Wang, Y.-Y., Jia, D., Johnson, D., Rapp, S., and Horsley, D., Low Strain Capacity Girth Welds in Newly Constructed Pipelines and Their Implications in Integrity Management, Paper No. 1, 22nd Joint Technical Meeting of APGA-EPRG-PRCI, Brisbane, Australia, April 29 – May 3, 2019.

Abstract

There have been a number of unexpected girth weld failures in newly constructed pipelines in North America. Girth weld failures have also been observed in pre-service hydrostatic testing. Most of the failures occurred in X70 pipelines with manual welds, although failures have been observed in linepipe grades ranging from X52 to X80. Post-incident investigations indicated that the pipes, girth weld qualification, and field girth welding and inspection met the requirements in relevant codes and standards. Traditional causes of weld failures such as weld flaws and high-low misalignment played no or insignificant roles. In other words, these failures are beyond expectations based on historical experience. More significantly, the causes of these failures have not been the focus of the relevant codes and standards that the industry has been relying on for quality assurance and long-term integrity.

The features of the recent girth weld incidents are first reviewed. The key characteristics of those incidents is summarized. The primary and secondary contributing factors to the incidents are listed by incident. Overall, the main contributing factors to the incidents are: (1) weld strength undermatching, (2) heat-affected zone (HAZ) softening, (3) weld bevel geometries of manual stick welding processes that favor plastic straining along the softened HAZ, and (4) elevated stresses/strains from normal settlement and other loads. The causes of weld strength undermatching and HAZ are further examined from the viewpoint of linepipe steel manufacturing, pipe testing and qualification requirements, and response to a regulatory advisory. The last part of the paper focuses on mitigative measures the industry can take to reduce the risk of similar failures in future pipeline construction. These measures include responses to the causes of weld strength undermatching and HAZ softening. The systematic gaps in current standards and industry practice are examined and mitigative proposals are provided. It is critically important that the responses to the incidents cover both technical improvements and, more significantly, systematic improvements that minimize the disconnect among different functional departments responsible for various stages of a pipeline's life.

Keywords

Linepipe, Modern microalloyed steels, Girth weld incident, Girth welding, HAZ softening, Weld strength undermatching, Strain capacity, Standards revision, Systematic approach