ABSTRACT

Laser welding is emerging as one of the promising technologies for joining variety of materials with and without filler materials. An attempt was made to study the laser welding process of sub-millimeter-thick stainless steel sheets of SS 304 and SS 316 type with the help of 2 kW Yb–fiber laser system. The welding was carried out in butt joint configuration by shrouding with argon gas without using any filler material. The objective of this study was to find out the variation and the optimum values of laser welding operating parameters over the changing thickness of sheets. Hence the selected thicknesses for SS 304 were 0.25 mm, 0.4 mm, and 0.8 mm and for SS 316 they were 0.2 mm, 0.56 mm, 0.85 mm. Central composite design technique was used to design the experiments to study welding with continuous mode of laser. The selected input parameters were laser power (W), welding speed (mm/min) and focal point position (mm). For characterization of the laser welding in pulse mode (PL), percentage of overlap of two consecutive welded spots was varied from 40% to 80% in continuous seam pulse mode welding. To study the quality of welded joints, the selected responses were ultimate tensile strength (UTS), weld width (WW) and micro-hardness. The results obtained showed that laser beam welding of SS 304 and SS 316 in butt joint configuration could be done successfully in pulsed as well as continuous mode of 2 kW Yb–fiber laser for sheets of thickness as low as 0.2 mm. Microstructure of laser welded joints was greatly affected by heat input, welding speed and the composition of the base materials. SS 304 weld got solidified by FA mode and SS316 weld got solidified by AF mode. Higher UTS was obtained for CW welded joints than the pulsed laser welded joints. For CW welding, the UTS for majority of welded joints exhibited higher values compared to BM. The percentage elongation for all the welded joints got reduced than its BM elongation. The developed second order polynomial equation for CW welding could predict the values of the weld quality characteristics with significant accuracy. The developed empirical model was tested with ANOVA with confidence level of 95%. The weld width increased linearly with increase in laser power and with decrease in laser scan speed. The pulsed welded joints of SS 304 exhibited higher UTS for 60% to 70% overlap and SS 316 exhibited higher UTS for 70% to 80% overlap. The corrosion resistance of welded joints was in the permissible range as compared to its base material and it increased with decrease in thickness of welded joints. The corrosion resistance deteriorated with increased line energy during welding. The CW welded joints of the same sheet exhibited higher joining efficiencies than the PL-welded joints. The XRD analysis also revealed the effect of increase in heat input on the formation of certain oxides without formation of any intermetallic compounds. Thus, the similar study can be extended to study laser welding of dissimilar materials in the sub-millimeter thickness in future.