Engineering Consulting & Training Services

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eNewsReport

January 2018


# Using ASME FFS-1 / API 579 to Assess HIC Damaged Equipment

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Hydrogen induced cracking (HIC) may occur in pressure equipment that contain wet $H_2S$ environments when hydrogen blisters form and are accompanied by cracks which link these blisters. Since the blisters can form at various depths, the cracking will appear as a stair step appearance. Hence, HIC may be referred to as "stepwise cracking."

To assess HIC damage, the ASME FFS-1 / API 579 standard presents Part 7 methodologies which contain three levels of assessment sophistication. A recent project involved evaluation of HIC damage which failed to pass a Level 1 assessment. A Level 3 assessment was performed which encompassed other parts of ASME FFS-1 / API 579, notably general metal loss [GML], local metal loss [LML], and the assessment of crack-like flaws.

Several difficulties were revealed for practitioners in applying the various levels of analysis. These included, on the part of the practitioner:

- Understanding and implementing applicability screening
- The limitations of assessment levels
- The crucial terminology to determine which assessment level to use
- The need to utilize multiple portions of the ASME FFS-1 / API 579 document to complete a Level 3 assessment

Notwithstanding the meticulous step-by-step approach of the standard, these difficulties in implementing this methodology are due to document complexity, inconsistencies in formulations, and overlooking documentation required by regulators. Other industry practice documents for in-service inspection alert users to the difficulties of assessing vessels to HIC damage which may preclude extending continued operation of a vessel that experiences this degradation mechanism.

We have recently developed a program for a client to assess the current status of damage in a tower, monitor damage progression, identify mechanical integrity limits, and the safeguarding steps required to ensure that vessel integrity is maintained in order to operate to the planned turnaround date.

*About the Author*

*John Aumuller has over 35 years' experience as a project manager and mechanical engineering specialist. He has expert knowledge of industry relevant codes, such as ASME, Boiler and Pressure Vessel Code Section VIII, Div. 1 and 2, Section I, B31.1, B31.3, CSA Z662, and related standards, including API standards.*

*Please contact Vince Carucci (vcarucci@carmagen.com) if you'd like more information on Carmagen's expertise.*

## Work Highlights

- *Performed fitness-for-service assessment (including FEA) of a high pressure amine scrubber column that had experienced HIC cracking. Concluded that the damaged areas did not meet API 579 / ASME FFS-1 Part 7 Level 1 acceptance rules, and recommended that further analysis and a risk assessment be made to determine appropriate actions.*
- *Made stress calculations of steam reformer heater outlet pigtails that had incurred creep rupture damage in multiple cases after less than three years of operation. Concluded that pigtail stresses likely exceeded the material creep rupture limit for 100,000 hours. This was due to exposure to temperatures higher than anticipated, rapid temperature changes during heater shutdown and startup, mechanical loads higher than anticipated, and/or thinner than required pigtail wall thickness.*
- *Rerate calculations made for a 40+ year above ground atmospheric storage tank due to large increase in required design temperature. Found that the tank would not meet API-650 design requirements due to current wind and/or earthquake design load considerations, and that anchoring may be necessary.*