Industrial Solutions – a large German company that engineers and erects complete cement plants and fully automated laboratories for cement plants – and Calmetrix – a US-based manufacturer of calorimeters for the cement industry – have developed an automated calorimeter (reactivity meter) called polabCal for cement plants. It is operated by an industrial robot that prepares samples of cement and water and quickly places them in a calorimeter, so that the initial heat production from the reaction can be quantified (search the internet for “polabCal”).

Master project

The aim of the calorimetric measurement in the PolabCal is to quantify the heat production rate from a cement-water-mix. However, the signal from the calorimeter is influenced by the heat capacities and thermal conductances of the instrument. We therefore work on a thermal model of the calorimeter, so that we can calculate the actual reaction rate from the calorimetric measurement. The aim of the master project is to:

- Generate a number of possible approaches to thermal system identification.

- Test these models with data that we have measured on the polabCal prototype, including temperature measurements in a calorimeter during use.

- Propose a practical model and how to calibrate this model in actual use.

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