A new thermometer for oil and gas wells
Upstream oil and gas operators are continuously challenged to find the safest and most cost-effective ways to remotely access and visualize real-time data from offshore wells. Traditionally, upstream oil and gas production engineers have reacted to challenges in their wells by procuring WRFM\textsuperscript{1} temperature surveillance data to help them make decisions that will yield the highest value. However, these services increase the risk to the workforce, increase operational costs, and defer revenues from production by taking the well offline. Enter fiber optics — this technology enables temperature data to be read continuously.

\textsuperscript{1}WRFM – A term used in the oil and gas industry for Wells Reservoirs and Facilities Management
**Fiber feels the heat (and the cold!)**

Fiber-optics technology (or ‘fiber’) continuously provides temperature surveillance data along the full depth of the wellbore, enabling oil and gas operators to avoid the use of a temperature Production Logging Tool (PLT) service. A PLT can be used to measure wellbore flow and wellbore temperature while a well is offline. The use of PLTs increase the safety risk to personnel as it requires them to open up the well to lower and raise the tool. This also adds operational expense and production deferment.

A single fiber-optic cable, thinner than a human hair, gathers the data that thousands of highly accurate temperature sensors would gather along the depth of a well, at a fraction of the cost of existing technologies. No downhole moving parts or electronics are needed. A light box located on the surface transmits brief pulses of laser light into the fiber. Changes in temperature downhole slightly deform the fiber and modify the returning light pulse. These deformations essentially turn a fiber into temperature sensors that are separated by a few feet (e.g., three feet is typical) along the full depth of the well. This provides near real-time WRFM surveillance without downhole moving parts or downhole electronics.

The use of fiber is enabling upstream businesses to minimize personnel risk, costs and production loss by keeping the well online. Although the technology started being applied in the 1990s, it is now becoming more mainstream. Three tangible fiber success stories:

- The US government regulatory agency required an operator to provide justification of well integrity to keep production online. The company calculated thermal pressure changes in the upper and lower annulus using historical temperature profiles measured from the fiber. They then provided well integrity documentation and obtained approval to keep the well online, protecting over $200 million in revenue.

- An operations manager wanted to increase production safely after a water breakthrough. The production engineer confirmed that a ramp-up of production could safely occur by using the historical temperature profiles from the fiber which validated that high-end temperatures had not been exceeded. They then used real-time temperature profiles as a calibration point while safely increasing production to historically high levels, generating an additional $20 million in revenue.

- A production engineer needed to determine if a malfunctioning gas lift valve was the cause of poor production. He used the temperature profiles to confirm the gas lift valve was functioning properly, confirming the fluid level was below the deepest gas lift valve. He was able to avoid the need to run a PLT for this purpose. This minimized the safety risk by involving a fewer number of employees and reduced operational spending by $300,000.

![Figure 1: A typical deep water fiber optic installation](image)
The case for fiber – eliminating expensive periodic services

The capital cost of a fiber optics Distributed Temperature Sensing (DTS) light box and cable can be a one-time installation for ~$500,000 - i.e., ~$200,000 for the fiber (for a 20,000' deep water well), plus ~$200,000 for installation, and ~$100,000 for the associated light box. The payback period is estimated at the cost of performing two PLT logs, with each costing approximately $250,000. Over time, companies will reduce overall costs, reduce safety risks, avoid production deferment and enable continuous monitoring during key activities.

A single light box can handle multiple wells that feed the same location (e.g., a Tension Leg Platform or Spar) so that future wells completed with fiber are connected to the same light box, reducing cost and complexity. An added bonus is obtaining a base case geothermal temperature profile soon after a new well is completed. Unlike the periodic PLT services, fiber provides continual temperature readings, irrespective of the well’s flowing status.

When compared to the traditional cost of on-going PLT costs, fiber offers an operating cost avoidance benefit that will grow over the life of the well.

Figure 2: Return on investment
Big data and visualization

As companies use fiber as an alternative thermometer, consideration is needed for how data will be managed and visualized. DTS data can be large in volume as it provides thousands of measurement values at a high frequency (at frequencies of every 30 seconds to every 3 hours).

• As data flows in, a data historian for enabling on-going analysis will be needed

• Production engineers and reservoir engineers typically have a visualization tool used for monitoring process data, but it may not be suitable to process large values of depth correlated temperature readings. Basic temperature profile analysis would be required through a visualization solution using a Software-as-a-Service (SaaS) capability

• Petrophysicists typically have powerful visualization tools with access to well lithology, well trajectory and well schematics. However, they may require a software plugin to enable access to DTS data. This will allow detailed analyses to be performed with multiple sets of information, for highly supportable operational decisions

As operators begin this journey, some initial mobilization is needed, but the on-going benefits are significant.
About the author

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Talib Daredia is a Senior Consultant within Wipro’s Energy, Natural Resources and Utilities industry vertical and is the Canadian Practice Manager for real-time data management. He has over 10 years of experience performing multiple roles, which have included field engineering, design engineering and project management. Talib has advised oil and gas companies on real-time data and infrastructure transformations, including the implementation of fiber optics for well surveillance and support for visualization. Talib is a registered Professional Engineer (P.Eng) and Project Management Professional (PMP)®. Talib can be reached at talib.daredia@wipro.com
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