Title

Chen, Y., Wang, Y.-Y., Thermal and Microstructure Analysis Software for GMAW Girth Welds of High Strength Pipelines, Proceedings of 62nd Annual Assembly and International Conference of IIW, 2009, Singapore

Year of Publication

2009

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Abstract

An integrated thermal and microstructure model for girth welds by gas metal arc welding (GMAW) process in pipeline construction is presented. For a multi-pass, narrow grooved girth weld made with GMAW process, or its variants such as tandem wire or dual torch, the temperature field is calculated with a transient finite element procedure. Given the chemical compositions of the consumables and the base metal, and the thermal cycles determined by the finite element procedure, the microstructure evolutions in both the weld metal and the heat-affected zone (HAZ) are simulated by calculating the key phase transformation parameters, the grain growth in austenite, and the austenite decomposition. The final hardness distribution and mechanical properties are determined from the cooling rates and microstructure information. Validations against a number of experimental data sets proved that the model was accurate and reliable for its targeted applications.

The integrated model was implemented in a generic finite element procedure along with a self-contained microstructure module, and a user interface that allows the inputs of all the needed welding information for the simulation. The independence of this integrated model from any other third-party analysis tools makes it possible to analyze the girth welding process with efficiency and easiness.

Keywords

GMAW, Heat transfer, Microstructure, Girth weld, High-strength steel