EFFECT OF HEAT TREATMENT ON A “LEAN” CHEMICAL STEEL COMPOSITION FOR CYLINDERS

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KEYWORDS: STEEL, MICROSTRUCTURE, HEAT TREATMENT

The development of steel “lean” chemical composition to be adopted for cylinders application is increasingly requested, aimed to reduce the critical alloying elements content while preserving adequate mechanical performance. In this framework the analysis of the heat treatment effect (temperatures and cooling rates) on microstructure evolution (hence mechanical properties) is a key issue. This work focuses on the assessment of the heat treatment response of a steel with 0.6%C-5.0% Cr nominal composition with 0.9% C in segregated region.

To do that, specimens have been machined starting from both the nominal and the segregated region for:

- Analysis of grain growth behavior in in the temperature range 950 °C-1010 °C (thus simulating the austenitisation stage of the heat treatment).
- Continuous Cooling Temperature (CCT) diagrams determination. CCT diagrams were derived based on the dilatometry experiments carried out on 10 mm length 6 mm diameter specimens, with controlled cooling rate CCT diagrams are built starting from two different austenitization temperatures (980 °C-1010 °C) thus simulating the effect of the cooling stage on both the cylinder regions characterized by nominal and segregated region.
- Tempering response after quenching in the temperature range 470 °C-590 °C.

Results show that:

- during austenitisation steel with a segregated composition shows a finer average austenitic grain size, mainly following a manganese content increase (Figure 1)

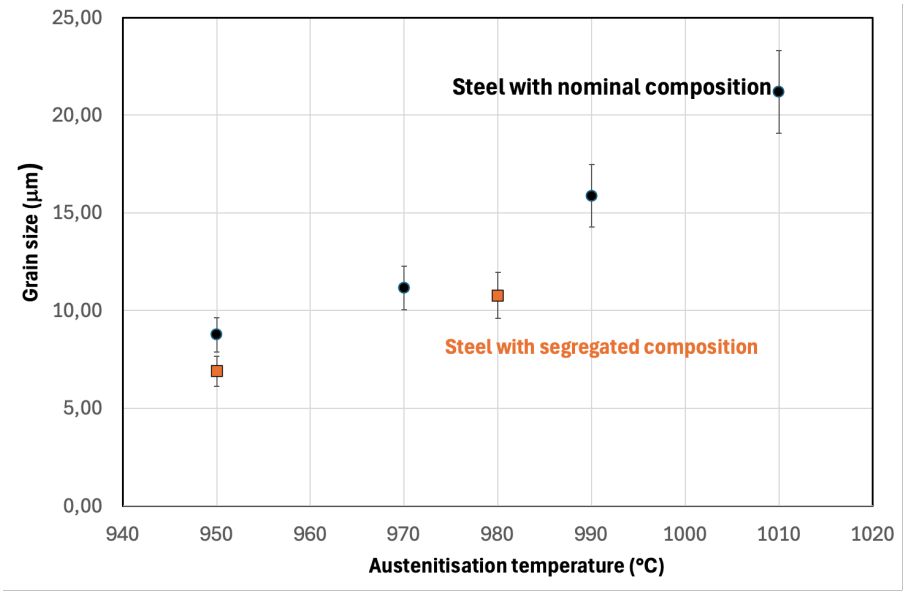

Fig. 1. Grain growth curves of materials with nominal and segregated composition.

- during quenching no effect is found by carbon increase from 0.65% to 0.82% in terms of martensite hardness, as expected for this carbon levels; a clear effect is detected of the average austenite grain size on steel hardenability;
- a secondary hardening peak in the case of the segregated steel is detected during tempering (Figure 2)

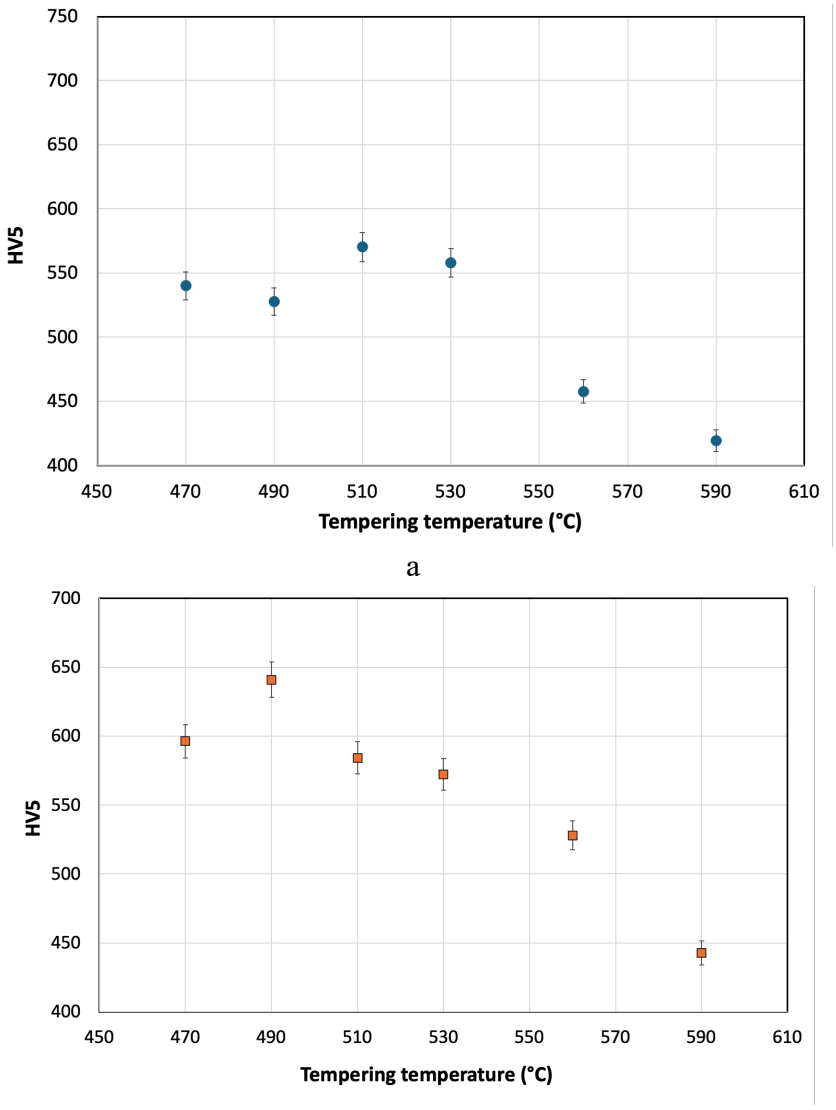

Fig. 2. Tempering behavior of the considered steel (a: nominal composition, T_{aust}=950°C; b: segregated composition, T_{aust}=950°C).

Results show that, even with a lean chemical composition, a wide range of microstructures and mechanical properties can be achieved through proper control of heat treatment parameters. This study provides useful guidelines for the design of steels with reduced alloying content, contributing to more environmentally sustainable steel production.