



Optical Distributed-Temperature-Sensing System

Weatherford's optical distributed-temperature-sensing (DTS) system is designed to provide an absolute determination of temperature profile typically across a producing well interval (or along the length of the wellbore where cable is deployed). It is available as a permanent monitoring system as well as an ad hoc wellsite logging service when characterization of the well performance is required.

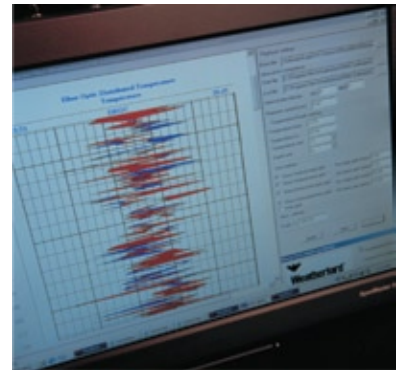
The DTS system provides continuous temperature measurements along one of three fibers in the standard Weatherford downhole optical cable. The cable can be installed with or without any other optical sensors, and the surface equipment can be permanently installed or mobilized when a temperature profile is required.

The standard cable contains a multi-mode optical fiber that is pre-calibrated for DTS measurements, enabling measurement immediately after installation and throughout the life of the well without recalibration. In addition, the cable incorporates a proprietary fiber-protection system that prevents the deterioration of optical signal experienced in other commercial optical systems and ensures high-quality DTS measurements.

Weatherford's DTS system is an integral part of its surface instrumentation and data system, providing a data source integrated with other installed sensing systems, including in-well reservoir pressure and temperature, flow, and multiphase-flow sensors.

Applications

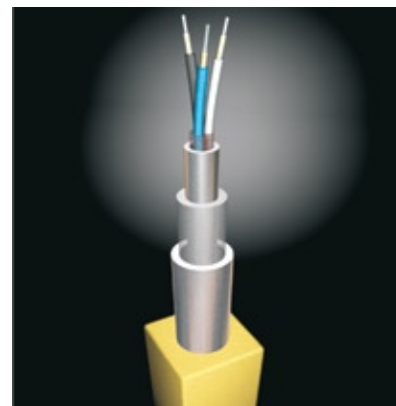
- Detection of water or gas breakthrough
- Monitoring of water, steam, and gas injection performance
- Determination of wellbore fluid rates
- Optimization of gas lift



WFT-6R



WFT-E10





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Applications (continued)

- Identification of well problems, such as flow behind casing, and detection of leaks, hydrates, asphaltenes, and paraffin
- Characterization of production contribution of well zones or segments, including oil, water, and gas

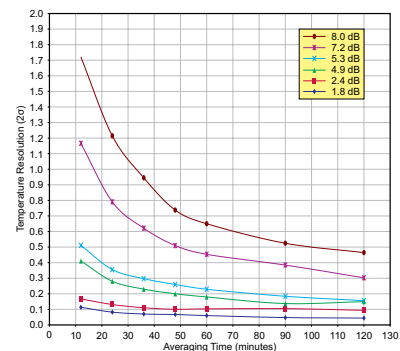
Features, Advantages and Benefits

- A minimal number of components and no moving parts ensure reliable system operation over the life of the well.
- In-well components are simple, and complex components are at the surface, facilitating service and enhancing system reliability.
- Designed with the industry's most durable and longest-lasting in-well optical cable, the sensor provides an on-demand temperature profile of the entire well to enable production optimization.
- Designed to withstand harsh conditions and using no in-well electronics, the sensor can function in high-temperature operations.
- Electrically passive sensor delivers temperature readings on demand, without the need to run logging tools, saving time and increasing efficiency.
- Standard Weatherford software generates API-formatted logs, correctly placed on depth and easily imported into production log analysis packages.
- The sensor delivers superior accuracy and stability when used in conjunction with a downhole optical pressure-temperature gauge, saving the cost of an extra in-well cable.
- For a permanent monitoring solution, one surface unit can be combined with an optical switch to poll multiple wells on a continuous cycle. Temperature logs can be made available to a wide area network, and anomaly alarm messages can be transmitted.

Temperature Resolution as a Function of Integration Time

Both temporal and spatial temperature resolution are a function of the total integration time. This dependency is illustrated in the cross-plot below of temporal temperature resolution. Curves are shown for various attenuation conditions that cover the possible installation conditions.

WFT-E10 Temporal Temperature Resolution





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Specifications

	WFT-E10	WFT-6R
Operational Performance		
Specification range (mi/km)	6.2 10	3.7 6
Maximum operating range (mi/km)	9.3 15	6.2 10
Sampling resolution (ft/m)	3.3 1	1.6 to 3.3 0.5 to 1.0
Spatial resolution (ft/m)	< 6.6 < 2	
Temperature resolution, temporal (°F/°C)	< 0.18° < 0.1°	
Temperature resolution, spatial (°F/°C)	< 0.18° < 0.1°	
Measurement interval time	10 sec to 24 hr	
Total integration time	3 min to no limit	
Short-term stability (°F/°C)	< 0.36° over 30 hr < 0.2° over 30 hr	< 0.18° over 45 hr < 0.1° over 45 hr
Accuracy (°F/°C)	< 5.4° over full operating conditions < 3° over full operating conditions	
Electrical Power		
Voltage	100 to 120, 200 to 240 VAC	24 V DC, 100 to 120, 200 to 240 VAC
Frequency	50 or 60 Hz	
Power	60 VA max	
Physical Data		
Size (DTS module only)	6U	3U
Weight (DTS module only) (lb/kg)	37 17	18 2.2
Plotter weight (lb/kg)	21 9.5	
Plotter size (in./mm)	12.3W × 4.87H × 12.0D 312W × 124H × 305D	
Environmental Data		
Operating temperature (°F/°C)	32° to 104° 0° to 40°	
Storage temperature (°F/°C)	14° to 140° -10° to 60°	
Relative humidity	85% max, non-condensing	
Operational vibration	5 to 500 Hz, 0.1 g, 90 min/axis	
Transportation vibration	5 to 50 Hz, 0.5 g 50 to 500 Hz, 3.0 g	
Operation shock	30 g, 11 ms	30 g, 30 ms
Drop test, unpackaged	3-in. height on each plane 75-mm height on each plane	