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Abstract

The mechanical properties of pipeline steel welds are controlled by thermal cycles experienced during welding and the chemical compositions of pipe steels and welding filler metals. The methods for identification and control of the essential welding variables in the current codes and standards are largely derived from experience with pipe materials that are significantly different from modern controlled-rolled and microalloyed steels supplied today. Both steel making and welding processes have evolved greatly in the past few decades. At the same time high-productivity arc welding processes have evolved. These processes produce more complex heating and cooling cycles than traditional processes. The result is that the heat-affected zone (HAZ) and deposited weld metal performance can be very different from historical experience. These changes have not been adequately considered and incorporated into the welding essential variables in the codes and standards.

An alternative approach to essential variables, termed essential welding variable methodology (EWVM), has been under development for over a decade. EWVM is rooted in the fundamentals of weld properties, i.e., the weld performance is controlled by its microstructure which, in turn, is controlled by the interaction between the chemical composition and the welding thermal cycles.

This paper first briefly introduces one of the key outputs of the previous efforts, namely, the essential welding variable methodology (EWVM). This is followed by a detailed description of applying this methodology for the welding an X70 pipe. The resulting weld properties demonstrate the sensitivity of weld properties to welding thermal cycles and the ability of EWVM to predict the trend of the properties. Other applications of EWVM are briefly summarized, including the potential for cost and time reduction in welding procedure qualifications.

Keywords

Girth welding procedure qualification, Essential variables, Cooling rate, Girth welding thermal analysis