Pump-Down Visualization Service with a Downhole Tension Tool

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Why Pump Down Perforating?

- Horizontal Drilling became practical and economical about 2000.
- Initial completions were time consuming and expensive
  - Each stage required tractor conveyed E-Line guns or Coil Tubing TCP type guns.
Why Pump Down Perforating?

- One – two stages per day considered acceptable
- Stimulation equipment idle between perforation stages

- Work in the Barnett Shale proved Pump Down economic viability
  - Eliminated added conveyance methods
  - Multiple stages per day became practical
Horizontal Multi-Stage Perforating

- Pump Down Services (PDS) offer quick, efficient and cost effective deployment of multi-gun/plug runs for multiple stage completions.
- PDS has been deployed in the USA and Canada for horizontal completions and also for other e-line services – method is expanding globally.
- Efficient PDS, depending on depths, now allow up to 5 stages per 24 hour day.
- A typical single E-Line stage consists of:
  - Multiple guns (3 foot - 6 spf carriers)
  - Explosive setting tool
  - Composite plug
Pump Down Plug and Perforate in Horizontal wells
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Pump Down Operations Today

- Wireline and Stimulation operate separately but not independently.

- No difference in operating method if Stimulation and Wireline are same company.

- 2 way radio communication between wireline operator and pump operator is only communication
  - No pre-run planning
  - Always reactive, never proactive
  - Neither party has all the information to identify a potential problem and adapt the operation ahead of a failure.
Horizontal Multi-Stage Perforating
Cerberus – Surface Tension Profile

Calculations based on user determined pump rate and line speed
Cerberus – Downhole Tension Profile

Calculations based on user determined pump rate and line speed
Typical wireline view

Wireline Tension increases rapidly

Wireline Speed increased to compensate

Pumps finally shut down 100 ft (30 m) later

Cable tension (surface tension)  Pump Pressure  Pump rate bbl/min  Cable speed

Cables 30 ft (9.1 m) later

Wireline Tension increases rapidly

Wireline Pressure increased to compensate

Pumps finally shut down 100 ft (30 m) later

Cables 30 ft (9.1 m) later

Wireline Tension increases rapidly

Wireline Pressure increased to compensate

Pumps finally shut down 100 ft (30 m) later

Cables 30 ft (9.1 m) later
Tool String Lost

Tools pumped off

Wireline Tension increase
RTO Monitor

TCC
- Pumping Pressure
- Pump Rate

Wireline Unit
- Depth
- Cable Speed

Mono-Conductor Tension Device
- Downhole Tension
# Pump Down Software Input Table

## Pump Down Visualization Inputs

<table>
<thead>
<tr>
<th>Wireline Unit</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface and Downhole Tension</td>
<td>Numeric Display</td>
</tr>
<tr>
<td>Line Speed</td>
<td>Gauge</td>
</tr>
<tr>
<td>Depth</td>
<td>Trend Graph</td>
</tr>
<tr>
<td>Collar Locator (CCL)</td>
<td></td>
</tr>
</tbody>
</table>

## Tech Command Center

| Pump Rate                     | Numeric Display                  |
| Wellhead Pressure             | Gauge                            |
|                               | Trend Graph                      |

## Customer

| Survey data (loaded into Cerberus) | Well Illustration               |
Pump Down Visualization Value

Improved efficiency resulting from Stimulation and Wireline sharing data

- Real time
- Easy to understand graphics
- Flag or alert if cable or cable head weak point nears or exceeds calculated failure value
- With Downhole Tension Tool (DTT) can compare run to run for changes that may occur downhole
- Post job diagnostics that captures all Stimulation and Cased Hole information in a single database
Pump Down Visualization – Wireline Unit
Pump Down Visualization – Wireline Unit

-194.3 ft
11.2 bpm
7308.7 psig
829.4 lbs
215.7 lbs

Tool Position Indicator
Pump Down Visualization – Pumping Unit
Pump Down Visualization – Pumping Unit

The diagram illustrates various parameters of the pumping unit, including depth, line speed, maximum pump rate, maximum pressure, and line tension. The interface shows real-time data such as line tension (1400.0 lbf), CCL (1.2 volt), and other critical values essential for monitoring the pumping unit's performance.
Downhole Tension Tool

Plugged grease injection return line stopped cable.

DTT indicates weight loss at tool well before cable stopped at surface.

Note tool bounce when cable stopped.
Downhole Tension Tool

- Pump down operations
- Surface tension insensitive to well trajectory changes
- Downhole tension follows well trajectory changes

3 degree increase
Downhole Tension Tool

- Faster reaction
- Improved accuracy
  - Sensor measures at the critical point
  - Not affected by line stretch
  - Not affected by weight of cable
  - Not influenced by cable friction or drag
Summary

- Pump Down Visualization combined with Downhole Tension Tool provides tool movement during a pump down run
- Allows real time viewing of data in user friendly interactive formats
- Offers run to run comparison of tension data to optimize run time efficiency
- Real time tension profile and caution indicators visible to both wireline operator and pump operator.
  - Can reduce or prevent stuck tools, accidental pump off of tools.
- Recorded data can be reviewed for post-job diagnostics