Utilising Acoustic Communication to Create Great TCP Technologies

APPS-13-10

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Agenda

- Acoustic Firing Head
- Acoustic Distributed Temperature System.

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- Acoustic Firing Head

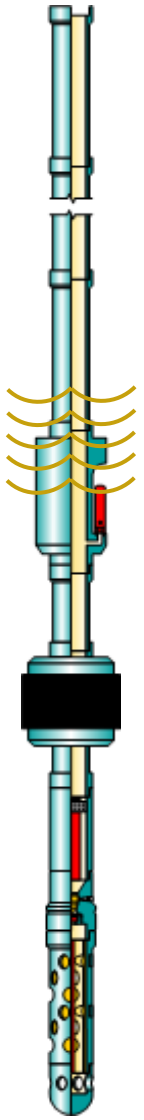
Current Firing Head Systems

- Mechanical – Bar Drop, Ball Drop
- Pressure – Direct, Differential
- Electronic – Pressure, Pulses, Acceleration, Time

- All have their place but all have a limitation…
  - Requirement for pressure or mechanical interventions

Plugging the Gap

- An acoustically operated firing head
- Uses tubing as the communication conduit
- Proven advanced acoustic and hardware technology
- Two way communication
- Optional real time pressure temperature data and detonation confirmation
- Surface safe



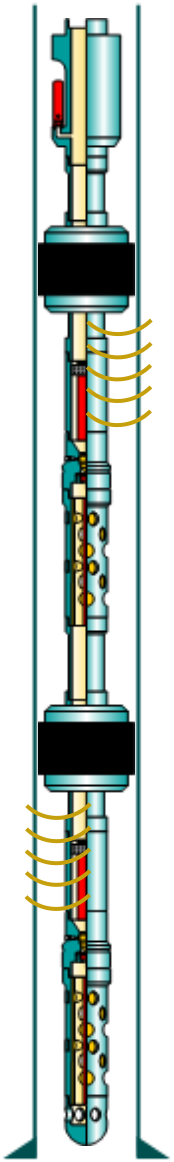
System

- Allows communication to the firing head at all times without the need of pressure or mechanical intervention at the firing head.
- Transmits through dry pipe, closed valves, packers, plugged profile nipples, Hi-Vis fluids etc.
- Allows maximum freedom while pressure testing, circulating, gas lifting, e/slickline intervention etc. without fear of gun detonation.

Operation

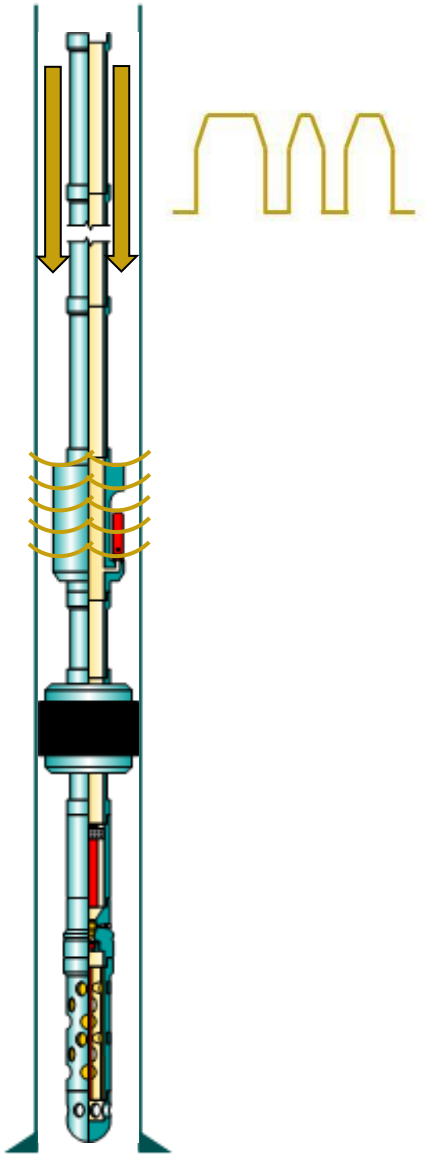
Acoustics

- Acoustic Signals via tubing from surface to firing head
- Requires multiple repeaters on tubing string
- Actuate single or multiple gun sets as required in any order



Pulse

- Annular pressure pulse to receiver above packer
- Receiver relays acoustic signals via BHA to firing head
- Actuate single or multiple gun sets as required in any order



Safety

- Electromechanical system – requires minimum hydrostatic to fire
- Firing piston is retained by a detent mechanism so will not function accidently if a seal failure occurs
- Minimum Temperature Requirement – motor power is provided via a thermal switch
- “Fire” command must be preceded by an independently sent “Prime” command
- Tool will come out of “Primed” state and revert to “Safe” state if “Fire” command is not received within a preset time limit
- Acoustic command sequences are very complex multi-character messages with built in error detection so cannot accidentally be received if not specifically sent
- Independent FMEA concluded system complies with API RP67
- Drop tested to comply with API RP67

Surface trials

Trial 1

- Completed successfully with gun detonation achieved from first signal transmitted. 4 ½” 12 spf system.
- Firing head continued to operate after gun detonation.

Trial 2

- Completed successfully with gun detonation achieved from first signal transmitted. 4 ½” 12 spf system.
- Firing head continued to operate after gun detonation.

Trial 3

- Completed successfully with gun detonation achieved from first signal transmitted. 4 ½” 5 spf system.
- Firing head continued to operate after gun detonation.

Run History

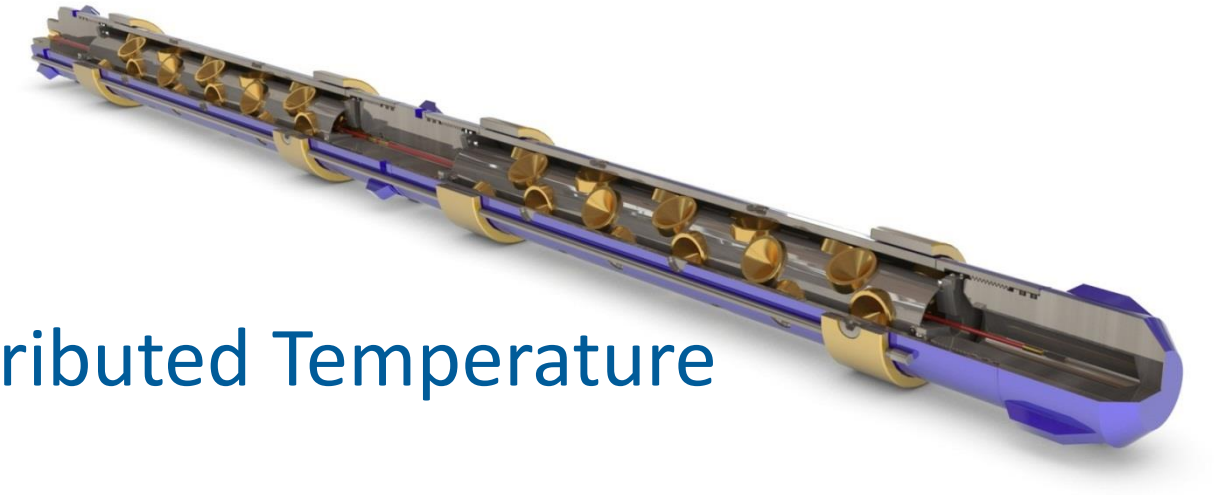
Field test	Max BHP (psia)	Pressure at Firing (psia)	Max BHT (°F)	Fired
1	15,675	9,723	279	No
2	15,675	9,727	279	No
3	3,565	2,156	100	Yes
4	3,565	2,156	100	Yes
5	8780	5838	209	Yes
6	8780	5838	209	Yes
7	10,436	6018	240	Yes
8	10,436	6082	240	Yes
9	6000	4350	181	Yes
10	6000	4350	181	Yes

Applications

Will this change the way we plan perforating?

- DST – Multizonal tests? Pressure testing regimes?
- Horizontal Wells – Non sequential perforating for clean up and/or evaluation.
- Completions - Eliminate concerns with pressure cycles to the well during completion.
- Wells with open perforations

Agenda



- Acoustic Distributed Temperature System.

System Overview

- Unconventional distributed temperature system
  - Positioning of multiple temperature sensors
- Individually autonomous sensor system, each with its own battery pack.
- Robust can be run alongside perforating gun system.
- Multiple system compatable
- Can communicate to surface via acoustic telemetry eliminating the need for packer feed throughs.

Gun Orientation

Gun Orientation

Specialised Clamps

Specialised Clamps

System

System

Surface Tests

Trial 1

- Slight collapse seen in control line
- 1 sensor damaged (from control line)
- Data recorded from all other sensors

Trial 2

- Higher pressure rating control line
- Trialled new style control line clamp
- Damaged sensors
- Data recorded from all other sensors

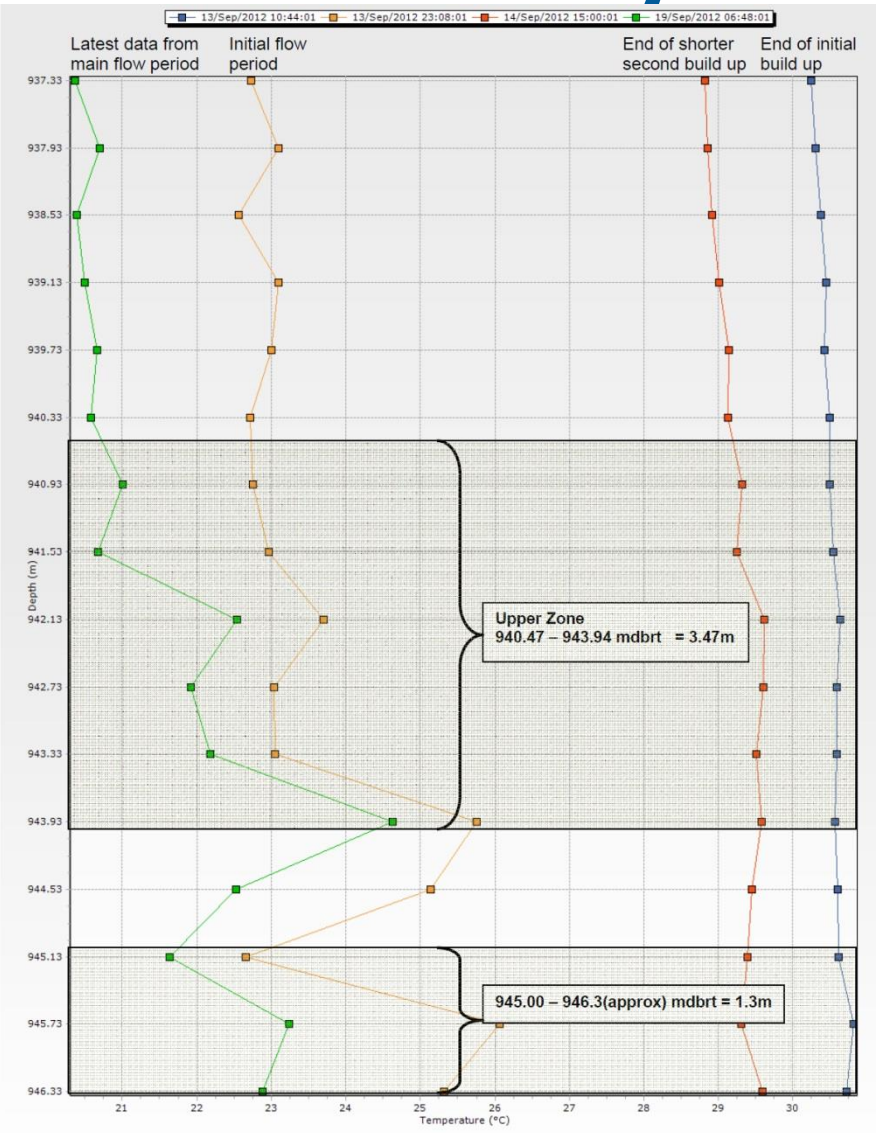
Trial 3

- Utilised improved sensor design – no sensor failures

Work History

- 3 surface tests completed with perforating gun system. Data received on all tests
- Standard prototype system has been operating since 2009
- Standard system is currently in hole with screens and operating successfully in West Africa for 3 months.
- Standard system run successfully in gas well on screens in North Sea and producing data.

Work History



Applications

- Temperature profiles across the reservoir directly before and after firing.
- Monitoring of multiple independent zones
- May eliminate the need for production logging
- Long term reservoir information available even when guns are left *in situ*.

Summary

Acoustic Firing Head

- Perforating isolated wellbores is now possible.
- Firing system will allow more complex zonal perforation in a single TCP run.
- Possible to confirm firing before moving to next section.

Acoustic DTS

- TCP compatible distributed temperature system.
- Pre and post perforation temperature profiles.
- No packer feed throughs

Questions?