Chen, Y., Wang, Y.-Y., Gianetto, J., Rajan, V., and Quintana, M., Simulation of Microstructure Evolution and Its Experimental Verifications for Girth Welds in High-Strength Pipelines, Proceedings of 8th International Pipeline Conference, Calgary, Alberta, Canada, 2010, Paper no. IPC2010-31374

Abstract

Girth Welding of high strength steels such as X80 or X100 poses a number of challenges because of the sensitivity of weld mechanical properties to variations in welding parameters and material properties. This dependency is further complicated by the application of alternative welding processes with multiple wires, tandem wire or dual torch welding, for example. In order to correlate the relation between weld mechanical properties and the welding conditions, an integrated thermal and microstructure model has been developed. Given the welding conditions, the thermal model is able to simulate the local thermal cycles for a girth weld with multiple passes and multiple electrode wires. In the mean time, a microstructure model, using the thermal cycles obtained from the thermal model as input, simulates the microstructure evolution both in the weld metal and the HAZ as the welding progresses. This paper presents the latest development of this microstructure model and its verification against metallurgical measurement data from X100 girth welds. These welds included girth welds made under practical welding conditions and experimental welds made with X100 plates. The measured hardness was compared to the predicted by the microstructure model. The comparison indicated that the microstructure was able to predict the hardness profiles in a multi-pass girth weld and the general trend of variation as a function of welding conditions. In order to improve the accuracy of hardness prediction, the areas of improvement in the microstructure model have been identified.

Keywords

Pipeline, Girth weld, P-GMAW, Hardness microstructure