Development and Compatibility Testing of CT with 140 ksi Yield Strength

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Agenda

- Background/History

 Product Description
 - The Case for CT140
- CT140 Testing
 - Tensile Properties
 - BOP
 - Injector
- CT140 Fatigue
 - Fatigue Assumptions
 - Initial Testing
- Future Work
 - Sour Gas Exposure SSC Resistanc
 - Fatigue Testing

Background/History

- High Strength CT Evolution
 - 2010: 125 ksi Yield Strength, limited by the weld
 - 2011: 130 ksi Yield Strength, welding issues overcome
 - 2016: 140 ksi Yield Strength

processes

• Tubing is manufactured using existing equipment and



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The Case for CT 140

- Higher Pressure Operations
 - Decrease OD
 - Increase Strength
- 20 kpsi (138 Mpa) Operations
 - Larger OD Potential Designs



2" (50.8 mm) OD Tapered Design: 38,288' (11,670 m) 2.375" (60.3 mm) OD Tapered Design: 35,964' (10,962 m) 2.625" (66.7 mm) OD Tapered Design: 32,910' (10,031)



CT140 Testing

- Tensile Properties
 - YS: 140 ksi (965 MPa) MIN / UTS: 145 ksi (1,000 MPa) MIN
- Parent Tubing
 - Tensile properties are documented on material certificates
 - Properties have been achieved for several years
- Bias Weld
 - Weld Procedure: Does not break in the weld
 - Tube tensile properties in the bias weld are consistent with the parent



CT140 Testing

– BOP Testing

- 0.250" (6.35 mm) Sheared
- 2.625" OD @ 142 ksi (979 MPa) YS (right)
- 2.375" OD @149 ksi (1,027 MPa) YS
- SPE 14152 (2010) was CT140





CT140 Testing

Injectors

- SPE 14152 (2010) was CT140
- String of CT with opposing injectors
- Connectors
 - Successful trials with:
 - Grapple
 - Dimple
 - Welding





CT140 Fatigue

- CT130 Testing includes samples with 140 ksi YS
- Assumption: CT140 is the same as (or better) than CT130
- Initial Testing:
 - Bias Weld 50% improved (compared to commercial model)
 - Parent: 40% improved (compared to commercial model)
- Further testing will be performed
- Takeaway: the CT130 model is conservative for CT140



CT140 Sour Gas

- CT130 and CT140 have the same maximum hardness
 - Hardness is generally thought of as the limiting factor for sour gas exposure
- CT130 Testing with inhibition has been successful
 - No SSC after 30 days of exposure at pH 2.8 in 100 bar H2S
 - No indications of HIC noted in the test specimens after exposure
 - Samples tested included seam weld, bias weld, parent
 - Sample YS was just shy of CT 140
- Initial Results presented at Calgary ICoTA Roundtable Oct. 2015
- Final Results presented at SPE ICoTA Conference (Houston) in March 2016
 Specimen Type OTY Condition



Specimen Type	QTY	Condition
Parent Tubing	2	
Seam Weld	2	No Fatigue
Bias Weld	2	
Parent Tubing	2	
Seam Weld	2	Pre-Fatigued
Bias Weld	2	

CT140 Sour Gas CT130 Results:



– CT140 Testing is in process

- Samples are "cranked up" at 150+ ksi YS (1,034+ MPa YS)
- Successful prior testing allows "skipping ahead" to 100 bar

CT140 Sour Gas – Next Steps

- Test for "de-rating" due to sour exposure with inhibition
 - Fatigue test before and after exposure
 - Validation of fatigue model (for non-exposed samples)
- Test with inhibitor "CG"
- Test with alternate inhibitor
- Report all Sour Gas Testing in upcoming SPE paper
- Upcoming projects with CT140
 - US Land
 - US Offshore
 - Offshore North Sea
 - Interest for Western Canada

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