Schlumberger

Permanent Optical Cable

Transmits DTS, DAS, and PT gauge readings

Rated to 20,000 psi [138 MPa]

Rated to 250 degC [482 degF]

APPLICATIONS

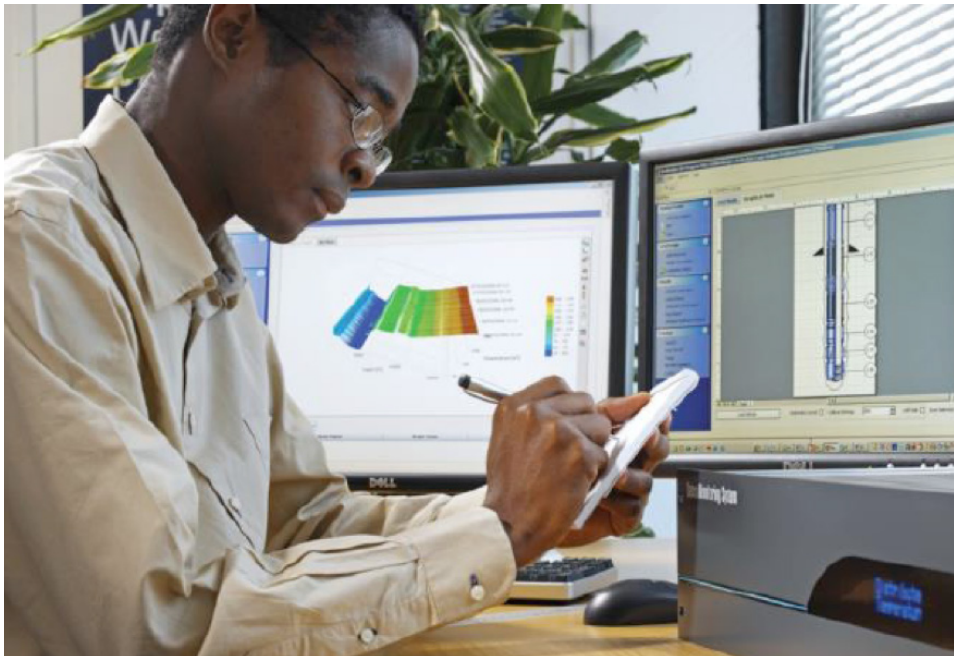
- Allocation of reservoir production or injection using inflow and outflow temperature profiles
- Seismic borehole surveys through optical vertical seismic profile (VSP)
- Optimization and diagnostics of gas lift systems

BENEFITS

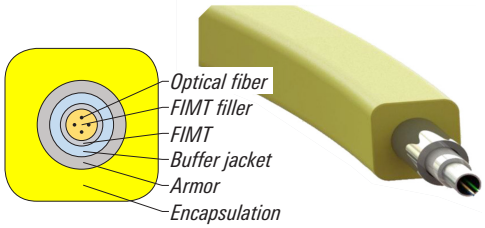
- Provides immediate indication of changing downhole conditions with real-time DTS, distributed acoustic sensing (DAS), and PT measurements
- Monitors tubing and completion equipment for leak integrity and flow assurance
- Monitors mudline-to-riser temperature profiles for riser integrity
- Identifies events at earlier stages
- Adapts to project needs with survey and diagnostic services

FEATURES

- Multiple fibers that enable DTS, DAS, strain, and optical gauge measurements
- Negligible loss characteristics in a hydrogen environment
- Enhanced production management and recovery through improved reservoir surveillance



The permanent optical cable comprises optical fiber—such as WellWatcher BriteBlue* multimode DTS fiber—filler, fiber in metal tube (FIMT), a buffer jacket, armor, and encapsulation. It is a key element in ensuring reliability of a fiber-optic system that provides a channel for transporting DTS, DAS, and PT readings from an optical gauge.



TThe permanent optical cable is made with controlled overstaffing, which is the manufacturing process the cable goes through to prevent strain and fiber-breaking. It is also created in a moisture environment to manage tension and maximize the hydrogen resistance of the fiber. These factors protect the enclosed optical fiber from pressure, humidity, expansion, bending, and hydrogen attack.

The DTS data provided by the permanent optical cable is typically used for allocation of injection or production and for optimization and diagnostics of the upper completion. The DAS data from the cable is used for VSP, as well as leak detection and flow properties analysis.

A special wellhead outlet for fiber-optic lines is also available. The reliability of the downhole connectivity equipment is ensured by the field-proven Intellitite* downhole dual-seal dry-mate connector.

The configuration of the cable is fully customized, including quantity and type of fibers and encapsulation, material and armor material, and size and FIMT filling agent.

Distributed temperature data logging

The information obtained from the fiber-optic distributed temperature sensors, combined with that from the electrical pressure and temperature gauges, provides a more thorough understanding of the reservoir than either sensor type would provide separately. For example, the pressure and temperature data can enable accurate diagnostics on gas lift systems, with the fiber optics adding capability to quickly identify a faulty valve or unstable flow. In addition, the optical fiber enables continuous temperature profiling along the tubing, which can be used to identify conditions such as sealing integrity loss. In many cases, the optical cable can be extended across the reservoir to calculate inflow and outflow contributions from the fiber temperature profile and optical pressure data.

The cable provides temperature measurements every 0.5 m [1.6 ft] along its length, producing a profile of temperature effects along the production string. The fiber-optic line can be interrogated continually or intermittently to rapidly diagnose well conditions during production. At the surface, data can be transmitted to multiple remote locations via wired or wireless technologies.

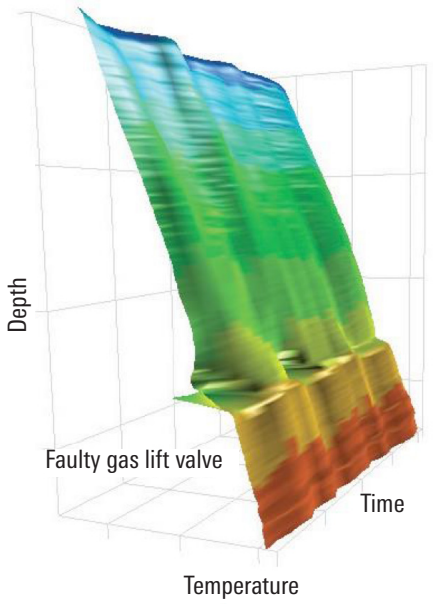
Multiple optical measurements

In addition to DTS and DAS, the permanent optical cable can be used for other optical measurements. For example, a fiber-optic pressure gauge can be connected to the optical cable. This setup provides reliable measurements of pressure even in HPHT conditions. Optically distributed strain sensing to monitor rock deformations across the well is also possible with the permanent optical cable.

Improved production and reservoir management

Measurements from the permanent optical cable are compatible with THERMA* distributed temperature and DAS analysis software, which defines flow by analyzing DTS data in the wellbore and in the near-wellbore area. The software calculates flowing well temperature on the basis of reservoir, fluid, well, and completion properties. Variables that control flow in the reservoir, such as permeability, are adjusted until the measured and calculated data coincide. At that point, distribution of the variables in the reservoir zones is uniquely defined, and the resulting model is used to determine flow rate from individual zones. THERMA software features a dedicated module for DTS modeling in gas lift applications.

With the help of the software, DTS and DAS data can provide critical information on mudline-to-riser transfer, artificial lift system operation, flow control valve performance, tubing or casing integrity, flow assurance, inflow temperature profiles, and other applications to support production and reservoir performance management.



In a gas-injection well with a slugging injection valve, distributed temperature measurements can quickly identify the problem valve, saving time during valve replacement and minimizing lost production.

Permanent Optical Cable System Specifications	
Cable size, in	¼
Operating temperature range, degC [degF]	–20 to 250 [–4 to 482]
Working pressure, psi [MPa]	20,000 [138]
Storage temperature, degC [degF]	–40 to 60 [–40 to 140]
Optical design life, years	>5
Number of fibers	Up to four
Type of fibers	Multimode and single mode
Cable armor material	INCONEL® 825 and 316
Cable encapsulation options	Polyolefin, Rilsan®, ethylene tetrafluoroethylene, perfluoroalkoxy alkanes, fluorinated ethylene propylene

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