Efficient Well Diagnostic using simple yet powerful Distributed Temperature Sensing (DTS) – A Case Example

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Outline

- Well Integrity
- Diagnostic tools
- DTS – Distributed Temperature Sensing
- Case Example
Is Anadarko leaking explosive methane into homes in Colorado? Company to shut down 3,000 oil wells after fatal home explosion April 17, 2017 in Firestone, Weld County that killed two, injured two.

Posted on April 26, 2017 by Website Admin

Source: www.ernstversusencana.ca
Diagnostic Tools

- Mechanical (PMIT)
- Ultrasonics (USIT/IBC)
- Electromagnetic (EMIT)
- DAS (Distributed Acoustic Sensing)
- Production Logging (PLT)
- Acoustics (Noise)
- DTS (Distributed Temperature Sensing)
Intervention Diagnostic Objectives

- **Well**
  - Gas well
  - Leak from tubing to A annulus
  - Well located in water protection area
  - Maximum deviation 3deg

- **Identify the leak from tubing to A annulus**

- **Conditions**
  - Gas well
  - Day light permit

- **DTS+PLT was chosen as the most optimal solution**
The backscattered light is made up of few different wavelengths. The main wavelength is called the Rayleigh peak/bank and is at the same wavelength as the emitted light. This peak is not used and is suppressed in the electronics.

The waves that results from the lattice vibrations show up as Brillouin peaks.

The weakest waves originating from molecular and atomic vibrations are the Raman bands. The Raman signal is used for temperature evaluation. The Raman bands are spaced away from Rayleigh and Brillouin so easy to detect and filter.

The Raman signal is comprised of so-called “Strokes” and “Anti-Strokes” bands. The “Strokes” has very low temperature sensitivity whereas the “Anti-Strokes” at lower wavelength have higher temperature sensitivity. The area under the “Anti-Strokes” is proportional to the temperature. The ratio of Anti-Strokes to Strokes band area is typically used to determine the temperature at the point where the wave originated.
DTS (Distributive Temperature Sensing) technology is chosen as the primary means for the diagnostic.

DTS technology provides the user with a technique to measure the temperature distribution along a fiber optic line in time domain.

With the DTS fiber line static, the measurement can be repeated as required. The DTS fiber line mounted on slickline drum was utilized. This service is usually referred to as “OPTICall” or “Sensaline” in Schlumberger.

The operation is inherently safe to use in environments where an electrical spark may pose a fire hazard. PLT (Production Logging Tool) sensors are run below the Fiber-optic line to record additional data in memory mode.
Once the Fiber is run to the desired depth, then short laser pulses are sent out. The light collides with the lattice structure and atoms of the fiber, producing small bursts of light which travel back to the beginning of the fiber.

This backscattered light is analyzed at the surface optical instrumentation to determine the temperature at the depth from where the backscattered originated. The two-way travel time helps to determine the point (depth) of the backscattered light, as the speed of light is constant.

We can see the difference in the how temperature data is acquired from a PLT versus DTS.
The diagnostic survey was planned as follows

- **Run-1 Slickline drift run**
  - To determine the HUD
  - To determine P/T

- **Run-2 DTS with memory PLT**
  - The PLT sensors (baseline temp, pressure, fluid level, density, spinner) in memory were run to provide additional insight for the leak detection and wellbore dynamics
  - RIH to TD
  - Perform static DTS survey – record data for ~1hr
  - Open A annulus to flow
  - Record DTS data to identify leak point
  - Record PLT memory data across the leak point (if identified)
Run-2 DTS/PLT Surface Setup Details

- The hot-spot check is performed once the fiber has been run to its desired depth. The length from hot-spot to wellhead (depth ref) is also measured to ensure the fiber depth can be converted to actual well depth.
### DTS/PLT Data Observations (1)

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<tr>
<th>Track</th>
<th>Remarks</th>
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<td>2</td>
<td>DTS temperature traces, in degC</td>
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<td>3</td>
<td>DTS temperature image, in degC</td>
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<td>Gradient plot, temperature vs depth</td>
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<td>Gradient plot image, temperature vs depth</td>
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Start recording baseline temperature at 10:10

Open A annulus to flow at 11:30

Notable change in temperature
Temperature anomalies noted on the Gradient plot
PLT data acquired under flowing conditions re-confirms the leak which was identified by DTS. The leak is not at the collar but on the body of the highlighted joint in red.
Summary

- There are many tools to determine well integrity/flow diagnostics
  - Mechanical
  - Ultrasonic
  - Electromagnetic
  - DTS/PLT
  - DAS
  - Acoustics/Noise etc.

- DTS + PLT are one of the simplest, cost effective and robust leak/flow detection measurement

- Readily available as short notice

- The data is analysed in realtime using Techlog Therma Module, realtime decision made to optimize the data acquisition

- Not that expensive!
Thank You