Effects of Second Thermal Cycles on Microstructure and CO₂ Corrosion Behavior of X80 Pipeline Steel

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The effects of the gas metal arc welding (GMAW) thermal cycle on the microstructures and carbon dioxide (CO₂) corrosion behaviors of X80 pipeline steel and its coarse-grained heat-affected zone (CGHAZ) from submerged arc welding (SAW) were studied. Different microstructural gradients were found to form in the two joints. The CO₂ corrosion resistances of those samples experiencing the SAW thermal cycle were inferior to those not experiencing it because of their relatively coarse microstructures. Two completely different corrosion mechanisms were operative for the base metal (BM) and the heat-affected zones in the electrolyte. The preferential dissolution of the martensite/austenite (M/A) constituents contributed to the presence of pitting and produced an inductive loop in the Nyquist plots and pitting holes in the corrosion morphologies of some of the sample surfaces. More importantly, the corrosion resistance of the intercritical CGHAZ (ICCGHAZ) with a secondary peak temperature between the characteristic austenite formation temperatures, Ac₁ and Ac₃, was the weakest because of the presence of coarse necklace-shaped M/A constituents and high-carbon martensite.

Keywords: second thermal cycles; heat-affected zone (HAZ); carbon dioxide (CO₂) corrosion; M/A constituents

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