

# Microbial Induced Corrosion, Premature CT Failures, & Remediation Practices

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Applications Engineer

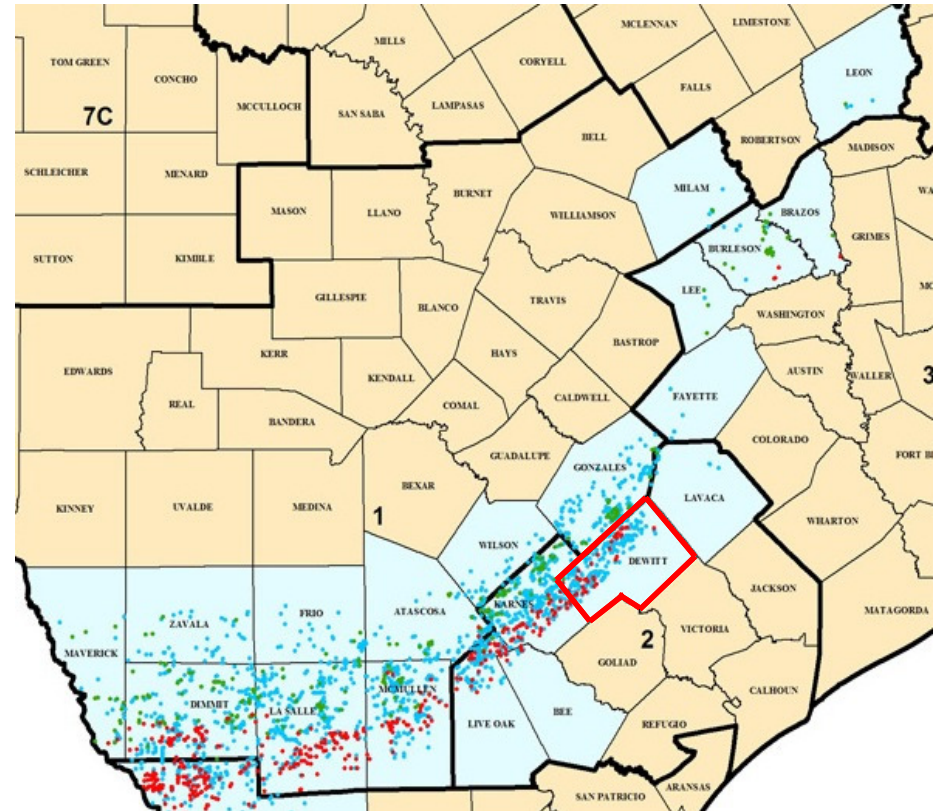
October 29th, 2014



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## Historic Overview

- Haynesville Shale
  - High pressure / temperature environment
  - Flow wells while milling
  - Some H<sub>2</sub>S
  - Large fluid surface volumes
- Eagle Ford Shale
  - High pressure / temperature
  - Recirculated fluids
  - Failures isolated to certain county (DeWitt)



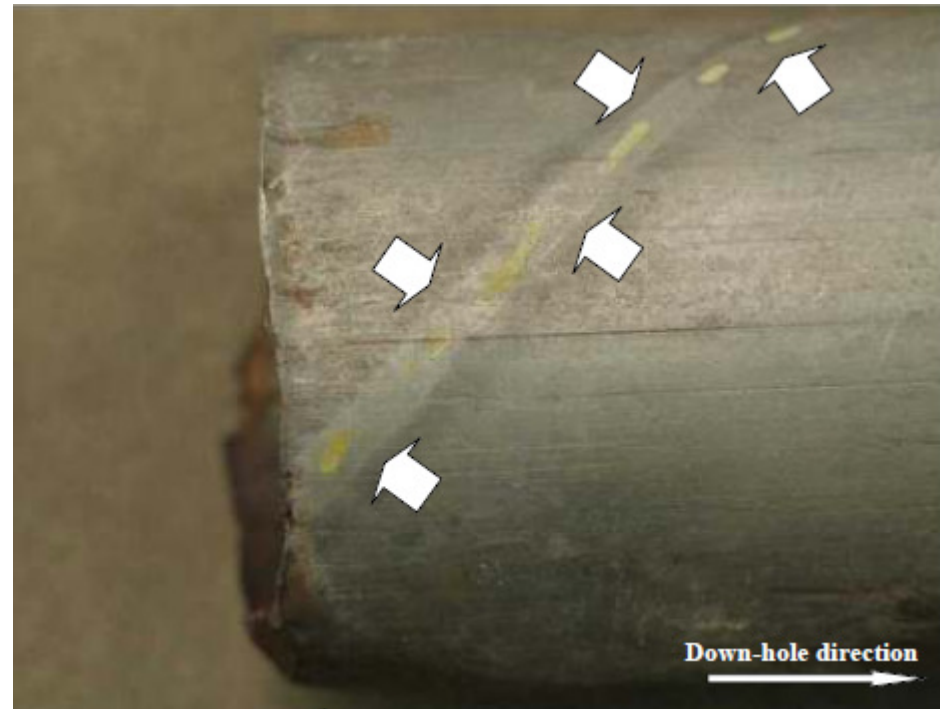
## Coiled Tubing Failures - Overview

- No equipment failure
- No external damage to coiled tubing
  - Pinhole
  - Mechanical
- No operator error
- Metallurgical testing was conducted
- Low fatigue life
- No Sour exposure reported



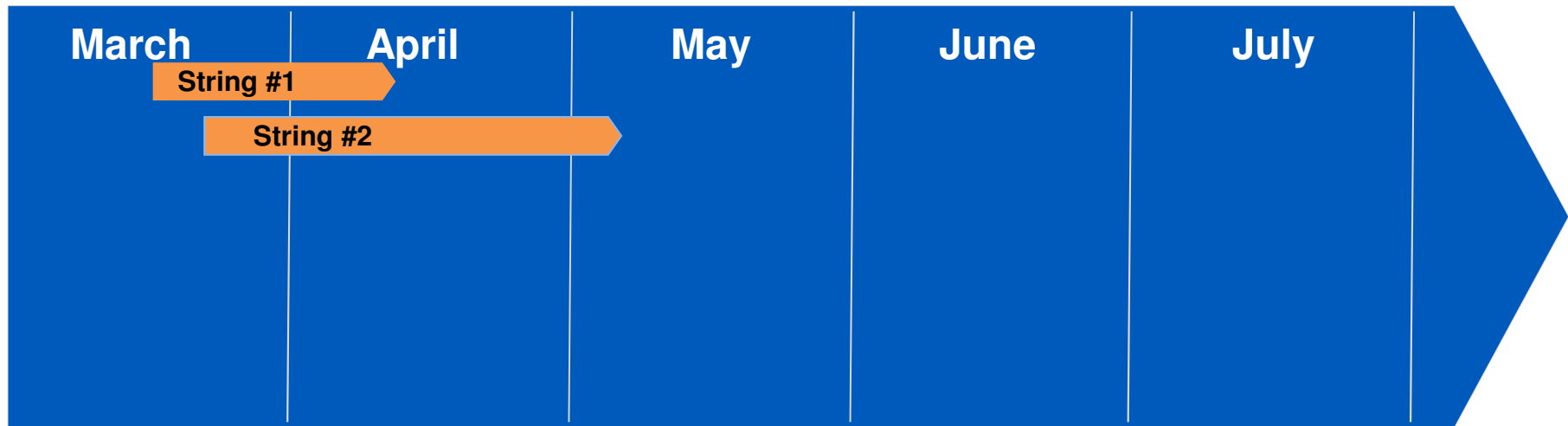
## Coiled Tubing Failures - Similarities

- Working for the same Operator
- All 90ksi grade tubing
- Multiple manufacturers
- All failures initiated at bias weld



# Pipe Failure Timeline

2013

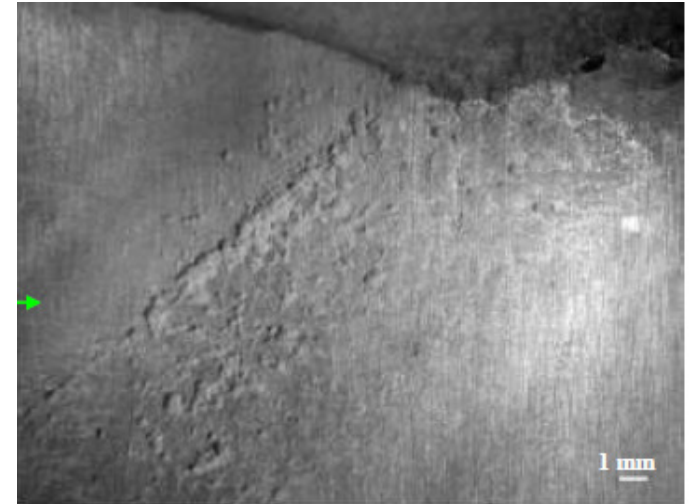


Pumped Through CT

- No Specific Treatment
- Corrosion inhibitor
- H<sub>2</sub>S anti-cracking inhibitor

## Coiled Tubing Failure # 1

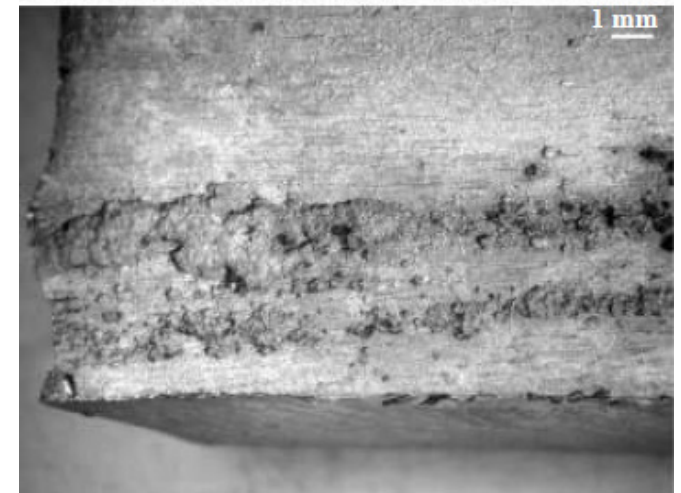
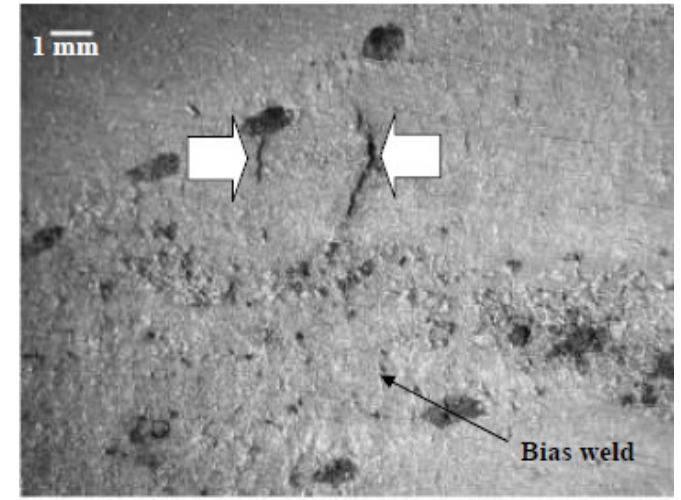
- April 9<sup>th</sup>
- 90k Grade
- 14,098'
- 0.190" Wall
- 26% Fatigued
- 478KRft
- 21 Runs, 6 wells
- Client A
- Premature fatigue at bias weld due to internal pitting
  - Pitting on some regions of the pipe parent material
  - 42 hours wet stagnation
  - 7 days storage





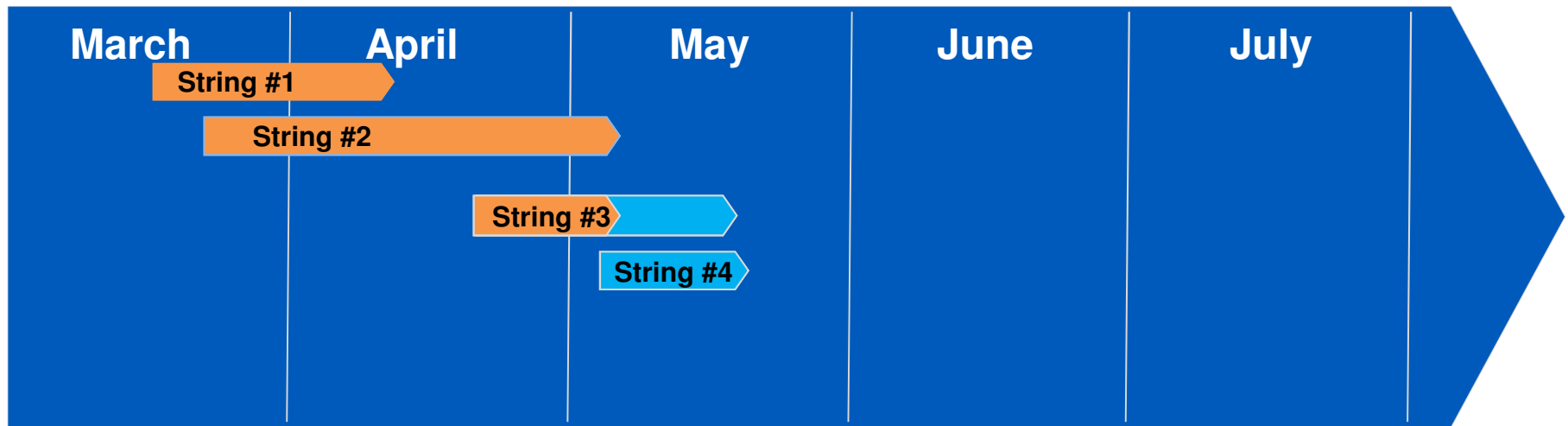
## Coiled Tubing Failure # 2

- May 6<sup>th</sup>
- 90k Grade
- 11,327'
- 0.190" Wall
- Premature fatigue at bias weld due to internal pitting
  - Pitting on some regions of the pipe parent material
  - Some cracks observed
  - 29 hours wet stagnation
  - 38 days storage
- 28% Fatigued
- 505KRft
- 24 Runs, 5 wells
- Last 2 wells, Client A



# Pipe Failure Timeline

2013



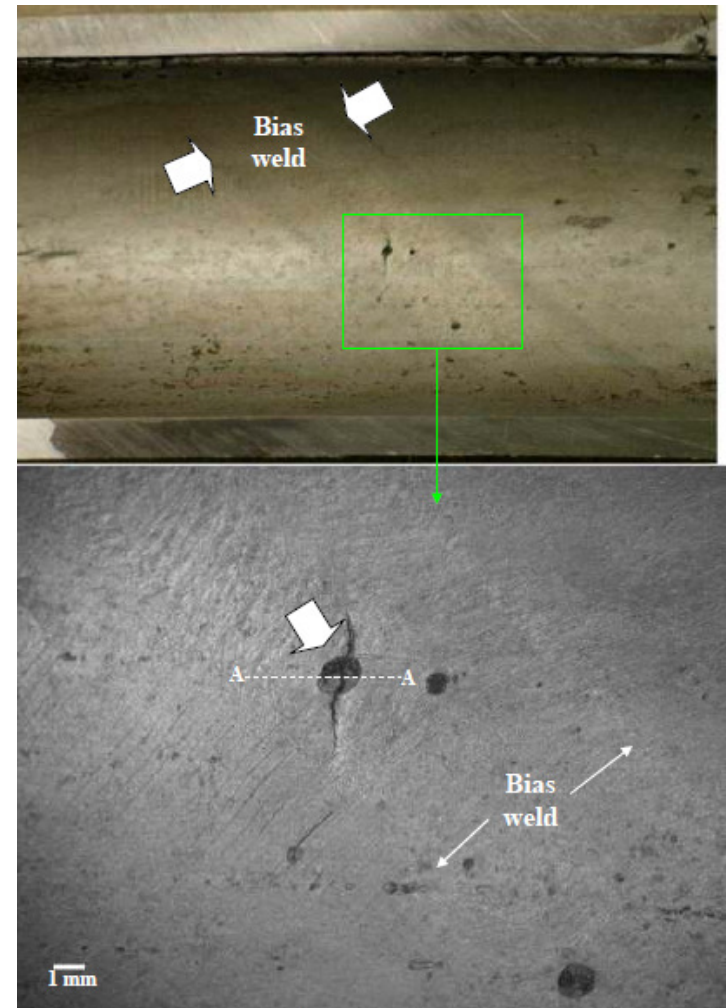
Pumped Through CT

- No Specific Treatment
- Corrosion inhibitor
- H<sub>2</sub>S anti-cracking inhibitor



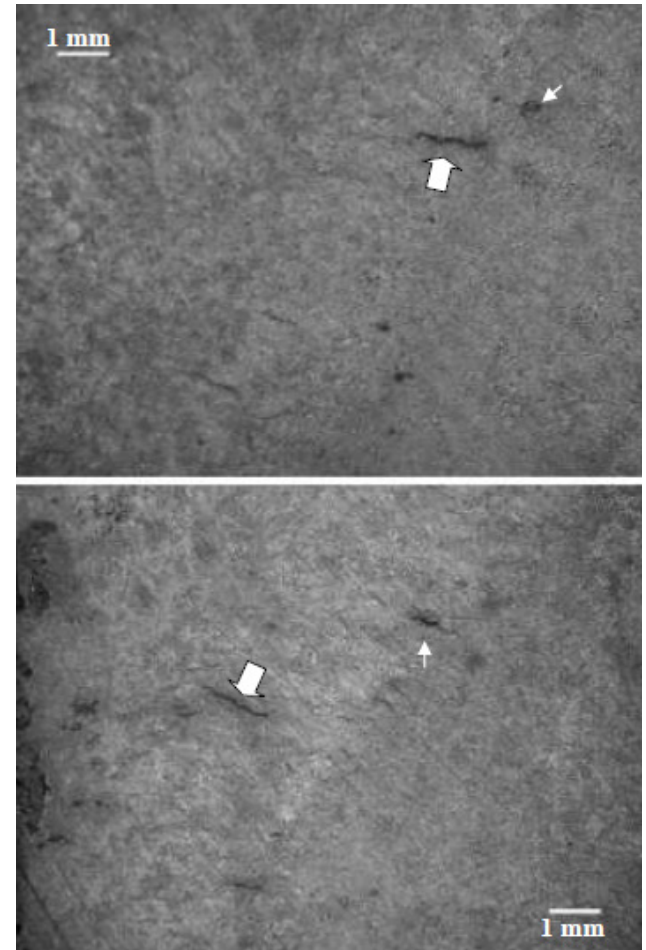
## Coiled Tubing Failure # 3

- May 18<sup>th</sup>
- 90k Grade
- 14,186'
- 0.188" Wall
- Premature fatigue at bias weld due to internal pitting
  - Corrosion Inhibitor sweeps circulated
  - Pitting less pronounced
  - Cracks observed in bias weld
  - 40 hours wet stagnation
  - 4 days storage
- 22% Fatigued
- 459KRft
- 13 Runs, 5 wells
- Client A



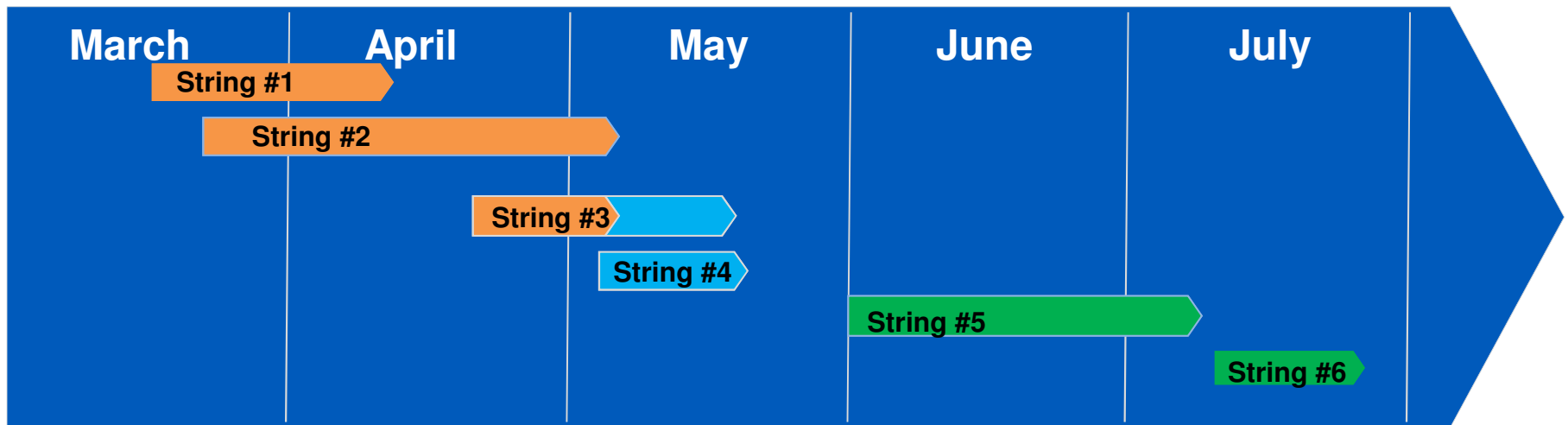
## Coiled Tubing Failure # 4

- May 20<sup>th</sup>
- 90k Grade
- 12,575'
- 0.188" Wall
- 15% Fatigued
- 282KRft
- 11 Runs, 4 wells
- Client A
- Premature fatigue at bias weld due to SSC cracks
  - Corrosion Inhibitor sweeps circulated
  - No Pitting
  - Cracks observed in bias weld
  - 14 hours wet stagnation
  - 4.5 days storage



# Pipe Failure Timeline

## 2013



Pumped Through CT



No Specific Treatment



Corrosion inhibitor

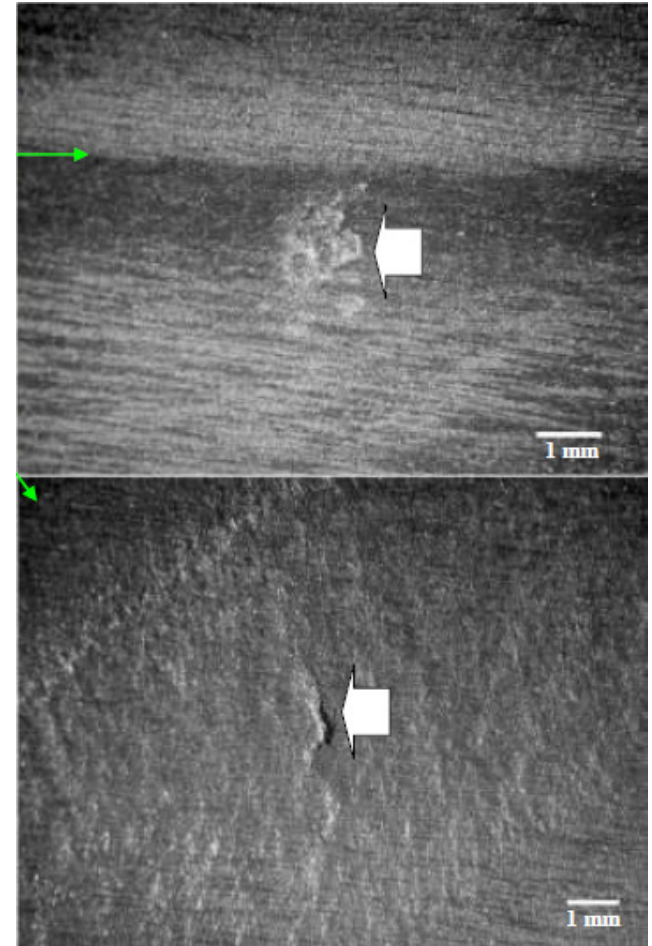


H<sub>2</sub>S anti-cracking inhibitor

\*Strings 5 and 6 also failed from SSC

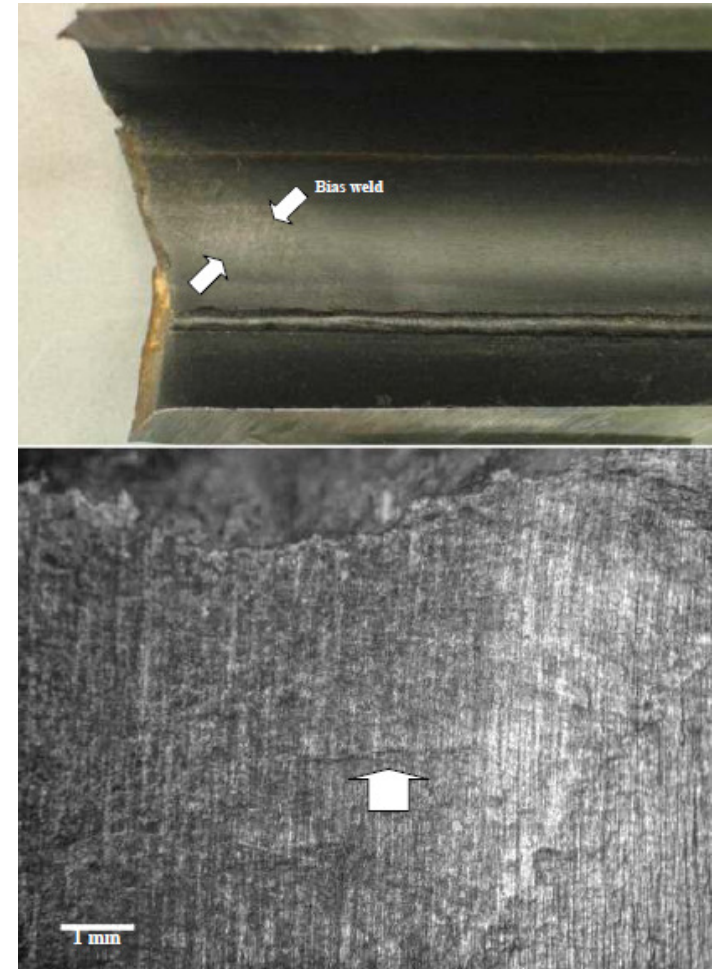
## Coiled Tubing Failure # 5

- July 5<sup>th</sup>
- 90k Grade
- 13,108'
- 0.190" Wall
- 40% Fatigued
- 498KRft
- 22 Runs, 4 wells
- Client A
- Premature fatigue at bias weld due to SSC
  - Corrosion Inhibitor sweeps circulated
  - Pitting less pronounced
  - Cracks observed in bias weld
  - Introduced Biocide & H<sub>2</sub>S anti-cracking inhibitor
  - 21 hours wet stagnation
  - 19 days storage



## Coiled Tubing Failure # 6

- July 24<sup>th</sup>
- 90k Grade
- 12,963'
- 0.190" Wall
- 25% Fatigued
- 239KRft
- 9 Runs, 3 wells
- Client A
- Premature fatigue at bias weld due to SSC cracks
  - Corrosion Inhibitor sweeps circulated
  - No Pitting
  - Cracks observed in bias weld
  - 14 hours wet stagnation
  - 0 days storage



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## Coiled Tubing Failures

- Initial mitigation factors ultimately unsuccessful
- Additional information gathered from treatments



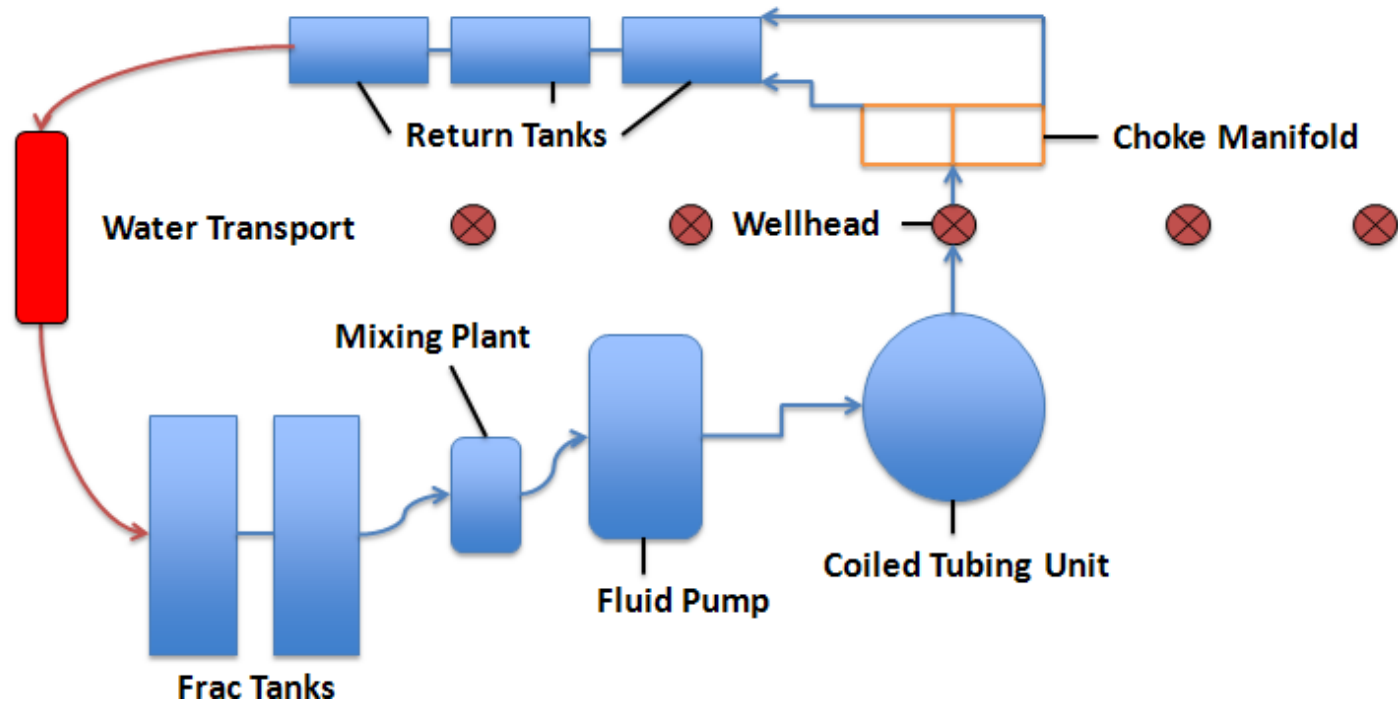


## Overview

- What we knew
  - Failures from both internal pitting and SSC
  - No H<sub>2</sub>S observed during operations
  - Corrosion inhibitor reduced pitting, but H<sub>2</sub>S inhibitor did not prevent SSC
  - Fluid was key player in failures



## Fluid System – Plug Milling



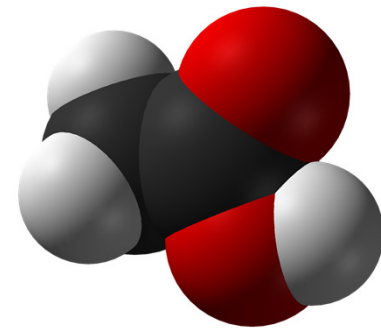
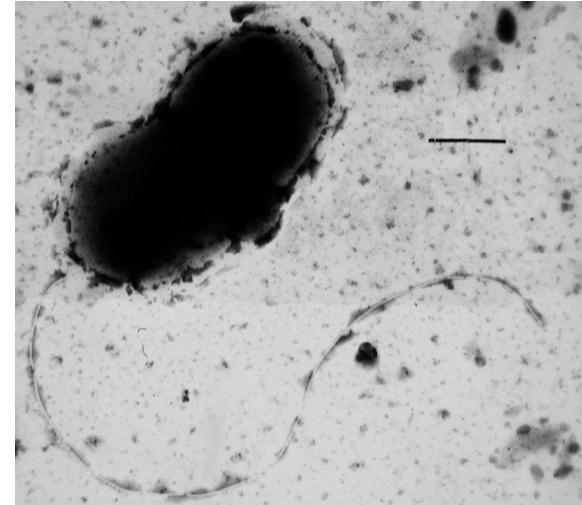
## Multi-Well Pads

- Small surface volumes
  - Circulation Temp: 180°F
- Stagnation time between wells
  - Rig up/Rig down on same pad



## Bacteria

- Water treatment testing done in recirculated fluid
- Extremely high values of bacteria observed
  - ATP control B – 1.6M bacteria per mL of fluid
  - 4.2-5.2M bacteria per mL of fluid





## Procedure

	<b>Bacteria Corrosion Prevention - Actions</b>
Step 1	Clean tanks – High End Biocide
Step 2	Fresh water circulate (5 to 10 bbls) – Mixture of treatments (inhibitors & biocide)
Step 3	Nitrogen Purge



## Additional Information

- 90 Grade coiled tubing to 100 grade coiled tubing
- After implementation of prevention procedure, two more failures observed in next 6 months
- Investigation showed that the procedure was changed and not fully supported

## Prevention Procedure

- Upon successful implementation of Bacteria Corrosion Prevention Procedure – No Failures
- Coiled Tubing strings retired upon reaching normal fatigue limits – 8 strings



# Acknowledgements:

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