Fracture Mechanics Based Weld Flaw Assessment Acceptance Criteria for C Mn Steel Pipelines in Sour Service

PUBLISHABLE SUMMARY

20252

Background

The use of engineering critical assessment (ECA), prior to the installation of a pipeline, to define flaw acceptance criteria for inspection is becoming more widespread. Such an approach is aimed at allowing larger imperfections to be permitted than would typically be permitted by traditional workmanship standards. In turn, the extent of rework at the time of installation can be reduced and costs minimised. However this approach does not provide flaw sizes for sour service which are consistent with industry experience using workmanship criteria, thus the benefits above cannot be realised in sour service applications.

This Joint Industry Project (JIP) was devised to gain an enhanced understanding of the performance of welded C Min pipes in sour environments and to develop an improved approach and guidance for conducting ECAs for pipes for sour service.

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Objectives

- Enhance understanding of the influence of test and material parameters upon the derivation of over-conservative conventional K_{ISSC} values for welded C-Mn steel pipelines operating in sour service.
- Define an improved approach and guidance to material testing and assessment of flaws in welded C-Mn steels exposed to sour service, to permit reliable fracture mechanics-based ECAs to be carried out.

Project Outcome

A series of progress reports were issued during the project. At the close of the project, a final report was produced providing full experimental details and a discussion of the main results. Although no definitive test methodology was defined in this programme, the significance of a number of test variables was explored and found, within specific ranges, to not significantly affect the results obtained.

Benefits

Improved reliability of ECAs for sour service will provides:

- Improved confidence in the safety of pipelines in service.
- Cost savings during pipe lay due to avoidance of unnecessary repairs, of the order of 2-3% for large projects.

Participants

The Sponsor Group comprised:

- Chevron;
- Petrobras.

Scope of Work

Initial activity in this programme focussed upon the re-analysis of the Phase 1 data and refinement of the finite element model developed in Phase 1 to better account for geometry and residual stress effects

An additional set of small scale K_{ISSC} tests was carried out using the same homogeneous simulated HAZ material as used in Phase 1 of the programme to further assess the effect of changes in crack length, but focussing upon shallow flaws, perhaps more representative of fabrication, with a/W of approximately 0.1.

Considering the testing that had been carried out in the early part of the current programme and Phase 1, one area of uncertainty that remained was the possible difference in the crack tip conditions associated with a natural flaw (for example a lack of root penetration flaw) and a fatigue pre-crack. Therefore, further small scale weldment K_{ISSC} testing was performed to assess the behaviour of both a natural flaw, a fatigue pre-crack and an oxidised fatigue precrack.

Analytical and finite element calculations were used to calculate the K applied during the tests and comparison made with the earlier small-scale data. Consideration was given to the significance of the results in relation to current test methods and assessment procedures.

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Price and Duration

The project had duration of three years and a budget of £160,000. The contribution per Sponsor was £80,000.

Further Information

For further information on Joint Industry Projects and their operation please visit:

http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/

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