

Cheng, W., Wang, Y.-Y., Amend, W., and Swatzel, J., Weld Microstructure and Hardness Prediction for In-Service Hot-Tap Welds, Proceedings of 4th International Pipeline Conference, Calgary, Alberta, Canada, 2004, Paper No. IPC2004-0558

Abstract

Welding onto an in-service pipeline is frequently required to repair damaged areas and for system modifications. There are often significant economic and environmental incentives to perform in-service welding, including the ability to maintain operations during welding and to avoid venting the contents to the atmosphere. Welds made onto in-service pipelines tend to cool at an accelerated rate. These welds are likely to have high heat-affected zone (HAZ) hardness which increases their susceptibility to hydrogen cracking. Accurate prediction of HAZ hardness is critical in developing successful welding procedures for in-service hot-tap welds. The present PRCI thermal analysis software for hot-tap welding uses an empirical formula-based HAZ hardness prediction procedure. This paper describes an effort funded by PRCI to produce a significantly improved HAZ hardness prediction procedure over the procedure in the current PRCI thermal analysis software. A markedly improved hardness prediction procedure was developed and systematically validated using extensive experimental data of actual welds. The underlying hardness calculation algorithms were based on the proven state-of-the-art phase transformation models. Although on the average the procedure under-predicts the measured hardness by a small amount, the new hardness prediction procedure is a significant improvement in overall accuracy over the procedure in the current PRCI thermal analysis software. The procedure developed here lays the foundation for a much more accurate hardness prediction module in the future version of the PRCI thermal analysis software.

Keywords

Welding, Cooling rate, Hardness, Microstructure