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On the damage of a work roll grade high speed steel by thermal cycling

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ABSTRACT

The surface degradation experienced by a work roll grade high speed steel as result of high frequency thermal cycling was characterized by means of X-ray diffraction, light optical and scanning electron microscopy. It was found that the degradation mechanisms experienced by the steel under these conditions include oxidation, carbide cracking and spallation and, crack formation in the martensite matrix which also presents a decrease in hardness as the number of thermal cycles is increased. The development of these mechanisms and their impact on the life of high speed steel work rolls is discussed.

1. Introduction

There is a marked trend for using high speed steel work rolls as the tools of the finishing stands in hot strip mills in the steel industry. Along the years, different production processes, steel compositions and heat treatment practices have been developed to manufacture work rolls with superior properties against wear. However, it is important to note that all these changes in chemical composition and metallurgical practices can lead to a different behaviour of the work rolls during the rolling process and therefore, an extensive knowledge on the mechanical conditions at which they are exposed in the mill and the degradation mechanisms product of these must be attained. Although the oxidation of the roll surface is an important issue regarding mechanical aspects of the process like friction, the surface could experience important changes due to the continuous thermal cycling resulting from the contact with the hot strip and the cooling practices which can lead to damage by thermal fatigue. Regarding this issue, Mercado-Solis and Beynon [1] found that high speed steel work rolls subject to thermal cycling present a good resistance to the formation of cracks leaving the surface of the steel almost not affected by thermal cycling but affected by oxidation. Molinari et al. [2] pointed out that the resistance of high speed steels to thermal fatigue is strongly influenced by the microstructure of the alloy and mentioned that the effects of thermal cycling consist in the formation of microcraks propagated through the steel matrix in the radial direction of the roll. The present work deals with a simple experimental methodology designed to analyse the effects of thermal cycling on a work roll grade high speed steel aiming to recreate the early stages of the degradation mechanisms experienced by high speed steel work rolls currently used in hot strip mills.

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