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INFLUENCE OF THE FURNACE TEMPERATURE IN CONTINUOUS FLUX QUENCHING ON THE CHARACTERISTICS OF LOW CARBON STEEL STRAPS

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ABSTRACT

In this paper there are presented mechanical characteristics (resiliency, elongation) and structural characteristics resulted from quenching thermal treatment made on an experimental installation, in continuous flux, on low carbon steel straps (C = 0,185%), cheep, elaborated without special purity prescriptions. The experiments were made varying the furnace temperature while keeping all the other technological parameters constant.

The straps' speed through the system was 2m/min and the cooling was made in water jet. Starting with heating temperatures of 900^{0}C good mechanical characteristics are obtained: R_m 1500 = MPa and A_{80} = 4%.

KEYWORDS: low carbon steels quenching, continuous flux thermal treatment

1. Introduction

Low carbon steels, having low hardenability are not used in quenching thermal treatment consequently there is little study in this direction. In order to achieve high ultimate stress values higher carbon content steels are used or steels with alloying elements which increase their hardenability. Considering that these low carbon steels are easier and cheaper to produce, research towards broadening their domain of usage are opportune. Products with thin section areas are to be considered which should allow high cooling speeds hereby low hardenability would no longer be a major impediment in obtaining high ultimate stress values.

2. Experimental results

An experimental installation was built for the research. Figure 1 presents a schematic representation of the installation. Furnace temperature and strap's speed logging and control were implemented. For continuous flux quenching several high speed cooling devices were designed and built trying to achieve stable robust high cooling speeds.

Table 1. *The chemical composition of the analyzed steel*

C	Mn	Si	P	S
[%]				
0.185	1.350	0.063	0.023	0.008

The studied steel is an ordinary elaborated steel as the microstructure on the polished and unetched sample shows in figure 2. – the inclusions' fiber-like texture resulted from rolling is present.

The studied samples presented in this paper were made from the following thermal treatment furnace temperatures: 850°C, 900°C, 950°C, 1000 °C.

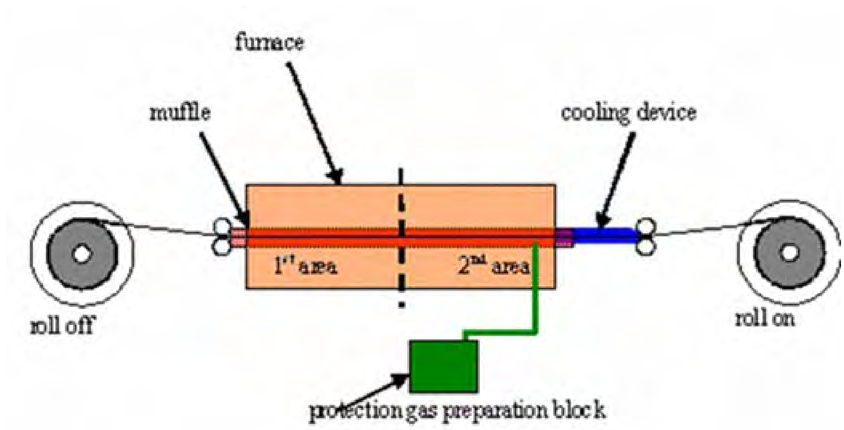


***Fig. 1.** Schematic representation of the continuous flux quenching installation.*

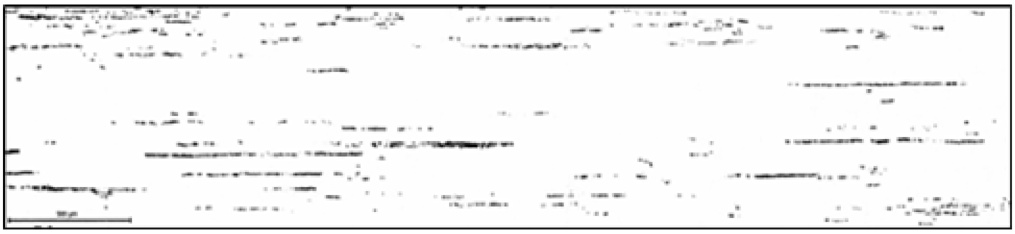


***Fig. 2.** Image realized on unetched sample showing the inclusions' fibrous structure*

In fig. 3 the ultimate strength and elongation from the analyzed samples is presented in a graphical form and also a spline extrapolation was made to point out the tendencies. As the results show very high ultimate stress values were obtained from an ordinary elaborated low carbon steel.

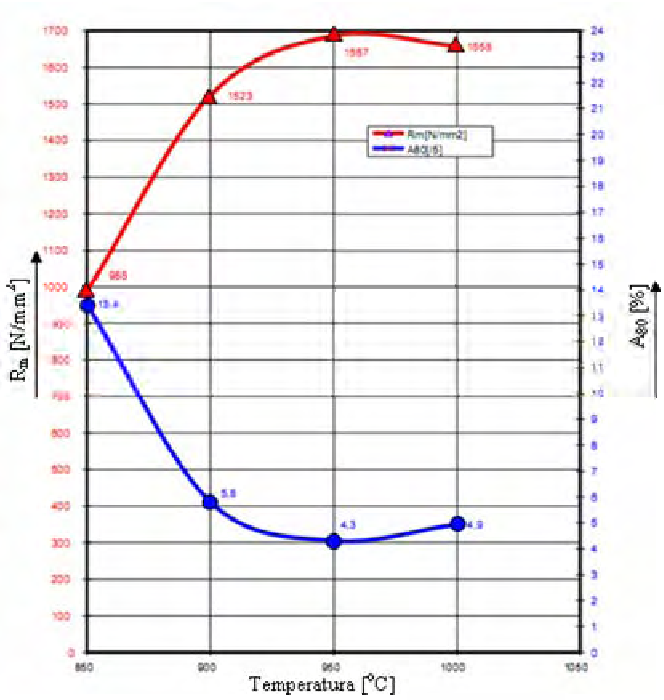


***Fig. 3.** The mechanical characteristics obtained at continuous flux quenching.*

In figure 4 the microstructure of the sample quenched from 900^{o}C is shown. The microstructure shows a typical quenching structure (martensitic structure, acicular, very fine) in correlation with the spectacular increase in ultimate strength.

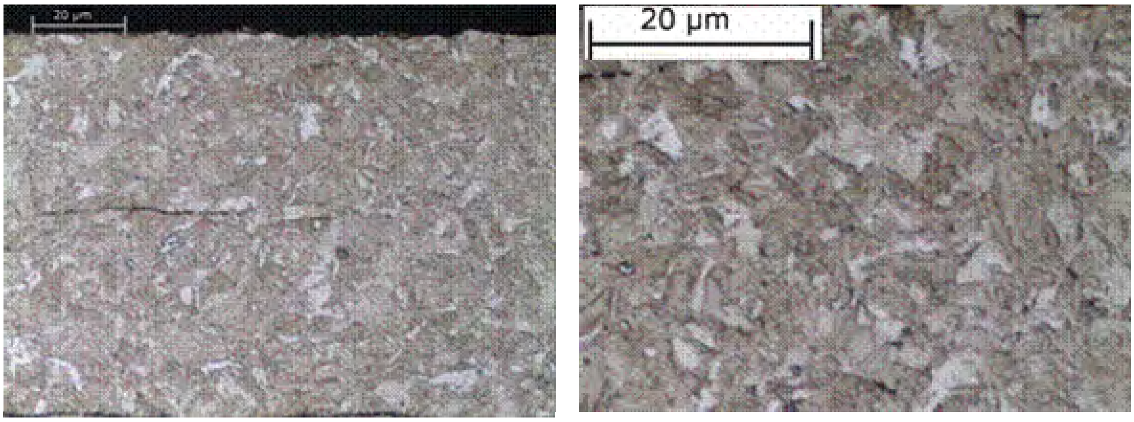


Fig.4. *Quenched steel microstructure (etchant: nital 3%).*

Both the mechanical ultimate strength value and the microstructural analysis show that for thin (0.8 mm) low carbon steel straps quenched in continuous flux, the austenite cooling transformation was without diffusion.

Although the microstructural analysis pointed out the presence of martensite grains, the XRD analysis showed only the ferrite specific peaks. The explanation is the low carbon content in the analyzed steel. It is known that in equilibrium cooling conditions ferrite can dissolve up to 0.002%C. The analyzed steel had a carbon content of 0.185%, during the fast cooling of the austenite from furnace temperature (900^{o}C) to water temperature (25^{o}C) the carbon diffusion was virtually avoided hereby the oversaturated solid solution called martensite was obtained. The carbon over saturation degree that martensite can accommodate is practically much higher than the one resulted for this steel, hereby the tetragonality of the lattice is insignificant and unobservable by XRD (the martensite peaks overlap the ferrite peaks fig. 5).

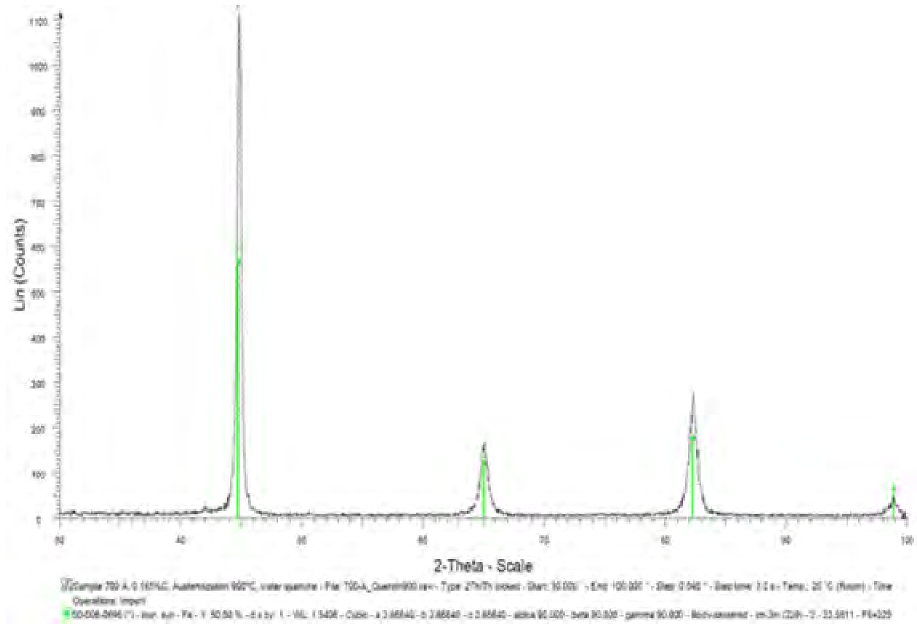
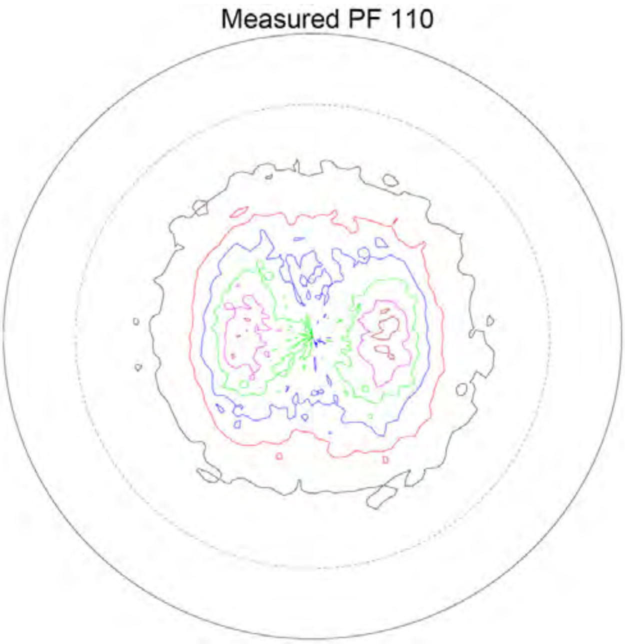
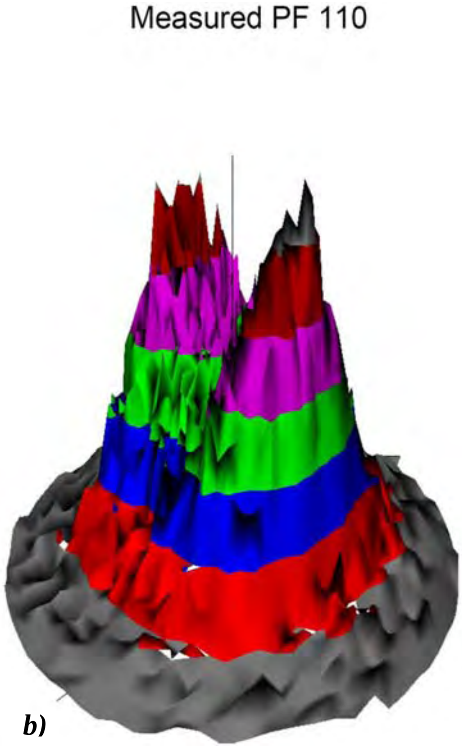


Fig. 5. *XRD crystallographic structure.*

X ray analysis showed that after the continuous flux thermal treatment the texture remains one characteristic for cold rolled steel as shown in figure 6.



a)



b)

Fig. 6. *XRD Pole Figure (110) – 2D (a) and 3D (b) representation.*

3. Conclusions

By applying quenching thermal treatment on a continuous flux installation for a steel with 0.185%C high ultimate strengths can be obtained (1500 N/mm^2) together with breaking elongations over 4%.

The research has shown that ordinary low carbon steels elaborated at convenient prices can enlarge their application area for products with thin sections (as packing steel straps) thereby hardenability can no longer be considered an obstacle in achieving high mechanical characteristics.

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