WellWatcher
Permanent monitoring systems
WellWatcher

Permanent monitoring systems

WellWatcher* permanent monitoring systems integrate the most advanced permanent downhole measurement technology with surface acquisition and data communication systems to allow remote monitoring of wells and reservoirs in real time. Pressure, temperature, density, and flow rate data are transmitted to surface and can also be transmitted to remote locations via satellite, the Internet, or cable.

Permanent downhole gauges
Permanent downhole electrical gauges and associated systems obtain highly accurate, stable, and reliable point measurements of pressure, temperature, flow rate, and fluid density.

Distributed and electric gauges and sensors
Fiber-optic distributed temperature sensors and arrayed electric pressure and temperature gauges acquire data over extended wellbore intervals in real time to identify the time, location, and reasons for changes in flow.

Reliability—The Key to Downhole Measurements
All components of the WellWatcher system are rigorously tested and qualified to meet the highest standards for reliability.
Permanent Downhole Gauges
Highly accurate, stable, and reliable point measurements

**Measurements of pressure, temperature, flow rate, and fluid density**
WellWatcher permanent monitoring systems include a wide range of downhole electrical gauges and associated systems for real-time point measurements of pressure, temperature, fluid density, and flow rate. The data provide long-term reservoir and production monitoring without the cost of well interventions, helping you optimize well productivity and hydrocarbon recovery by identifying trends throughout the producing life of your well or field.

The gauges incorporate the most recent innovations in pressure transducers, fully welded assemblies, corrosion-resistant alloys, and robust electronic components. Advanced cable head connector technology enhances reliability at the system level.

**WellWatcher Remote* battery-powered PT monitoring system**
- Pressure and temperature
- Rated to 68,947 kPa [10,000 psi] and 110 degC [230 degF]
- Maximum 16 gauges per cable

**WellWatcher Sapphire* PT gauge**
- Pressure and temperature
- Rated to 68,947 kPa [10,000 psi] and 110 degC [230 degF]
- Maximum 6 gauges per cable

**WellWatcher Quartz LT* N series high-resolution PT gauge**
- Pressure and temperature
- Rated to 68,947 kPa [10,000 psi] and 130 degC [266 degF]
- Maximum 8 gauges per cable

**WellWatcher Quartz* X series high-resolution PT gauge**
- Pressure and temperature
- Rated to 172,368 kPa [25,000 psi] and 176 degC [350 degF]
- Maximum 8 gauges per cable

**WellWatcher Extend* high-resolution PT gauge**
- High pressure and temperature
- Rated to 110,316 kPa [16,000 psi] and 150 degC [302 degF]
- Maximum 10 dual gauges per cable

**FloWatcher* flow rate, fluid density, and PT monitoring system**
- Pressure, temperature, flow rate, and fluid density
- Rated to 172,368 kPa [25,000 psi] and 175 degC [347 degF]
WellWatcher Quartz
X series high-resolution PT gauge

WellWatcher Extend
High-resolution PT gauge
Remote site and icy conditions present monitoring challenges
A well in a remote, environmentally sensitive area of Alaska required real-time downhole monitoring. The site was cold, difficult to reach, and had no permanent power source. The monitoring system has to be installed in the 4 months before the roads made of ice began to melt. Also in these 4 months, a road and well pad had to be constructed, the rig moved onsite, and the well drilled and completed.

Compact, lithium battery–powered monitoring system streamlines installation
The WellWatcher Remote battery-powered wireless PT monitoring system was selected. Its small replaceable lithium battery eliminated the need for a permanent electric power supply or solar panels, which are frequently stolen but were not an option because of the short daylight time in Alaskan winters. Its miniaturized remote acquisition unit was easy to transport. The long-life lithium battery met the high reliability standards needed in the remote location. After well abandonment, the equipment could be easily and inexpensively moved to another site.

Use of monitoring system saves 4 days and USD ½ million
The WellWatcher Remote system operated as planned and was left in place for several months to monitor downhole pressure and temperature and ensure well integrity until the well was permanently abandoned. Months later, an engineer sent to the site to recover the equipment found the system still working. By eliminating the construction and other time-consuming requirements of traditional power sources, the operator saved an estimated 4 days and USD ½ million.
Individual well production allocation is difficult in wells with shared pipeline
An operator and its partner were developing remote offshore North Sea fields that had several subsea wells tied in to adjacent fields. These fields were developed together with several gathering points but shared a common pipeline. The two companies had different allocation workflows but lacked adequate information about the performance of the individual wells. Because well interventions to test individual wells are expensive, and individual well production allocation could not be achieved without disrupting the total production from all the wells, they needed a way to obtain consistent data and to develop separate but consistent reservoir models.

FloWatcher system reveals allocation from individual wells
The FloWatcher flow rate, fluid density, and PT monitoring system enabled the subsea wells to be monitored individually. The system was installed in one of the wells, and total production from all three wells was monitored at the gathering point. The continuous pressure and temperature data and application of specific workflows transformed the downhole data into fluid flow rates and allowed each well to be accurately evaluated.

Improved allocation tracking enhances recovery strategies
The results—independently validated by multiphase flowmeter calculations—showed that one of the three wells was producing at a much higher rate than initially allocated and that no water had been produced for the first 2.5 years. Because the wells were tied in together at the gathering point and the performance of one well affected the performance of the others, the data automatically implied that the remaining two wells had produced less than initially thought. The operator was able to understand the production allocation of the three wells without the time, expense, and added risks of testing the wells individually.
More Than 10,000 WellWatcher Permanent Monitoring System Gauges Deployed in 50 Countries Worldwide

Enough permanent downhole cable to circle the entire globe

Schlumberger is the industry-recognized permanent monitoring leader, having deployed more than 10,000 permanent downhole pressure and temperature gauges in 50 countries over the past 42 years.
Distributed Measurement Systems
Distributed measurements over extended wellbore intervals

**Distributed temperature and pressure measurements**

Distributed temperature sensing (DTS) fiber-optic technology for permanent monitoring can provide temperature measurements over long intervals extending up to the complete length of the wellbore. Alternatively, an array of point sensors can be used to obtain distributed measurements. Multidropping several pressure gauges provides distributed pressure measurements.

The highly sensitive data can identify the source of changes in well performance as they occur rather than later during a production logging run, enabling accurate diagnostics for gas lift systems, monitoring of completion integrity, and quick identification—without interrupting production—of a faulty valve or unstable flow.

Interpretation and real-time communication software applications provide critical data for reservoir analysis workflows. Acquiring data from multiple wells provides an overall reservoir perspective that can help operators optimize the number and placement of wells to maximize production and recovery and contain costs.

**WellWatcher Neon** DTS and PT gauge system
- Distributed temperature and pressure
- Rated to 103,421 kPa [15,000 psi] and 175 degC [347 degF]

**WellWatcher Flux** electrical permanent monitoring system
- Distributed temperature and pressure
- Rated to 137,895 kPa [20,000 psi] and 150 degC [302 degF]

**WellWatcher BriteBlue** multimode DTS fiber
- Distributed temperature
- Rated to 175 degC [347 degF]

**WellWatcher BriteBlue HT** high-temperature multimode DTS fiber
- Distributed temperature
- Rated to 300 degC [572 degF]
Distributed Measurement Systems

WellWatcher Flux
Digital temperature array and PT gauge system
WellWatcher Neon
DTS and PT gauge system

WellWatcher BriteBlue
Multimode DTS fiber
Case Studies

WellWatcher Neon DTS and PT Gauge System Determines Behavior of Multilayered Reservoir Offshore Malaysia

Stacked reservoir complicates zonal allocation
An operator was redeveloping an oilfield offshore east Malaysia. A well was drilled to explore the deeper layers of the reservoir, for which very little information was available. The sandstone multizone reservoirs were stacked, with some distinct shale barrier separation. Reservoir predictions had indicated significant variations in the reservoir layers. In such reservoirs with uncertain behavior and commingled production, determining zonal allocation is critical yet challenging. Reservoirs have traditionally been monitored by wireline logging, reservoir saturation logging, and surface well testing, but these techniques often result in deferred production, increased intervention risk, and higher surveillance costs. The operator asked Schlumberger to design a completion and monitoring system to evaluate the zonal flow and depletion behavior of this reservoir.

Optoelectric DTS and PT gauges monitor individual zones simultaneously
A dual-string multizone completion with a WellWatcher Neon DTS and PT gauge system allowed the pressure and temperature of each zone to be monitored individually. The WellWatcher Neon system added a fiber-optic DTS line to the permanent downhole cable, enabling simultaneous acquisition of pressure gauge data and distributed temperature data. WellWatcher Quartz high-resolution PT gauges operate as usual on an electrical conductor, while the fiber-optic line operates independently of the electric conductor and does not affect its reliability. The system was installed at each reservoir perforation and interval, making it possible to calculate flow contributions, crossflow, and other critical factors for each zonal layer’s flow and depletion characteristics.
Analysis of commingled production optimizes management of multilayered reservoir

The DTS data and analysis of the complex zonal commingled production allowed earlier detection and prevention of internal crossflow zones during well clean-up. Zonal pressure and rate profiling optimized the zonal completion design with the downhole zonal sliding side door, which enabled better management of the reservoir layer drawdowns and layer inflow split.

THERMA thermal modeling and analysis DTS software was used to analyze the distributed temperature data and calculate flowing well temperatures on the basis of reservoir, fluid, well, and completion properties. Variables that control flow in the reservoir, such as permeability, were adjusted until the measured and calculated data coincided.
Operator needs drainage strategy to ensure capture of secondary production

BP was developing a portion of an oil field offshore Azerbaijan. The main producing formations consisted of layers of sandstone interbedded with shale. More than 100 million barrels of secondary production were at risk of being bypassed because of the reservoir’s characteristics. The development and management strategies required a good understanding of the conformance between the producer and injector wells both by geography and by formation. The use of conventional logging would have shut down production while the tool was being run in hole, increasing rig time and costs. The operator needed a faster, more efficient way to manage reservoir performance.

DTS fiber identifies reservoir properties and calculates flow rate

The WellWatcher BriteBlue multimode DTS fiber was installed to provide distributed temperature profiles that could be monitored at the surface in real time. Unlike production logging tools, the fiber requires no intervention after installation. The fiber was installed on the outside of the sand screens over the reservoir interval so that it would react to the temperature changes of each flowing layer. Fluid flows from a reservoir into a wellbore because of a pressure drop. This fluid movement and subsequent Joule-Thomson effect cause the fluid to change temperature from its normal geothermal value. When the reservoir fluid passes through the sand screen to the wellbore, it mixes with the flow coming up the basepipe from layers below, and the temperature again changes. These two temperatures — Joule-Thomson and axial mixture — along with reservoir properties and well
Reductions in the temperature profile from August to October revealed the layer (pink) where depletion had occurred. From this information, a new flow distribution model was created, and changes to the reservoir management strategy were put in place.

**Improved reservoir management strategy optimizes drainage of secondary oil**

The continuous temperature profiles of individual reservoir zones enabled the effects of differential depletion to be monitored over time. BP improved its reservoir management strategy for water injection and oil drainage—optimizing the drainage of more than 100 million barrels of secondary oil.
WellWatcher System Accessories
Data acquisition, connectivity, power, communication, and analysis

**WellWatcher Ultra** DTS acquisition system
Acquisition unit used with distributed temperature fibers to generate multiple high-resolution temperature logs over the life of a well. Measures up to 9.32 m [15 km] of fiber at a resolution of 3 ft [1 m], updates data in seconds, resolves temperatures to 0.01 degC [0.018 degF], and interrogates numerous fibers from one surface system.

**WellWatcher ArConn** multiwell rack-mountable acquisition unit
Single expandable interface for data acquisition, storage, control, and transmission. Provides power and communication for downhole gauges and interfaces with SCADA and other remote communication and control systems. Monitors multiple well and operation data points.

**RTAC** real-time acquisition and control software
SCADA system for real-time acquisition and control consisting of standard modules for interfacing with Schlumberger downhole tools and other equipment. Allows remote monitoring through a web interface from any PC.
Inductive coupler
Device that enables wireless communication and power to be transmitted between the upper and lower completions. High tolerance for debris and vibration, making the coupler suitable for multistage deepwater completions, where intervention costs and risks are high.

Intellitite* downhole dual-seal dry-mate connector
Field-proven premium connector that maximizes system reliability, even in the harshest conditions by eliminating fluid ingress. Redundant metal-to-metal seals are independently tested at the wellsite using a microleak detection system.

Surface and subsea interface cards
Devices that communicate with downhole equipment via proprietary communications protocol. Compatible with IWIS and all vendor-specific control modules.
Enhanced Production Management
Use data to make informed decisions

The extensive reservoir and production data obtained by WellWatcher system gauges and DTS systems provide a foundation for critical decision-making that helps operators enhance well diagnostics, reservoir performance, and, ultimately, production management. Schlumberger offers petrotechnical services to enhance the workflows available for WellWatcher monitoring systems when you want support for your production management decisions.

- Production allocation
- Productivity analysis
- Inflow profiling
- Pressure transient analysis (PTA)
- Decline analysis
- Transient and thermal recovery analysis
- Completion integrity monitoring
- Skin evolution monitoring
- Intelligent completions management
- Artificial lift system optimization
- Riser temperature monitoring
- Opportunistic pressure buildup capture
- Enhanced bubblepoint and sanding pressure drawdown control
- Improved reservoir pressure history matching

**Pressure transient analysis**

Early water breakthrough requires operators to balance choke adjustments with the stimulation treatment. WellWatcher Quartz high-resolution PT gauges can be placed in a well to provide PTA workflows. These workflows reveal changes in skin and can be used to determine the productivity index (PI) of the well. Understanding the changes in PI enables operators to take the necessary steps to optimize production over the life of the well.
**Unconventional well stimulation**
Using WellWatcher Quartz Extend high-resolution PT gauges in unconventional oil and gas wells to monitor bottomhole pressure helps in identifying significant changes to skin, degradation of fracture size and conductivity, and stress-related permeability behaviors. Proactively analyzing the data enables operators to monitor drawdown during production and the health of the fractures, both of which are important for long-term well performance.

**ESP management**
Downhole pressure and temperature measurements obtained with WellWatcher Sapphire PT gauges can be combined with ESP surface parameters such as variable speed drive frequency to prevent deadheading, which often requires a costly workover and ESP replacement. The data can also be used to troubleshoot other common ESP scenarios that reduce well productivity, such as scale deposition above the pump and loss of pump submergence.

**Inflow profiling**
In fields with stacked reservoirs, where pressure, permeability, and oil and gas characteristics vary greatly between layers, WellWatcher BriteBlue multimode DTS fiber can be run to provide inflow profiling of individual zones. Downhole flow control valves can then be used to manage individual zones independently without costly intervention.