Well Intervention and Well End-Of-Life

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- Texas / USA
- Education
  - Angus University
  - Robert Gordon University
- Company
  - President & CEO

**Volunteering in my Local Community**
- Oncology Consultant (volunteer).
  - I assist cancer patients with life altering challenges.

**Publications and Presentations**
- SPE/IADC Middle East Drilling Technology Conference, Bahrain - Use of Corrugated Material Technology to Provide Low-Risk Solution to Repair Connector Leakage on Texaco Captain Sub Sea, UKCS
- Drilling Engineering Association (Europe) Offshore Europe, Aberdeen – General Guidelines for Efficient Well Abandonment Operations (TOC IWAKI A8 Platform-Japan)
- Drilling Engineering Association (Europe) Offshore Europe, Aberdeen - Technical Forum: General Guidelines for Effective Milling

**Patents**
- SIGNAL OPERATEDTOOLS FOR MILLING, DRILLING, AND/OR FISHING OPERATIONS
Remember.....

No job is so important and No service is so urgent, that we cannot take time to perform our work safely.
A **well intervention**, or 'well work', is any operation carried out on an oil or gas well during, or at the end of, its productive life, that alters the state of the well and or well geometry, provides well diagnostics or manages the production of the well.
The Well Life Cycle

New Reservoirs
- Hot Zones
- Deeper Zones
- Remote Access
- Complex Differentiability
- Velocity Flow

Depleting Reservoirs
- Formation Damage
- Fluid Circulation Issues
- Differential Sticking
- Production Failures
- Poor Production Recovery

Intruding H₂O
- Oxidation of Metals
- Reservoir Management
- Sand Access
- Production Differentiability
- Bypass Reservoir
Decommissioning / Well Abandonment

Offshore Operation

Land Operation

H₂O

Well Plugging and Abandonment

Government Views

Guidelines

Likely Options

Removal Fleet

Disposal Options

Groundwater Aquifer

Water Quality Questions

Groundwater Pollution

Depth to Various Aquifers

Channel Contaminants

Ground Water Monitor
USA Oldest Producing Well?

McClintock No. 1 (Quaker State Corporation)

Location: Pennsylvania, PA, United States
12 barrels a month since drilled in August 1861 (153 years) = $665M X 3% royalties $20M

A little history
- China in 347 AD or earlier drilled 800’ with a drill bit attached to bamboo poles
- Russia drilled its first well in 1719 that produced until 1986 (267 years)
- North America drilled its first well in 1753 in Pennsylvania
- Oil sands were mined from 1745
- In 1848, James Young set up a small business refining crude oil
Production Issues and how they are Identified

Finding the PROBLEM?

- Asset Monitoring
- Well Diagnostic Logging
- Intelligent Completion
- Production Improvements

Intervention

- Water and Gas Influx
- Wax
- Hydrates
- H2S
- Scales

- Brown Field Development
- Accessing New Reserves

- Retrieval (Fishing)
- Operation

- Technology
Production Management Systems

1. Capture the measurements

2. Production Database
   Securely store in a collaborative environment

3. Turn data into meaningful information

4. Make the data available for analysis, optimization

5. Enable correct decisions for the asset management
Well Completion Design & Production Issues

- Gas production decreased?
- Producing water or sand?
- Increase or decrease pressure?
- Production STOPPED?

I need to get my well producing! How do I fix it? What’s wrong?

I need to start with log for a diagnostic examination.
Well Completion Design & Production Issues

Oil Pump Jack

Production Problems!!

- Oil STOPPED?
- Sand, scale or paraffin problems?
- Pump not working?
- High oil viscosity?
- Rod parted?

I need to get my well producing! How do I fix it? What’s wrong?

I need to start with a Remedial workover.

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Production Problems

Some PROBLEMS

- Wax
- Hydrates
- H2S - hydrogen sulfide
- Fines migration
- Phase related permeability changes
- Scales
- Obstructions
- CO2 Corrosion

Well interventions have a large opportunity to enhance well production if correctly designed and implemented. Conversely, they can have a large negative impact on production if they’re not.
Well Intervention Conveyance Methods

- Rig based workovers
- Coiled tubing
- Hydraulic workover
- Wireline (slickline & e-line)
- Intervention in sub-sea wells (Rig and mono-hull vessel techniques) with horizontal and conventional trees
- Deepwater Drillship
Wireline Conveyance and Intervention Methods

- Service Units – Land & Offshore
- Free Point / Backoff Services
- Pipe Cutting Services
- Pipe Recovery
- Mechanical Services
  - Bridge Plugs
  - Packers
  - Cement Dumping
- Logging Services
  - Cement Bond Log
  - Gamma Ray Log
  - Neutron Log
  - Temperature Log
  - Noise Log
  - Casing Caliper Log
  - Stuck Pipe Log
- Perforating Services
Wireline Conveyance and Intervention Methods

- Identify completion components?
- Identifying downhole issues quickly?
- Wireline fishing techniques?
- Wax cutting and scale chipping?
- Nipple setting for plugging zone?

Wireline tractor can support high deviated wells

Lubricator

Pipe Cutting Services

Logs

Aamnd, we're back.
Coil Tubing Conveyance and Intervention Methods

- Service Units – Land & Offshore
- Reduced Operational Footprint
  - The ability to intervene without a rig
  - Offer a highly effective and cost-efficient alternative
- Well Cleaning
- Multi - Zone Solation
- Stimulation & Fracturing
- Weight Kill Fluids
- Acid Stimulation/Nitrogen Pumping
- Fishing, motor milling and drillout of plugs, Pipe Cutting Services
- Mechanical Services
  - Bridge Plugs
  - Packers
  - Cement Dumping
- Logging Services
  - Cement Bond Log
  - Gamma Ray Log
  - Neutron Log
  - Temperature Log
  - Noise Log
  - Casing Caliper Log
  - Stuck Pipe Log
- Perforating Services
- The global oil and gas industry is using coiled tubing for an ever-increasing array of well intervention projects.

Faster deployment method, small and transportable with normally 1" to 3.25" in diameter continues coil tubing, rigless operations.
Multi-Stage Horizontal Fracturing

- TCP gun run on CT to perforate toe
- Hydraulic fracture stimulation for 1st stage performed
- Composite bridge plug/perforation gun assembly pumped down on WL
- Hydraulic fracture stimulation for next stage
- Process repeated until full horizontal section
Demographic Shifts Rig Assist

- **Rig Assist Snubbing Units (HWO) vs. Coil Tubing: benefits**
  - Intended completion tubing is snubbed into the well to drill-out the composite plugs, eliminate friction reducing chemicals and the risk of kill fluid damage to producing formation to run completion tubing after a coil tubing drill-out
  - 2" coil tubing is limited at 8K FT horizontal, day rates of 2/3 3/8" coil tubing isn’t cost effective to the subbing operation
  - Different Rig Assist Snubbing Units are available, 150k, 225k, 340k and 600k, handles surface pressures up to 20,000 psi, 200,000 LBS lift capacity, 123,000 LBS snub capacity. Coil Tubing Unit continuous pull capacity of the injector is 80,000 LBS with a snubbing capacity of 40,000 LBS

- **Pump-Off Bit Sub: benefits**
  - Upon completing the composite plug drilling operation and landing the tubing at surface, a ball is dropped and or pumped to the releasing tool. As a result, pressure is generated causing the locking mechanism to shear and release. The bottom sub then separates and the well is ready for production tubing—leaving it open-ended and ready for production. Viking offers these styles of bit sub with single flapper, double flapper, ball check and reverse circulating
Well Fishing & Intervention Methods

Fishing Services

The application of tools, equipment and techniques for the removal of junk, debris or fish from a wellbore. The key elements of a fishing operation include an understanding of the dimensions and nature of the fish to be removed, the wellbore conditions, the tools and techniques employed and the process by which the recovered fish will be handled at surface.
Well Fishing & Intervention Methods

Production Issues!!

- How long do I spend FISHING before I abandon the well?
- How much production can I afford to lose trying to fix this?
- What on Earth is down there?
- Is it riskier to fix this or drill a new well?

I need to get my well producing again; time is money!!!
Communication operational flowchart

- A flowchart is a common type of diagram, that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting these with arrows. This diagrammatic representation can give a step-by-step solution to a given problem. Data is represented in these boxes, and arrows connecting them represent flow / direction of flow of data. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields.

**Workover Operations**

1. **Engage the tubing hanger and take an overpull & disengage the ELTSR**
   - **Tubing free?**
     - Yes
     - **Recover tubing to surface**
     - **Determine tubing free point**
     - **Chemically cut tubing and recover to cut point**
   - **No**
     - **Run a fishing assembly and recover remainder.**
       - **Note: If free point be high and sand expected - recovery and washover operations would be required**

2. **Pick up a spear RH set or overshot assy and rotate out the ELTSR**
   - **Free?**
     - Yes
     - **POOH and lay out recovery**
     - **Run a clean out through the packer to ensure the PMT will function correctly when run.**
     - **Junk from anchor remaining in packer bore?**
     - **No**
     - **Run down to plug set below patch and mill any remaining debris**
   - **No**
     - **Job Complete**

3. **RIH with packer milling assembly, stab in and mill the packer until it drops**
   - **Packer milled successfully?**
     - Yes
     - **POOH and re-run a new PMT and mill until packer drops**
     - **Clean out well prior to running new completion**
     - **Job Complete**
   - **No**
     - **Continue to RH until patch is tagged**

**Internal Casing Patch Removal**

1. **Set balanced plug below the patch**
2. **Make up milling assembly and RIH to 30ft above patch and take parameters**
3. **Activate modified section and tag top of patch**
4. **Top at expected position?**
   - Yes
     - **POOH and pick up new mill**
   - No
     - **Continue to RH until patch is tagged**
8. **Tag patch?**
   - Yes
     - **POOH and pick up new mill**
   - No
     - **Job complete**
Well Fishing & Intervention Methods

- Circulate and kill/well control
- Washing and cleaning fill from wellbore
- Milling operations requiring the removal of packers and plugs
- Fishing operations involving milling and washovers
- Sidetrack Whipstocks
- Light drilling or deepening operations
- Manifold gives ability to reverse circulation path
Well Fishing & Intervention Methods

Managing Drilling Risk
- Stuck Pipe Prevention
- Rock Mechanics
- Wellbore Stress
- Wellbore Instability
- Trend Recognition
- Hole Cleaning
- Differential Sticking
- Wellbore Geometry
- Tripping Practices
Well Fishing & Intervention Methods

- The hydraulic **Jar**, single acting (Up only) is a high-impact, pressure and temperature compensated jar designed specifically for fishing operations.
- The **Accelerator** maximises jar impact regardless of depth because it either replaces drill pipe stretch as the energy source in shallow wells or supplements the pipe stretch energy in deeper wells when used in conjunction with the fishing jar.
- **Bumper Sub** provides a durable upward or downward bumping action for fishing operations.

**Milling and Cutting**
- Pilot Mills
- Multistring Cutters
- Washover Shoes
- Packer Retrieving Equipment
- Junk Mills
- Section Mills
- Underreamers
Well Departure & Intervention Methods

- Brown Field Development
- Production Enhancement
- Multilaterals Development

- Open Hole Sidetrack
- Cased Hole Sidetrack
- Casing
- Whipstock

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Well Departure & Intervention Methods

Criteria for Successful Casing Exits

- Window Quality
  - Sufficient window size and shape to conduct operations

- Rathole Objective
  - Sufficient length and trajectory

- First Trip Success
  - Major driver of total cost to perform casing exit

- Milling Time
  - Secondary driver of casing exit cost
Well Departure & Intervention Methods

Criteria for Successful Casing Exits

Gauge Section
- Elongates full gauge window
- Hook slot for retrieval

Mid-Ramp
- Mechanically pushes mill across center
- Reduces center point coring

Mechanical Anchor
- Fully retrievable
- High axial load capability

Hydraulic Expandable Anchor
- Fully Retrievable
- Anti-rotation and high axial load slip design
- Spans multiple weights casing sizes

Permanent Packer
- Hydraulic actuation
- Packer rated to 5,000 psi
What is Decommissioning?

Decommissioning is a controlled process used to safely retire a facility that is no longer needed. During decommissioning, radioactive and hazardous materials, equipment or structures are cleaned or secured so that the facility does not pose a risk to public health or the environment now or in the future.

End-of-life (product)
Decommissioning / Well Abandonment

Expected cost for the overall decommissioning program for North West Hutton is $288 million.
What is Plug & Abandon (P&A)?

It is the first stage of the decommissioning process. **Definition**

To prepare a well to be closed temporal or permanently

If logs confirms insufficient hydrocarbons is place

After production operations have drained the reservoir fluids

Most countries have their own regulations in place

Cement plug placement across fresh water aquifers, wellbore

Placement of bridge plugs to avoid higher density slurries from falling
Modern regulatory standards in all US jurisdictions require specific provisions for plugging and documenting oil and natural gas wells before they are abandoned. Plugging and abandonment (P&A) regulations vary to some degree among states and countries, but all regulations prescribe the depth intervals which must be cemented as well as the materials that are allowable in plugging practices.

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<td>1 yr before</td>
<td>Now idle iron &gt; 5 yrs</td>
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Thank You!

Well Intervention and Well End-Of-Life

Go Rockets!!