Effect of Heat Treatment on Thermal Expansion Behavior and Corrosion Resistance of Martensitic Stainless Steel Manufactured by Submerged Arc Welding

Xinyue Wang¹, Jihui Wang¹, Zhiming Gao^{1,*}, Wenbin Hu^{1,2,*}

¹ Tianjin Key Laboratory of composite & Functional Materials, School of Materials Science and Engineering, Tianjin University, Tianjin, 300072, China

² Key Laboratory of Advanced ceramics and Machining Technology (Ministry of Education), Tianjin University, Tianjin, 300072, China

*E-mail: gaozhiming@tju.edu.cn; wbhu@tju.edu.cn

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The martensitic stainless steel surfacing layer was deposited on the H13 steel using submerged arc welding (SAW). The effect of the tempering conditions (350 °C ~ 650 °C for 2 h and 450 °C for 0.5 h ~ 4 h) on the microstructure, thermal expansion behavior and corrosion resistance was systematically analyzed. The results indicated that tempering led to the transformation of the residual austenite and coarse martensite in the as-welded sample to the fine tempered martensite and carbides (Fe₃C-450 °C/0.5 h and M₇C₃-other conditions). An optimal fusion between the H13 steel and surfacing layer was obtained in all cases, with no appreciable cracks. Relative thermal expansion ($\Delta L/L_0$) and thermal expansion coefficient (CTE) were observed to increase at first due to the reduction in the welding defects, followed by a decrease due to the phase transition and microstructure coarsening on increasing the tempering temperature and duration. The thermal expansion behavior closest to that of the H13 steel was obtained at 450 °C for 2 h, along with a better thermal stability and lower cracking sensitivity. Furthermore, the surfacing layer with a high alloy content exhibited much better corrosion resistance than the H13 steel. After tempering at or above 450 °C for 2 h, the corrosion resistance of the surfacing layers was noted to be higher than the as-welded sample. The corrosion resistance enhanced further on increasing the tempering temperature and duration, which was dependent on the even phase composition and homogeneous microstructure as well as decreased welding defects and grain boundaries. The maximum R_{ct} value ($1.961 \times 10^5 \Omega \cdot \text{cm}^2$) was obtained at 650 °C for 2 h, thus, suggesting an optimal corrosion resistance.

Keywords: H13 steel, submerged arc welding, martensitic stainless steel, tempering, thermal expansion, corrosion resistance.

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