Agenda

- Coiled Tubing Market
- How Coiled Tubing is Manufactured?
- CT Unit Components
- Why Coiled Tubing?
- Coiled Tubing in P&A
- Q&A
Evolution of Coiled Tubing Market

**Worldwide CT Market**

- Yearly market values from 2001 to 2016.
- Market values range from $0M to $10,000M.

**Worldwide CTU Count**

- Yearly count from 2001 to 2016.
- Count range from 0 CTUs to 2,500 CTUs.

*Source: SPEAR*  
*Source: SPE ICoTA*
Product Portfolios

- **Coiled Tubing Equipment**
  - Units
  - Data Acquisition

- **Coiled Tubing Fluid Applications**
  - Well Kill / Kick Off
  - Nitrogen Applications
  - Wellbore Fill Removal
  - Acid and Screen Wash
  - Matrix acidizing
  - Chemical Treatments and Shut offs
  - CT Cementing

- **Coiled Tubing Tools**
  - Flow Control
  - Scale Removal
  - Fishing
  - Zonal Isolation
  - Milling/ Drilling / Underreaming
  - Tubing Cutting

- **Coiled Tubing Logging and Perforating**
  - Perforating
  - Logging

- **Coiled Tubing Completions**
  - Velocity String
  - Completion – Conventional and Spoolable
  - ESP
  - Sand Management – Gravel Pack and Consolidation

- **Advanced Services**
  - Live Downhole Coiled Tubing Services
  - Integrated Coiled Tubing Production Service
  - Real Time Production Logging
  - Inflatable Packers
Coiled Tubing Welds (Bias)

Bias Weld
- Welded as flat strip: joints two strips. Traditionally used filler material
- Till final length is reached
- When tubing is formed, the weld takes the shape of a helix
Coiled Tubing Welds (Seam Weld)

- **Inline Seam Weld**
  - In every string where the flat steel was rolled and joined
  - Often referred to as the “flash”
  - No filler material
How Coiled Tubing Is Made

- Sheet Alloy
- In Line Seam Welding
- Weld Surface Finished and Heat Treated
- Rollers Pressing Sheet Into Tube
Tapered CT String

Strips of different thickness are jointed to form a tapered string

- Heavier wall
- Intermediate
- Lighter wall
Residual Bend

A Key Issue
- Its influence
- Compression
- Buckling
- Access
Helical Lockup

- The distance to which the CT can be pushed into a highly deviated or horizontal well is not the instant when helical buckling occurs.
- It has been shown experimentally and proven through numerous field cases that the pipe can proceed further, without damage, beyond what is the load for helical buckling.
- The maximum penetration depth is reached when the applied force on the CT at surface can no longer overcome the friction due to the helical wall contact forces.
- This situation is called “helical lockup”.

Sinusoidal Buckling

Helical Buckling
Common Intervention Methods
Where Coiled Tubing Fits

- **Slick Line**
- **Coiled Tubing**
- **Snubbing Unit**
- **Workover Rig**
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Coiled Tubing Unit

- Prime Mover
- Control Cabin
- Tubing Reel
- Injector Head
- BOP/Stripper
- Lifting Equipment
CT Reel – Functions

Basic functions of the reel:

- Storing and protecting the CT string – reel drum (1)
- Maintaining proper tension between reel and injector head (reel drive system)
- Efficiently spooling the CT string onto the reel drum - levelwind system (2)
- Circulating fluids with the drum rotating – swivel (3)
- Application of protective coating or inhibitor on tubing string - tubing lubricator system (4)
- CT depth measurement system - reel mounted counter and integrity monitor (5)

This is always the heaviest load. Determines logistics and applicability in many situations!
Reel Models

Reel Size Comparison
Injector Head – Functions

Basic functions of the injector head or equipment normally mounted on the injector head include:

- Injecting and retrieving the CT string
- Holding the CT string static
- Guiding the CT to the reel
- Tension/compression measurement (weight indicator)
- Depth/speed measurement (depth system sensor)
- Mounting place for primary pressure barrier (stripper)
Gooseneck

The “44” rule .....
CT Well Control Equipment

- Equipment providing pressure control in live well operations
- Stripper
- BOP
- Check valve in the BHA
Stripper

- Primary Well Control
- Hydraulically actuated
- 10,000 or 15,000 psi WP
- 3 different configurations
  - Top loaded
  - Side Door
  - Radial (High Pressure)
BOP Features

- Blind ram
- Shear Ram
- Slip ram
- Pipe ram
- WHP Sensor Port
- Equalizing Valve
- 2" side port
- Equalizing Valve
CTU Power Pack and Control Cab
CTU – Skid Mounted
CTU – Barge Mounted

Lake Maracaibo Barge Unit

Nigerian Barge Unit
Coiled Tubing Express

Trailer mounted CTU – Examples of Slb Units
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Market Driver: NAM Horizontal Rig Growth

Source: Baker Hughes
Market Driver: NAM Shale Plays
Market Driver: Maximum Reservoir Contact
Market Driver: Extreme Reservoir Contact

Source: Saudi Aramco
Well Intervention Interacts with a wide range of services

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- DTS
- CT Sand Control
- Domain Expertise
- Thru-Tubing tools

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<td>CT Cementing</td>
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Impact of Real-Time Downhole Measurements
Intervention and Stimulation Workflow

In the past Conventional CT

- Initial Treatment Design
- Full Treatment Evaluation
- Treatment Execution
Intervention and Stimulation Workflow

Initial Treatment Design → Treatment Execution → Treatment Evaluation

New Treatment Design → Decision

Full Treatment Evaluation

Now using ACTive technologies
Real-time downhole measurements

SPE 165121
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“Life of a Well”

Drill to Complete
- DD/MWD/LWD
- Zonal Isolation

Complete to Produce
- Completion
- Frac/Stimulation

Produce to Recover
- Reservoir Mgmt
- Well Intervention

P&A
- Recover
- Zonal Isolation
Permanent Well Abandonment

Cable-tubing systems are used for perforating, fishing, well cleanup, and cementing services during well abandonment operations.

The latest rigless intervention systems cut and pull 30-ft conductor sections, improving safety and efficiency during well abandonment.

Rigless well and abandonment system.
Questions