Coiled Tubing Bias Welds Recent Failures Trend

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Bias Weld Failures - Outline

• Background Information
• Bias Weld Failures Causes
• Main Ideas
Bias Weld Failures - Background

Bias weld: plasma arc weld at 45° to joint steel strips ...After conforming the pipe it forms a helical weld
Bias weld failures trend in BHI:
Bias Weld Failures - Background

- CT90 and CT100+: 88% of bias weld failures
- 68% of the failures associated with 2” pipe
- Strings from the 3 CT manufacturers
Bias Weld Failures - Causes

Corrosion Operations, Fatigue, and H2S Cracking represent 84% of the bias weld failures.
Bias Weld Failures – Corrosion Operations

Corrosion Operations: failures associated with corrosion damage caused by fluids used during operations.
Six (6) CT failures occurred while milling plugs in Alice – USA.

String characteristics:
- 2” OD x tapered
- 90 Grade
- Basically new strings

All the failures occurred on bias welds.
Bias Weld Failures – Corrosion Operations

- On 3 failures: internal pitting corrosion on the bias weld region.
- Fatigue cracks starting at these pits
- High pressure regime (around 7,000 psi).
- Fluid: recycled fluid “treated” with biocide.
• Sulfur (S) was found within the internal pits

• Recycled fluid analyses revealed:
  – Sulfur, pungent odors of rotten eggs, and sulfide in the form of black precipitates
  – 4.2 – 5.2 million bacteria per ml
  – APBs and SRBs
Bias Weld Failures – Corrosion Operations

Failure: Pinhole; Date: November 2013; String: 2-3/8” x 0.156” – CT100+
Fluid: Customer supplied “treated” sea water (oxygen scavenger + biocide)
Failure: Ext. corrosion on bias weld; Date: October 2013; String: 2” x Tapered – CT90

Fluids: fracturing fluid + acid mix with inhibitor
Corrosion Operations:

- The examples showed a greater susceptibility to corrosion damage on the bias weld region – this is considered as “expected” but….Could this be a topic for investigation and improvement?
Bias Weld Failures – H2S Cracking

H2S cracking: failure by internal cracking due to the exposure to a sour environment. H2S sources could be different, i.e. well, contaminated fluid, etc.
• Three (3) CT failures occurred while milling plugs in Alice – USA.
• String characteristics: 2” OD x tapered - 90 Grade / Basically new strings
• Failures occurred as fractures at bias welds
Bias Weld Failures – H2S Cracking

- Internal corrosion damage very mild or absent – no fatigue cracking associated with isolated pits
- Internal cracking on the bias welds – “cleavage” features - similar to cracking due to exposure to H2S
Bias Weld Failures – H2S Cracking

- Fluid: recycled fluid “treated” with biocide
- Sulfur was observed on some shallow pits
- Fluid analyses revealed the presence of SRBs
- “Localized sour environments” – Bias weld weakest point
Bias Weld Failures – Contaminated Recycled Fluid

Corrective actions:

- Treating for bacteria in the system (including tanks)
- Treating circulating fluid
- Treating stagnant fluid
Bias Weld Failures – Fatigue

Not common to have “pure” fatigue failures
Bias Weld Failures – Fatigue

- Strings: 2” x tapered – CT100+
- Operating Pressure: 6,000 – 7,000 psi
- **Strains at bias weld locations:** 1.8% - 2.3%
- SFL used at bias weld locations: around 50%
Bias Weld Failures – Fatigue - Main Ideas

- Analysis of strings records showed:
  - Most of the retired strings without failures – SFL at bias welds < 50%
  - Failures at bias welds – SFL ≥ 50%
Bias Weld Failures – Fatigue

Data for CT100 and up from two CT manufacturers
At low strain (1.4%) the measured bias weld fatigue life was 87% of the pipe base material.
At 1.8% strain most of the values were lower than 80% (55% - 77%)
At 2.1% strain the reduction of fatigue life at the bias weld is more significant (below 70%)
Bias Weld Failures – Fatigue

Similar to 2.1% strain (bias weld fatigue life around 60s% of the pipe)
At high strain CT100+ bias weld fatigue life showed a significant reduction when compared to the pipe body.
From the failures and the fatigue data it can be inferred that a bias weld de-rating is required for strings CT100 and up.

De-rating should consider strain (reel and gooseneck):

Further fatigue testing on used bias welds (from strings retired from service) confirmed that the de-rating was required.
Bias Weld Failures – Main Ideas

• Between 2011 and 2013 and abnormal increase of failures associated with bias welds was observed.

• Strings involved: CT90 and 100+; mainly 2” OD; from the 3 CT manufacturers

• Causes of failures:
  – Corrosion operations
  – H2S cracking
  – Fatigue
Bias Weld Failures – Main Ideas

• Corrosion operations and H2S cracking:
  – Bias weld more susceptible to corrosion damage – Improvement?
  – Mainly associated with recycled fluid contaminated with bacteria
  – Corrective actions: treatment of system, fluid, and stagnant conditions

• Fatigue failures:
  – Associated with high strained CT100+ bias welds (1.8% to 2.3%)
  – Fatigue data confirmed need of de-rating factor for CT100+ bias welds
  – De-rating depending on level of strain
Acknowledgments

- CTRE
- Steven Craig and BHI USA land staff
Backup
Great Yarmouth P2216
Bias Weld Failures – Corrosion Operations
Bias Weld Failures – H2S Cracking

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Bias Weld Failures – H2S Cracking
Bias Weld Failures – H2S Cracking

- Date: January 2013
- String: 1-3/4” x tapered – CT80
- Failure: two cracks on bias welds
- Well: 37 psi H2S partial pressure
- Use of only H2S scavenger – not anti-cracking inhibitor
- Cracking on bias welds due to Sulfide Stress Corrosion Cracking (SSCC).
Bias Weld Failures – Fatigue

- Bias weld Charpy energy at room temp. lower than base metal (16% to 35%). Mode of fracture: cleavage

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