NUMERICAL MODEL OF STEEL SLAB REHEATING IN PUSHER FURNACES

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***Abstract* -- The difficulty in measuring load temperatures inside reheating gas furnaces may be circumvented by appropriate use of on-line numerical models. In this article we describe a model of pusher furnaces, used to reheat steel slabs. The model uses thermocouple measurements at fixed positions inside the furnace to calculate the temperature of the combustion products, and takes into account radiative exchanges among those gases, the furnace refractories and the load. A good correlation is found between a temperature profile measured after the slab leaves the roughing stands and the results of the numerical calculations. We conclude that the model is a powerful tool to monitor the thermal state of the load inside the furnace and is suitable, together with an appropriate control algorithm, to automatically calculate the furnace settings required ensuring the objectives of the heating process.**

***Keywords* -- Numerical modeling, Reheating furnaces, Steel industry, Zone method**

I. INTRODUCTION

Gas-fired reheating furnaces are present in different manufacturing stages in the steel industry, such as rolling and heat treating of steel products. Monitoring the load temperature during these processes would be highly desirable in order to achieve the specified process standards, but is often either impossible or costly and cumbersome. Indeed, most measurements on the products are carried out once they are already outside the furnace.

Furnace operation is therefore based on production tables tailored to the range of manufactured products. These tables correspond, however, to steady-state operation, which is seldom achieved in continuous production lines because of various reasons: changes in product geometry, eventual changes in the inlet load temperature, and upstream or downstream events that may slow down and even temporarily halt the production schedule.

This article describes a numerical model that was developed as an aid to furnace operation, to overcome the difficulties of measuring load temperatures inside the furnace and in the interior of heated parts. The two leading applications are the improvement of set-up parameters in steady-state operation to increase productivity and the on-line control of the furnace operation to anticipate and avoid departures from established quality objectives during transients.

II. INDUSTRIAL APPLICATION

At our Center for Industrial Research, numerical modeling of reheating furnaces has been applied to four different kinds of furnaces (Altschuler *et al.*, 2000): pusher type furnaces used for reheating slabs before rolling, rotary hearth furnaces for heating billets before piercing (Marino and Pignotti, 1997), walking-beam furnaces for heating steel tubes (Marino, 2000), and tunnel furnaces for continuous annealing of steel plate (Altschuler *et al*., 1999). In the following, we focus on the first of these applications, including model validation and comparison with some plant results.

A. Pusher Furnace

At the hot rolling facility of SIDERAR at San Nicolás, steel slabs are reheated up to 1200°C to be milled in the steel sheet production process. Reheating takes place in four 25*m* long gas-fired furnaces. Slabs 6*m* long, width between .8 and 1.4*m*, and thickness of .18 or .20*m* are oriented in a direction that is transverse to the furnace axis and proceed sideways, until they reach the furnace exit. At the other end, a slab is positioned in front of the furnace entrance, and is pushed in by a mechanical device when the furnace is ready to discharge a slab, thus generating a rigid displacement of the load inside the furnace.