Well·SENSE TECHNOLOGY LIMITED

FLI FIBERLINE INTERVENTION

Cement Assurance

FULLY CHARACTERISE YOUR CEMENT JOB FOR A FRACTION OF THE COST AND RISK

Identify top of cement, fluid/slurry interfaces and void areas during cement cure. No need to wait for complex data interpretation. Low cost. Data rich intelligence.

FLI is a small, portable and disposable tool that installs bare optical fibre along the whole length of your well to gather instant, distributed data simultaneously from every location. FLI tells you what is happening at all times, everywhere, to give you the complete picture. FLI is highly intelligent and data rich but being compact and disposable is incredibly low cost, low risk and fast to deliver results. One tool, in one box, with one engineer on site gives you results in a matter of hours.

WHY DO YOU NEED FLI?

A common challenge during drilling and completion is ensuring the cement barrier between the well and surrounding subsurface formations and reservoirs is well executed. Cementing the well prevents pressurized downhole fluids from reaching the surface or contaminating shallow water table formations. In some locations the quality of the cement job must be validated to meet regulatory requirements.

In the ideal case, cement slurry is smoothly and evenly pumped in the casing annulus. The cement completely fills the space between the casing and the formation and provides a permanent barrier to pressurized fluids along the casing and from below. In reality, cement slurry can follow a complex path up the annulus and towards the surface.

Validating the cement job can be problematic when using conventional wireline or slickline techniques, as single point instruments can only capture measurements at the depth of the logging tool. Conventional temperature logs can be used but the tool must be moved up and down the well to identify features in the cement during setting. It is not possible to sample the entire wellbore simultaneously. This leads to many hours or days of logging to capture the relevant data and understand more than just finding the top of cement, for example areas of less effective or poor isolation. Significant uncertainties and limitations exist using this method because the dynamic temperature can only be measured at specific depths at specific times. To more fully understand the cement job, multiple, complex and costly well logs, using cement bond and ultrasonic imaging tools, must be run. But these logs are typically run at the end of the curing process, missing valuable data from the heating and cooling phase.

Now FLI can tell you everything you need to know about the quality of your cement job at all points along the well during the curing process.

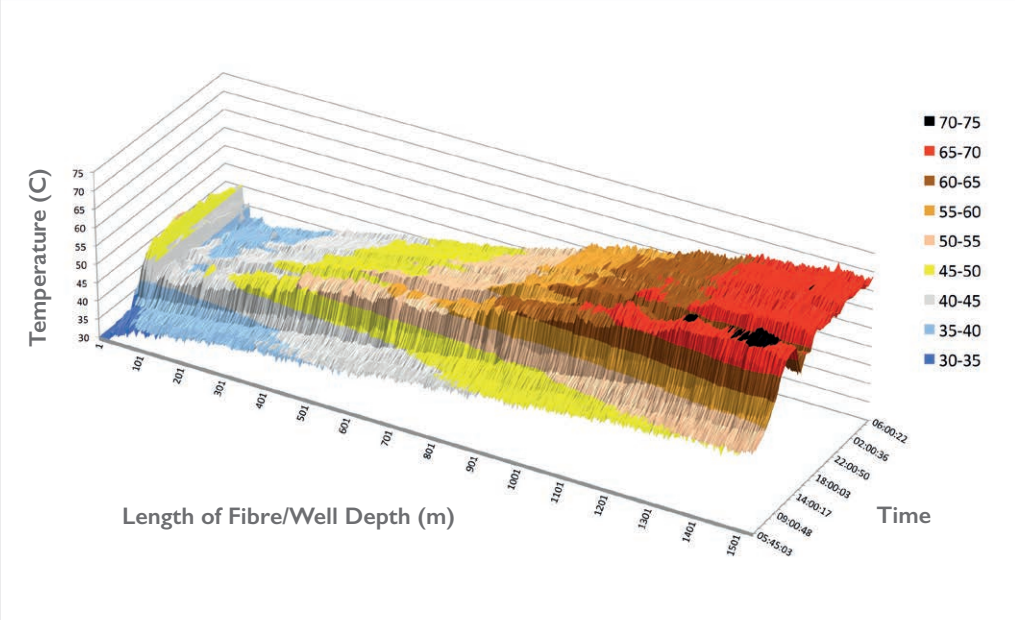
FLI's dynamic, distributed temperature measurements are captured along the full length of its fibre, from just after the cement slurry is loaded into the casing annulus. It provides a time elapsed view of exothermic heating and cooling of the cement throughout the entire wellbore. When the wellbore returns to its subsurface geothermal condition, in about 24 hours, the profile can immediately be interpreted to identify top of cement, cement/fluid interfaces, density changes and crucial void areas. Once data is acquired, the fibre is cut and the FLI tool left to degrade in the well or to be drilled out.

CONVENTIONAL METHODS VS FLI

FLI dramatically reduces cost, logistics and risk to personnel, equipment, wellbore and drilling location.

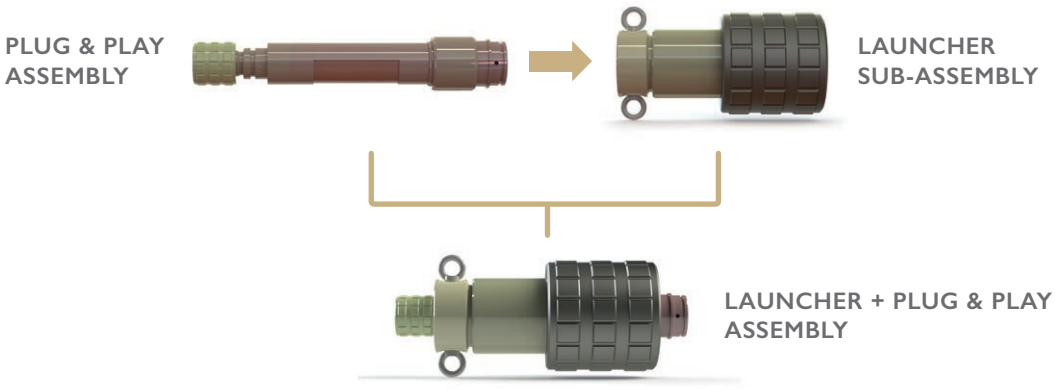
	TRADITIONAL CEMENT ASSURANCE METHODS	FLI CEMENT ASSURANCE
Logistics	Large footprint of wireline/slickline intervention equipment, use of drilling rig equipment, large rental crane or workover rig, support of multiple rig personnel required.	Lightweight self-contained system <55 lbs (25 kg), easy to transport and handle.
Risks	Multiple personnel onsite, overhead loads, rotating equipment, dynamic pressure control at wellhead, wireline/slickline under tension, fuel/chemical spillage, tool failure/repair & replace, stuck tool/fishing operation, potential lost tool in hole.	1-2 person operation, no rotating equipment, no overhead equipment, static pressure seal at wellhead, disposable fibre and tool.
Time	Several hours rig up/rig down, continuous operation and supervision of logging unit, NPT for non-measurement tool positioning. Temperature log data is captured slowly over multiple passes. Cement bond and ultrasonic imaging logs are usually captured after cement has cured.	Less than an hour cumulative rig up and rig down, full wellbore monitoring begins in less than an hour. Data captured straight after cement installed to monitor early heating and cooling phase.
Measurement	Single point temperature log or costly, complex cement bond or ultrasonic imaging tools.	Continuous DTS thermal monitoring of the entire wellbore at 1 meter intervals throughout the cement curing process.
Project Execution	Various service providers involved, multiple rental items, high mobilization and standby costs.	Integrated Well-SENSE service (job planning, delivery, logistics, onsite personnel, FLI intervention, interpretation, answer/solution). One provider, one point of contact, minimal pressure control equipment, rapid mobilisation, minimal personnel and equipment standby.

DISTRIBUTED TEMPERATURE SENSING (DTS) CEMENT ASSURANCE



This example shows a static visualization of a time elapsed DTS log. The entire history of the cement curing process is displayed for interpretation of heating and cooling along the wellbore over time. DTS data can also be easily reproduced in video format to replay and revisit the cement cure process and behaviour.

FLI IN ACTION



Our plug and play system is low risk and simple to operate

FEATURES AND BENEFITS

- Simple 'plug and play' deployment system
- Less personnel and equipment needed on site
- Distributed fibre optic sensing captured in real-time
- Simple to understand interpretation
- No NPT for tool retrieval
- Smaller footprint, minimal rig up/rig down time
- Lower cost, lower HS&E risk
- Rich data without compromise
- Faster results
- No more lost in hole charges

TECHNICAL SPECIFICATIONS

Plug and Play FLI:	Ultra-fast FLI setup and deployment
Tool Diameter:	1.0 – 3.5 in (25.4 – 88.9 mm)
Tool Length:	OD Less than 5 ft (1.5 m)
Fibre Type:	Multi-mode, single mode, standard and harsh environment options
Well Depth/Fibre Length:	Up to 45,000 ft (13,716 m)*
Maximum Wellhead Pressure:	10,000 psi (690 bar)
Maximum Downhole Operating Pressure:	25,000 psi (1,724 bar)
Maximum Downhole Operating Temperature:	Up to 572°F (300°C)**

* Depends on tool diameter and fibre type ** Depends on fibre type

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FREQUENTLY ASKED QUESTIONS

1. **So the fibre itself is the sensor?**

   Yes, optical fibre is a well proven method of in-well sensing.

2. **How does it work?**

   FLI deploys fibre along the entire length of the wellbore.
   A fibre optic connector is available on the surface.
   A DTS unit is connected via a small diameter surface cable and DTS data recording begins immediately upon launching the tool into the well.

3. **What if it gets stuck in the well?**

   The tool can be allowed to degrade, or can be drilled or milled out. Alternatively, all tools come with a standard fishing neck.

4. **What about the fibre that's left in the hole?**

   10,000 ft of our standard fibre will produce the equivalent of 1 square inch of debris. The fibre will break down over time and presents no risk to the well or surface equipment.

5. **What happens if the fibre is damaged or broken during the logging operation?**

   In the unlikely event of this happening, a backup FLI tool can quickly be loaded onto the wellhead and launched into the well.

6. **Is it safe to leave in my well?**

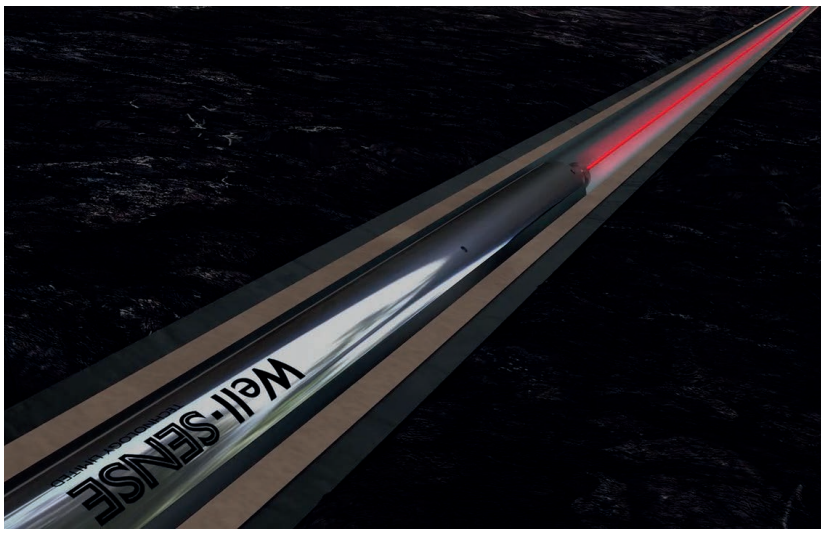
   Yes, the tool bodies and internal components are made from aluminium and plastic which degrade over a short period of time in normal well conditions, leaving no harmful substances or obstructions in the well.

7. **Have fibre optics been used for well profiling and production logging before and what's the difference?**

   Distributed fibre optic sensing technology has been fully commercialized and proven over the last few decades but FLI is different to other solutions because it uses bare fibre and is disposable. The main difference between fibre and conventional production logging methods is the ability to simultaneously measure key parameters along the entire length of the fibre.

8. **Why is it so much cheaper?**

   FLI is a self-contained sensing tool requiring minimal personnel, well footprint and support equipment. It is a single use, disposable product which does not require protection to install in the well and does not need to be retrieved. This results in significantly lower direct costs for the FLI solution, reduced associated operational cost to the well operator and dramatically reduced health, safety and environmental risk to the well location and the wellbore.



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