THE EFFECT OF AUSTENITISING AND TEMPERING PARAMETERS ON THE MICROSTRUCTURE AND HARDNESS OF MARTENSITIC STAINLESS STEEL AISI 420

by

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ABSTRACT

The effect of austenitising and tempering practice on the microstructure and mechanical properties of two martensitic stainless steels was examined with the aim of supplying heat treatment guidelines to the consumer or fabricator that, if followed, would result in a martensitic structure with minimal retained austenite, evenly dispersed carbides and a hardness of between 610 HV and 740 HV (hardness on the Vickers scale) after quenching and tempering. The steels examined during the course of this examination conform in composition to medium-carbon AISI type 420 martensitic stainless steel, except for the addition of 0.13% vanadium and 0.62% molybdenum to one of the alloys. The effect of various austenitising and tempering heat treatments was examined. Steel samples were austenitised at temperatures between 1000°C and 1200°C, followed by quenching in oil. The as-quenched microstructures were found to range from almost fully martensitic structures to martensite with up to 35% retained austenite after quenching, with varying amounts of carbide precipitates. The influence of tempering, double tempering, and sub-zero treatment was investigated. Optical and scanning electron microscopy was used to characterise the as-quenched microstructures, and X-ray diffraction analysis was employed to identify the carbide present in the as-quenched structures and to quantify the retained austenite contents. Hardness tests were performed to determine the effect of heat treatment on mechanical properties. As-quenched hardness values ranged from 700 HV to 270 HV, depending on the amount of retained austenite. Thermodynamic predictions (using the CALPHAD™ model) were used to explain these microstructures based on the solubility of the carbide particles in the matrix at various austenitising temperatures. The carbide particles were found to be mainly in the form of M_7C_3 at elevated temperatures, transforming to $M_{23}C_6$ on cooling.

Keywords: martensitic, stainless, austenitising temperature, retained austenite, M_7C_3, $M_{23}C_6$, carbide

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