Hydraulic Dewatering
Retrievable Pump System
Hydraulic Dewatering
Continuing the Evolution

• Since 2008 we have been exclusively focused on developing a:
  – Reliable
  – Cost effective
  – Serviceable
• Hydraulic dewatering system
• Each year, since we have introduced an advancement in pump design and performance improving the reliability and production rates
• This year we are introducing a significant improvement in production rate, but also most importantly, in cost effectiveness
Hydraulic Dewatering

PRODUCTION RATE

- **TTSA** – Tubing Pump Single Action
  - 1 Hydraulic Conduit
- **TCSA** – Casing Pump Single Action
  - 1 Hydraulic Conduit
  - 1 Water Conduit
- **DA** – Dual Action Pump
  - 2 Hydraulic Conduits
  - 1 Water Conduit
- **1.5 - 1.5Action Hybrid Pump**
  - 1. Hydraulic Conduit
  - 1 Water Conduit
- **SRS0 / P** – Self Reciprocating Pump

Pump Selection Chart

![Diagram showing pump selection chart with production rate (BPD) and well depth (1000, 2000, 3000, 4000 ft). The chart includes lines for different pumps (TTSA, TCSA, DA, 1.5Action, SRS0) indicating their performance at various depths.]

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Costs of Hydraulic Dewatering

- Cost of the Pump System is only a portion of the total installation and commissioning cost.
- Multi String Coils (3x) represent a significant investment and extend system payback.
- Multi string coils also require a specialized Coiled Tubing rig.
In a typical pull and replace cycle, the major cost is the coiled tubing rig.

We have been working to improve the overall economics of Hydraulic Dewatering:
- Reduce the cost of the coil
- Reduce the rig time
- Reduce the cost or replacement
- Increase the replacement cycle
SELF RECIPROCATING SYSTEM

- Designed to address 3 primary objectives:
  - 1 – Production Rate
    - 50+ BPD for 2 3/8 Tubing version
    - 100+ BPD for 2 7/8 design
  - 2 – Coiled Tubing Costs in the total system cost
    - SRSP – Uses Single Coiled Tubing
    - SRSO – Uses Concentric Tubing
  - 3 – Replacement Costs – SRSP does not require a Coiled Tubing Rig for pump replacement – Pumps in and Out of the well bore
SELF RECIPROCATING SYSTEM

- SRSO – Dual Acting Oil Driven Pump for 2 3/8 or 2 7/8 Tubing
- SRSP – Dual Acting Produced Fluid Pump for 2 3/8 or 2 7/8 Tubing – *Remainder of presentation is focused on the SRSP*
- Both of these systems use a new integral hydraulic valve to drive the pump downhole
- For the last year we have focused our development efforts on this system
  - Results have exceeded our expectations!!
  - Expected challenges with reliability and life have simply not appeared
    - Actual parts from a years testing are at the Cormorant Booth
SRSP System Overview

- **Produced Fluid System:**
  - Surface Power Unit – Provides a constant flow of pressurized fluid – Up to 5000 psi
  - Runs on single coiled tubing
    - 1 ¾ - 2 3/8 tubing version
    - 2 ¼ - 2 7/8 tubing version
  - Bottom Hole Assembly
    - Attached to the bottom of the Coiled Tubing
    - Sits in standard Pump Seating Nipple
    - Gas / anchor, screen, and standing valve
  - Pump in / Pump Out Hydraulic Pump
    - Power Section
    - Water Section
Reciprocating Pump - SRSP

- The Heart
  - Valve Designed for reliability
  - Surfaces are at or near a 90 Rc hardness ceramic
  - Add a dual acting power section
  - Signal Rod for valve action
  - Add water section with standing valve
  - Traveling Valve
  - Add Seating cups and seals
BHA Detail

- 2 3/8 Production Tubing and Seating Nipple
- BHA Sits in Pump Seating Nipple
- Standing Valve to maintain water column during install and retrieval
- Screen and Gas Anchor
- Rod Pump Seating Cups for Pump Seating Nipple (PSN)
- BHA Housing attached to 1 3/4 x .105 wall Coiled Tubing (2 3/8 Pump)
  - Coiled Tubing has weld bead removed

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Surface Unit Description

- Uses the Oil Based SRSO as the surface Pump
  - Rod Pump Technology is known for reliability in pumping produced water
  - Hydraulic valve, seal, and pump technology well understood, reliable, and serviceable
  - Reliability and cost improvement over other high pressure water pumps

- Pumps produced water up to 5000 psi
- 2 stage filter system
  - Advanced perforated screens
    - 100 micron
    - 20 micron
    - Backflushable
- Electric or Natural Gas
  - 10 – 30 hp
SRSP Development

- Testing began in April 2013
- Running in the Cormorant test facility
  - 15000 feet of coil
  - Instrumentation
  - Oil / Water / Combination
  - Solids
- Downhole simulation conditions:
  - 6000 ft
  - 160 deg F
- Valve and Power Section show outstanding performance
- Rebuilt water section 1x
Pump which is deployable in 2 3/8 tubing with a pump seating nipple
- Horizontal / Deviation – 16 deg DLS capable
- Capable of being deployed to 10k and beyond (production rate decreases as depth increases)
- A cost effective solution for deviated and horizontal wells were well energy not sufficient to lift water
- Especially suited for small bore wells beyond 5000k ft.
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