CONTROL OF PUSHER FURNACES FOR STEEL SLAB REHEATING USING A NUMERICAL MODEL

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***Abstract* – Steel slabs are reheated in pusher-type furnaces up to a temperature of 1200°C in the steel sheet manufacturing process. In this article we describe a control system that uses an on-line numerical model to calculate the furnace setpoints in order to improve the heating quality. Examples of actual furnace operation with and without the system are presented to show the improvements that are obtained handling typical non-stationary situations.**

***Keywords* -- Steel industry, Reheating furnaces, Furnace control**

I. INTRODUCTION

In the steel strip manufacturing process (Figure 1), steel slabs obtained from continuous casting are reheated up to temperatures of approximately 1200°C prior to the rolling process. The required temperature at the end of such process has to be comprehended within a narrow range determined by the subsequent on-line heat treatment process. Slab reheating in pusher furnaces is one of the sources of variability that produce departures from that narrow range.

In the case of SIDERAR's hot rolling facility in San Nicolás, Argentina, four pusher-type furnaces are used to reheat slabs that are approximately 6m long, between 0.65 and 1.53m wide, and from 0.18 to 0.20m thick. These furnaces are named after the way the slabs are pushed forward inside the furnace. Every time a hot slab has to be discharged to be rolled a new slab is introduced into the furnace and the intermediate slabs are pushed sideways towards the furnace outlet. In the first part of the furnace the slabs are supported by four refrigerated skids, while near the outlet they lie on a refractory hearth that is intended to diminish the temperature inhomogeneity generated by the skids The heating power is supplied by gas burners that use either natural gas or a mixture of natural and coke gases and are arranged in several zones. Typically one preheating zone, two heating zones (an upper and a lower one) and one soaking zone are present (Figure 2). The burners of each zone are controlled through thermocouple setpoints: a control loop regulates the air and gas flowrates to match the set value with the temperature measured by a properly placed zone thermocouple. Therefore, the problem of furnace temperature control is that of specifying the setpoints that produce an adequate slab outlet temperature distribution.

To monitor the slab outlet temperature there is an infrared pyrometer at the rougher exit (R4 in Figure 1), which measures the slab longitudinal temperature profile on the upper side of the slab. The mean temperature and the maximum temperature difference of this profile are the target variables of the furnace control and define the heating quality. Although it would be desirable to have a measurement point closer to the furnace outlet, the oxide layer that is formed during the heating process and that is removed by a descaler at the rougher inlet, prevents a reliable measurement prior to the rougher exit.

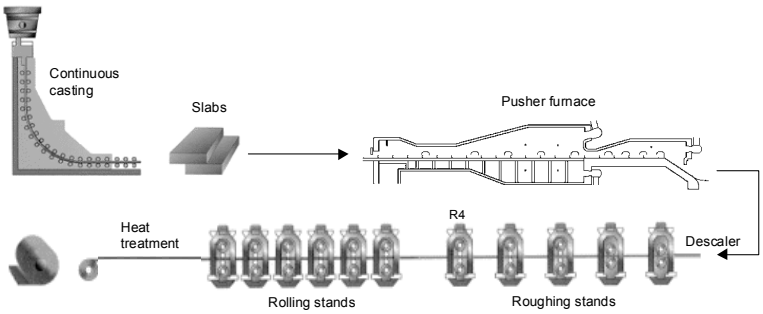

Figure 1. Schematic illustration of the steel strip manufacturing process