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Abstract

Pulsed gas metal arc welding (P-GMAW) is one of the most effective joining methods for mainline field girth welding of large diameter and long-distance pipelines. Most of the current applications are single-wire processes coupled with narrow-groove weld geometry. Multi-wire variants, such as tandem-wire and dual torch processes, have been developed to increase welding productivity and reduce overall project cost. The P-GMAW processes have some unique characteristics that need to be considered in the heat transfer and microstructure analyses of the processes. This paper presents integrated thermal and microstructure models for P-GMAW processes with a consistent heat source model and its associated thermal boundary conditions. The objective of this study is to extend the existing numerical welding modeling approaches to cover wider range of P-GMAW processes, such as the multi-wire variants. To validate the integrated models, the predicted cooling times and hardness for welds produced under different preheat temperatures and different P-GMAW processes were compared to actual thermal cycle and hardness measurements. Generally good agreements were achieved and certain areas of continued improvements were identified.

Keywords

GMAW, Narrow groove, Heat transfer, Microstructure, Cooling time, Hardness, Finite element analysis