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Abstract

Girth welds in high-strength pipeline constructions are often made with mechanized pulsed gas-metal-arc welding (PGMAW) process. Welding of the high strength steels poses a number of challenges because of the sensitivity of weld mechanical properties to variations in welding parameters and material properties. In addition to the unique characteristics of narrow groove weld geometry and multiple weld passes, the fabrication of P-GMAW girth welds sometimes also employs alternative welding processes such as dual torch or tandem wire in order to increase pipeline construction productivity. In order to understand the dependency of weld properties on welding processes and their parameters, a transient thermal model for multi-pass girth weld had been proposed and successfully developed. The heat transfer model used the superposition principle of heat sources to handle the welding processes with multiple wires or multiple passes. This paper presents the latest development of this numerical approach and its verification against experimental measurements of thermal cycles from X100 girth welds under different welding conditions. A number of X100 pipe girth welds under different welding conditions were made for the verification purpose. The welding conditions include single torch and dual torch P-GMAW process, 1G and 5G welding. Thermocouples were placed in the heat-affected zone (HAZ) and the weld-pool for the measurements of thermal cycles. The measured thermal cycles and cooling times from 800 ℃ to 500 ℃ were compared to those predicted by the thermal model. Very good agreements between the measured results and the numerical prediction by the thermal model were achieved.

Keywords

Heat transfer, GMAW, Girth weld, High-strength steels