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UNDERSTANDING PRINCIPAL DRIVERS TO BURST PRESSURE AND LOCAL DEFORMATION OF PIPES WITH SCC COLONIES

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ABSTRACT

Two pups with SCC colonies were removed from service. The most dominant cracks in the colonies are short and deep. One of the pups had a bulge in the area of the SCC colony. The two pups were subjected to hydrostatic burst tests and detailed post-test metallurgical examination. A companion paper covers the formation, dormancy, and growth of these SCC colonies using forensic analysis. This paper covers two main elements aimed at understanding the behavior of pipes with SCC colonies and supporting the work covered in the companion paper:

(1) Burst pressure prediction, and
(2) Analysis of the bulge.

Burst pressure predictions were made with available material properties and flaw dimensions measured by MPI, UT, and PAUT prior to the actual burst tests. After the burst tests, the predictions were updated with more relevant material property data and the flaw dimensions obtained from fracture surfaces exposed. The modified Ln-Sec, CorLAS™, MAT-8, and Level 2 of API 579 burst pressure models and the associated Charpy to fracture toughness correlations were used. Two flaw interaction rules, CEPA and PRCI-CRES, were used to determine the single equivalent crack dimensions for input into the burst pressure models. The burst pressure predictions were compared with the experimentally measured burst pressures.

Of the multiple factors affecting the burst pressure prediction, the selection of flaw interaction rules has the most prominent impact on the accuracy of the burst pressure prediction. The selection of burst pressure models has a secondary impact with the exception of API 579, which tends to give lower burst pressure predictions than other models.

The formation of the bulge was simulated under different longitudinal/axial loading conditions and two levels of internal pressure. It is shown that the level of the residual bulge has a strong dependence on the severity of SCC (length, depth, and spatial distribution), the level of maximum internal pressure before depressurization, and the longitudinal stress state. Compressive longitudinal stress reduces the level of internal pressure needed to produce a bulge of the same magnitude when the severity of SCC remains constant. Multiple possible conditions could have existed to produce the observed bulge.

KEYWORDS

SCC, burst pressure prediction, burst pressure models, flaw interaction rules, bulge at SCC, effects of longitudinal/axial loads

1 INTRODUCTION

Two pups with SCC colonies, named Dig 1777 and Dig 2692, were removed from a pipeline transporting natural gas in 2021. The most dominant cracks in the colonies are short and deep. A bulge in the area of the SCC colony was visible on Dig 1777.

The pipeline was constructed in 1957 with API Grade X52 pipes with 30-inch OD and 0.375-inch WT. A hydrostatic test was done in 1986. The two pups were on the discharge side of a compressor station before the flow direction was reversed in 2015. The MAOP before and after the 2015 flow reversal was 1040 psi (80% SMYS) and 936 psi (72% SMYS), respectively.

The two pups were subjected to hydrostatic burst tests and detailed post-test metallurgical examination in 2021. A companion paper covers the formation, dormancy, and growth of these SCC colonies using forensic analysis [1]. This paper