Remotely Operated Cementing Methods for Drilling with Liner Installations

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Outline

- Valhall Field history
- Drilling and completion challenges
- Drilling with Liner (DwL) strategy
- Cementing solution
- RFID Cement Port Collar Operation
- Liner components
- Procedures
- Summary
Valhall Field History

- North Sea Chalk Field, 69 m water depth
- 180 miles SSE of Stavanger, Norway
- Drilling commenced in 1969
- Producing from the Tor and Lower Hod formations @ 2,400 m subsea since 1982
- Estimated recoverable reserves - 600 MM barrels of oil
Drilling, Completion and P&A Challenges

- Compaction, subsidence, and depletion
- Collapsed and sheared casings
- ±7 ppge decrease in pore pressure at shale overburden/chalk reservoir interface
- Overburden fracturing
- Poor cement jobs
- Degraded annulus barriers
- Sustained annulus casing pressures

IADC/SPE 39399 “Rotary Liner Drilling for Depleted Reservoirs”, Sinor et.al.
DwL Benefits

- No rig modifications
- Mitigation of lost circulation and associated wellbore instability
- Isolate hazard intervals in a single trip
- Manage annular fluid level
- Maintain existing wellbore trajectory
Valhall Drilling with Liner (DwL) Strategy

Drill with conventional BHA above Tor chalk

DwL remaining shale into Tor chalk

IADC/SPE 39399 “Rotary Liner Drilling for Depleted Reservoirs”, Sinor et.al.
Cementing Solution

- Use proven non-retrievable DwL technology
- Pump primary cement through a port collar/stage cementing tool on initial liner trip
  - Bypass pumping cement through casing bit
  - No pressure surge to formation upon opening
    - RFID (Radio Frequency Identification) system vs. mechanical/hydraulic stage cementing tools
- Install metal expandable annulus casing packer barrier above depleted chalk interval (below port collar) for cement base and well annular barrier
- Install casing swivel above stuck depth to enable rotation of liner
- All components must be compatible with workings of liner system
**DwL System with RFID Cementing Port Collars**

- Liner Running Tool Assembly
- Closing Plug
- Shut Off Plug
- Shut off ball and closing DP dart
- Liner Top Packer
- Liner Hanger
- Casing Swivel
- RFID Cementing Port Collar(s)
- Metal Expandable ACP
- DwC Centralizer
- DV Latch-in Float Collar
- Stabilizer
- Defyer® DPA Casing Bit

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RFID in Oilfield Context

**Fuse Based Tools**
- Built on Fuse Block and Atmospheric Module Technologies.
- Single Cycle Devices.
- Use Well Hydrostatic Pressure to Function Device or series of Devices.

**Common Enablers**
- RFID Electronics.
- Pressure Pulse.
- Antennae Technology.
- Lithium Battery.
- Graphic User Interface.
- Wireless Communication.

**Pump Based Tools**
- Built on Micro-Pump and Spool Valve Technologies.
- Multi-Cycle Devices.
- Use Hydraulic Fluid Reservoir, Positive Displacement Pump and Multi-Position Spool Valve.

REMOTE OPERATED CEMENTING METHODS FOR DWL INSTALLATIONS
RFID Cementing Port Collar (RCPC)

- Uses Fused Valve Block and Atmospheric Module Technologies
  - uses well hydrostatic pressures to function port collar(s)
- Pressure pulse and/or RFID activated
- Individual activation of multiple port collars
- Delayed opening (timer)
RFID Cement Port Collar - Summary

- Adopts Weatherford’s Fuse based RFID activation system
- Existing 4.5” and 2 7/8” field history
- Development of two new 9 5/8” Variants
  - Single Fuse Remote open – Wiper dart close
  - Dual Fuse Remote open – Remote close
- Takes field proven completion and drilling technology and complements Weatherford’s DwL system
- DwL design implements all lessons learned from both Completions and Drill product lines
RFID Cement Port Collar - Benefits

- Remote interventionless operation, removes need for wash pipe/intervention
  - Reduction in Rig time, crew, risk and HSE concerns
- Multiple ways to trigger tool boosts operational flexibility
  - RFID, Pressure cycle, Timer
  - In built delayed opening prevents pressure surge on opening
- Monobore design and remote intervention allows unlimited tools to be run
- Once functioned, sleeve is permanently locked closed
- Mechanical contingency as standard
RFID Cement Port Collar - Operation

- Antenna Section
  - Antenna
  - Balance Piston
  - Hydraulic Reservoir
RFID Cement Port Collar - Operation

- Electronics Housing
RFID Cement Port Collar - Operation

- Sleeve Section
- Main Sleeve
- Contingency Sleeve
RFID Cement Port Collar - Operation

- RIH Position
  - Sleeve closed
  - 3 ATM chambers
  - Hydrostatic pressure held by Fuse valve
RFID Cement Port Collar - Operation

- Fuse 1 Open Position- Pressure cycled
  - Sleeve open
  - 2 ATM chambers
  - Sleeve move open with Hydrostatic piston
  - Pump cement job

Pressure moves into ATM chamber 1 to open sleeve

Fuse 1 open
Fuse 2 closed
RFID Cement Port Collar - Operation

- Final closed position – Sleeve Closed with RFID
  - Sleeve closed
  - 1 ATM chambers
  - Sleeve moves closed with Hydrostatic piston
  - Sleeve permanently locked closed

Pressure moves into ATM chamber 2 to close sleeve
Fuse 1 open
Fuse 2 open
Snap ring locks sleeve
RFID Cement Port Collar - Operation

- Final closed position - Closed with Wiper Plug
  - Wiper plug pumped down and lands in profile in sleeve.
  - Sleeve pumped shut
  - Sleeve permanently locked closed

Cement dart lands in Profile and closes dart
Metal Expandable Annulus Casing Packer

- Foundation for cement column
- Well annular barrier
- HNBR elements mounted on top of expandable steel sleeve
  - Able to withstand rigors of DwL vs. elastomer design
- Large expansion ratio
  - Full-bore inside diameter
- Hydraulically activated
  - Pressure event expands packer
  - Compatible with DwL system

MEACP before and after expansion (Drechsler et.al., SPE/IADC 163511)
Casing Swivel

- Designed to rotate liner during cement job
- Strategically positioned on liner above projected stuck point
  - Mechanical strengths > liner
  - Full-bore inside diameter
- Hydraulically activated
  - Pressure event decouples swivel
  - Compatible with DwL system
- Rotationally locked while liner is drilled down
  - Enables torque and rotation to be transmitted through swivel.
High Level DwL Procedures with a Primary and Backup RCPC

1. Drill liner into loss zone until losses sustained and/or liner becomes stuck.
2. Drop shut off plug ball, pump ball to shut off plug and displace plug to float collar.
3. Increase pressure in stages to 4,500 psi±
   a. Release liner setting tool and set liner hanger. (2,500 psi).
   b. Decouple casing swivel. (3,500 psi).
   c. Expand annulus casing packer. (4,500 psi).
   d. Verify liner setting tool is released.
4. Send unique pressure cycle to open primary RCPC (i.e. 3 x 3 min pulses)
   a. Algorithm looking for rate and timing of pressure rises and falls.
   b. There is a variable delay on timer to eliminate pressure surge.
   c. Bleed off remaining liner pressure.
   d. RCPC opens after set time. (Note: if RCPC fails to open, send unique pressure cycle to open backup RCPC installed xxx ft. lower in liner BHA –see next slide)
5. Establish circulation and pump cement job.
6. Launch closing plug DP dart, land in wiper plug and displace to top (backup) RCPC landing profile.
7. Increase pressure to close and lock RCPC.
Backup RCPC Operation

- If primary RCPC fails to open, send unique pressure cycles to open backup RCPC installed xxx ft. lower in liner BHA.
  - Backup RCPC is a dual fuse tool (pressure pulse to open and RFID tags to close)

- Establish circulation and pump cement job.

- Launch RFID closing tags via injection port inlet.
  - Ensure fluid volume sufficient so RFID closing tags reach detection zone before closing plug lands in the upper RCPC.

- Launch closing DP dart, pump DP dart to closing plug, and displace closing plug to RCPC landing profile.

- Increase pressure and lock RCPC closed.
  - Pre-programmed time delay in backup RCPC allows the backup RCPC to remain open at least until closing plug lands in primary or upper RCPC
In Summary, RFID Cementing Port Collar Systems...

- Are versatile
- Are remotely opened and closed and are equipped with a contingency mechanical option.
- Remove need for primary work string intervention
- Can be deployed for narrow pressure windows and long casings/liners
- Eliminate pressure surge upon opening
- Are strategically positioned to enhance wellbore integrity
- Are compatible with hydraulic liner systems
- Remove the geometric uncertainties seen with installation of multiple stage collars
Questions?

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