Abstract

Temperature distribution and cooling rate during welding process have significant effect on the mechanical and the metallurgical properties of a weldment. The change in microstructure, grain growth, hardness and residual stress in a weldment are very much dependent on the temperature distribution and cooling rate. In the present work a three-dimensional transient finite element analysis of heat transfer in arc welding has been presented. The problem was solved by taking several important factors into the consideration (like, temperature dependent material properties, Gaussian distribution of welding arc, enthalpy, etc). The temperature distribution and cooling curve were theoretically estimated and compared with the standard published experimental and theoretical results. To reduce the computation time finer mesh was generated where temperature gradient was very high and gradually mesh size was increased away from the heat source. The effect of arc radius and higher value of thermal conductivity were also investigated. The model was indirectly verified by conducting some experiments on submerged arc welding. Weld metal zone, coarse-grained zone, and fine-grained zone were theoretically estimated and compared with the experimentally measured values. Grain size and micro hardness were also measured and explained on the basis of estimated peak temperature and cooling rate. Cooling curves were superimposed on the TTT diagram and study of different constituents of microstructures was made. It was found that estimated results by the model well correspond to the experimental results.