U.S. Department of Transportation

Optimizing Weld Integrity for X80 and X100 Linepipe
DTRS56-04-BAA-0002
November 2005

OPS ACCOMPLISHMENTS

Pipeline Safety Research and Development for Focus area

Improved Materials Performance

Challenge

Reducing the cost of new pipelines is a major driving force within the pipeline industry and the use of high strength steels offers major cost benefits for long distance gas transmission pipelines. The move towards higher strength steels also comes at a time when design practices are evolving and there is greater focus on overmatching criteria for pipeline girth welds. In the case of X80 and X100 pipe, this leads to minimum weld tensile requirements of 100ksi and 120ksi while still maintaining high toughness and CTOD properties. One of the major challenges in high strength pipeline construction is producing girth welds that both overmatch the tensile properties of the parent pipe and also exhibit excellent toughness.

Technology Description

This project will provide a better understanding of the factors that control strength and toughness in high strength in high strength girth welds and will enable high integrity girth welds to be more reliably and economically achieved in high strength pipelines. Specific project tasks include:

1. **Review of X80 and X100 pipeline welding and a review of the case for overmatching**
2. **Develop Best Practice Welding Guideline for X80 Pipelines**
3. **Develop Optimized Welding Consumables and Procedures for X100 Pipelines**

Projects like the Cheyenne Plains X80 Pipeline Project Require Advanced Welding Technology. The Cheyenne Plains Pipeline, constructed in the Fall of 2004, is the first X80 cross country gas pipeline constructed in the USA and the longest X80 gas pipeline in the world.

Accomplishments

Task 1. Completed initial review of X80 and X100 pipeline welding.

Task 2. A draft best practice guideline which includes a comprehensive benchmark of the Cheyenne Plains X80 Pipeline Project has been prepared.

Task 3. Current X100 efforts are focused on single wire welding. A 2-dimensional axisymmetric model was created and calibrated. Cooling rate data predicted by the FE models have been used to correlate welding parameters with observed microstructure and material properties. These data have been used as input to create a neural network (NN) model. The NN model will help predict the material properties of the weld metal based on the welding procedure and weld metal chemistry selected. The NN model can then be used to select the appropriate consumables.

Contact

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Concept of 2D modeling

Measuring the thickness of each weld

▼

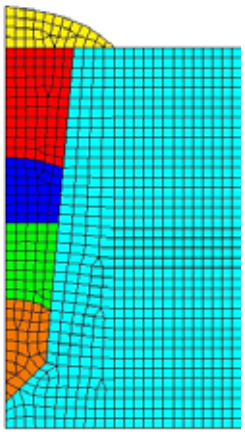
Develop the 2D FE model and calculate area and width of each pass:

▼

Calculate duration time;
Δt = 3R/TS ; TS = travel speed

▼

Calculate uniform body flux on each



Axisymmetric model

2D Model for Cooling Rate Calculation (1. Hudson, M., " Welding of X100 Linepipe"

Benefits

The use of higher operating pressure offers an opportunity to reduce the pipeline diameter required for a given throughput. The welding guidelines and optimized welding consumables developed in this project will provide pipeline operators with robust methods for welding X80 and X100 in the field and guidance on the specification of overmatching requirements. This will result in higher integrity girth welds.

Future Activities

Task 1. Complete the final report summarizing the X80 and X100 pipeline welding review.
Task 2. Incorporate partner input into the best practice welding guideline
Task 3. Produce and test welding consumables in accordance with the best property predictions from the NN model

Partners in Success

- **Edison Welding Institute, Inc. (EWI) - Lead Organization www.ewi.org**
- **EWI Microalloying www.ewi.org**
- **Pipeline Research Council International, Inc. (PRCI) www.prci.com**
- **CANMET, El Paso Pipeline Group, TransCanada Pipelines, BP, ITW (Miller Electric Manufacturing Company and Hobart Brothers) www.nrcan-rncan.gc.ca/inter/index_e.html**

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