Abstract

This research focuses on optimizing TIG welding parameters for similar and dissimilar welds of AISI 304L austenitic stainless steel and AISI 409M ferritic stainless steel, materials widely valued for their mechanical properties across industries. Using GTA welding, experiments based on the Taguchi L_9 orthogonal array investigated the effects of welding current (95 A, 105 A, 115 A), gas flow rate (10 L/min, 15 L/min, 20 L/min), and travel speed (2 mm/s, 2.5 mm/s, 3 mm/s) on bead geometry, microhardness, and tensile properties. Nine butt-welded joints with 3 mm plate thickness were fabricated and analyzed through visual and X-ray inspections, tensile testing, and metallographic analysis using optical microscopy and SEM. Multi-objective optimization techniques, including GRA, TOPSIS, and ANOVA, were employed to determine optimal parameter settings, assess individual contributions, and enhance weld quality by improving bead geometry, microhardness, and tensile strength. This novel approach to joining incompatible materials offers valuable insights for achieving high-quality, reliable welds and demonstrates the effectiveness of advanced analytical methods in optimizing complex welding processes for industrial applications.

Keywords: TIG Welding, ASS, FSS, HAZ, UTS, SEM, X-ray radiography, ANOVA, TOPSIS, GRG