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Successful Field Application in Continuous DTS Monitoring Under Harsh Environment of SAGD Wells Using New Optical-Fiber Technology: Case Study from Canada

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Abstract

The use of optical fibers in the oil and gas industry is becoming more viable for several applications, particularly in permanent reservoir monitoring, such as distributed temperature sensing (DTS) and optical pressure transducers. However, poor long-term performance of fibers, especially at elevated temperatures, is still an issue yet to be fully resolved. This problem is critically important in steam assisted gravity drainage (SAGD) applications, where wells operate in extreme conditions of high temperatures, often exceeding 250°C, as well as in high pressures within a hydrogen-rich environment. Optical fiber performance is seriously affected by many factors, including:

- Hydrogen ingress
- Thermal resistance of the materials
- Mechanical resistance of the fiber

Exposure of optical fibers to hydrogen changes the performance of the fibers through what is referred to in the industry as “hydrogen aging” or “hydrogen darkening.” Hydrogen darkening is increased absorption or light loss due to various chemical species in the glass fiber resulting from the presence of hydrogen.

Value Proposition in SAGD Applications

It is known that temperature monitoring in SAGD wells is of significant importance as it provides a good understanding of the temperature distribution along the horizontal section. Conventionally thermocouples have been used to measure and monitor the temperature along the horizontal section, typically installed at Heel, Middle and Toe of the section. Since thermocouples (TC) inherently provide temperature data at these discrete points, as a result, temperature information between the TC's is usually interpolated to understand the temperature distribution. As a result of this interpolation, there could be sections of the wellbore that would require more data from different sources for a detailed analysis instead of just being able to visualize the temperature behavior. Hence there is a need for tool that can provide temperature data along the entire length of the Horizontal section. In addition, the installation has to be simple to keep it safe and cost effective. The optical fiber based DTS technology has been applied in the past successfully and it is known that the optical fiber based DTS technique provides temperature data along the entire length of the fiber. This temperature data provides a lot of information for e.g.

- What sections of the lateral are operating at “SubCool”,
- Quickly Identify anomalies,
- Immediately implement corrective action, &
- Allow for better steam utilization

Figure 1 shows a SAGD pair well where the upper well is being steamed and the oil is being produced through the lower wellbore. The adjacent schematic shows the actual data being collected during the production of the well when it is on production. It shows the temperature on the Y-axis and the well length on the X-axis. The dark blue line represents the distributed temperature data being collected along the length of the fiber. The orange dots are the temperature data being collected by the TC sensor placed at strategic position on the length of the lateral section. It can be observed from this schematic that the entire lateral is almost at the same temperature. We can also see the thermocouple reading well within +/- 5% of the fiber data. During this phase, pseudo steady state production only provides information on subcool production.