Abstract

Manufacturing companies often fail to maintain good weld quality due to poor arc stability, inadequate weld bead and its inadequate microstructure in conventional gas metal arc welding (GMAW) processes. Pulsed GMAW (P-GMAW) is an alternative technique that overcomes these problems to a large extent since optimum weld joint characteristics can be achieved by adjusting the pulse parameters. The arc stability in GMAW primarily depends on arc length variations and metal transfer behavior. However, GMAW processes are highly nonlinear with many uncontrollable factors and uncertainties. Hence, the increasing demand of weld quality monitoring in modern automated manufacturing industries has necessitated the development of an intelligent system with robust, reliable and non-contact sensors to evaluate the process and determine the best adjustments. Arc sensors are widely used in such systems because of their simplicity and reliability. Various advanced cameras, radiographic sensors, infrared sensors etc also have been used. However, the arc monitoring is disturbed due to glare of arc. Arc acoustic sensors may prove to be useful in overcoming this handicap. In this work, the influence of various process parameters were studied on low carbon steel plate using bead-on-plate, as well as butt welding method in P-GMAW. Infrared pyrometer and sound sensor along with arc sensors were used to monitor the process. Arc sound kurtosis, arc power and weld peak temperature were found to be highly correlated with welding process stability, weld penetration and transverse shrinkage. The frequency domain features and time-frequency wavelet features of welding sound were also found to be an indicator of the process characteristics. These signal based features were used with process parameters in back propagation neural network (BPNN) models to improve the monitoring capability. Finally, multi-objective optimization has been done using neuro based non-dominated shorting genetic algorithm (NSGA-II) to achieve desired joint quality features.

Keywords: P-GMAW, torch angle, pulse shape, metal transfer mode, joint strength, distortion, arc acoustics, weld peak temperature, arc power, BPNN.