

Temperature Control in Slab Reheating Furnace



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Introduction

The design was made and simulation executed with real time data of a Model Predictive Controller (MPC) with a dynamic model for a reheating furnace in a Hot Strip Mill. The predictor is chosen to be a so-called ARX model, which has been identified by data from a test slab. Simulations were executed with actual data from a full day of operation, using a Furnace Response Model, which has been identified by the same data.

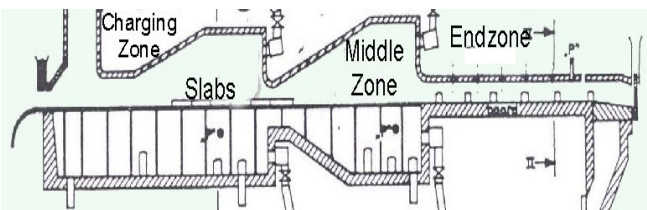


Figure 1 Lay-out pusher type furnace.

ARX model

A basic dynamic model description in discrete form is:

This is a so-called ARX (Auto Regressive with eXtra input) model. Not knowing the noise e , the equation for a 1st order ARX model is:

with y the output and u the input of the system and i the sample

Identification of Slab Heat-up Model

The coefficients of a non-linear ARX model for slab heat-up were estimated using data of a test slab containing thermocouples and a data collector. As a result slab temperatures during the process become available. Using the local radiation temperatures as inputs, sufficient data for identification are available. See result below.

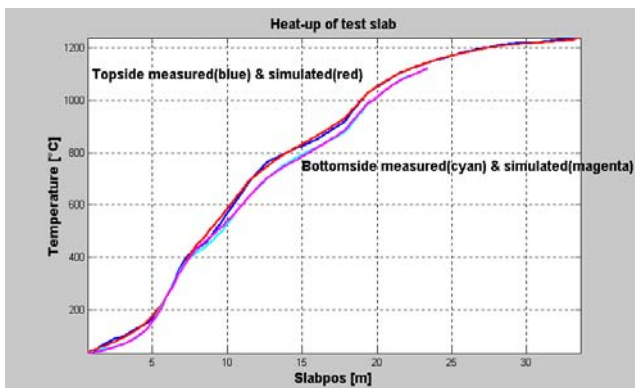


Figure 2 Comparison Predictive model and test slab measurement.

Furnace Response Model

The Furnace Response model is also an ARX model as described above. The advantage of this model is that it can be identified with data from the day of which the simulation data are used. Important prerequisite for such identification is that there is sufficient variation of the inputs of the controller of the process, especially as the data are measured in a closed loop control

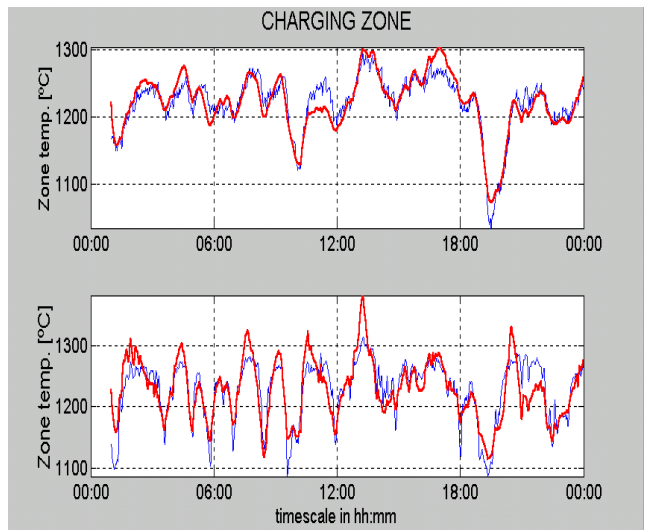


Figure 3 Furnace response model Charging Zone for 2 thermocouple responses. Blue lines = measured temperatures, bold red = model result of temperatures.

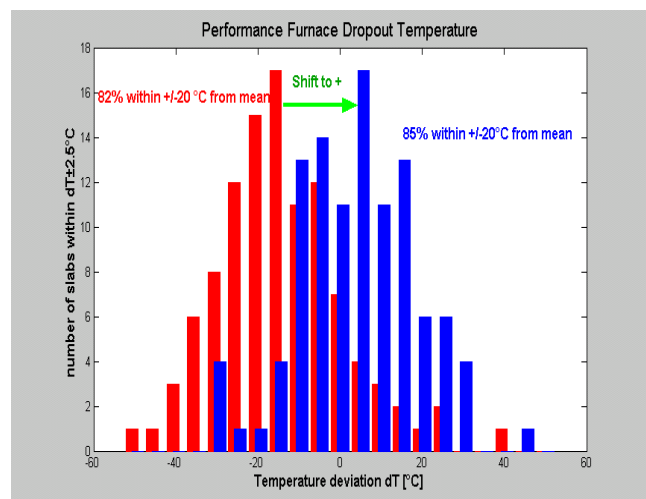


Figure 4 Histograms showing performance improvement.