Decipher reservoir behavior in individual reservoir sections of virgin zones for production and development.

Install dual-string, multizone completion with WellWatcher Neon* DTS, DAS, and PT gauge system to gather pressure and temperature data.

Acquired real-time data over the life of the well without intervention and successfully managed zonal flow in the multilayered, stacked reservoir.

Determine zonal allocation in stacked reservoir
An operator was redeveloping an oil field offshore east Malaysia. A well was drilled to explore the deeper layers of the reservoir, for which very little information was available. The multizone sandstone reservoirs were stacked, with some distinct shale barrier separation. Reservoir predictions had indicated that the reservoir layers varied significantly in pressure, permeability, oil and gas characteristics, and zonal flow dynamics. In such multilayered 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. Unfortunately, these techniques often result in deferred production, increased intervention risks, and higher surveillance costs. Distributed temperature sensing (DTS) technology has been available for many years, but recently more efficient and cost-effective alternative deployment techniques have become available. The operator asked Schlumberger to design a DTS system to evaluate the zonal flow and depletion behavior of this reservoir.

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.
Determine reservoir behavior with optoelectric monitoring system
Schlumberger designed a dual-string multizone completion with a WellWatcher Neon DTS, DAS, and PT gauge system that allowed the pressure and temperature of each zone to be monitored individually.

This system expands the capability of other WellWatcher* permanent monitoring systems, which help improve well productivity by identifying trends throughout the producing life of a well or field. The WellWatcher Neon system adds a fiber-optic DTS line to the permanent downhole cable, enabling simultaneous acquisition of pressure gauge data and distributed temperature data. WellWatcher Quartz* premium high-temperature, 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. The system also permitted gas lift performance to be monitored and optimized and potential leak points to be identified along the completion accessories and tubulars because the DTS line was installed all the way to the surface.

THERMA thermal modeling and analysis DTS software was used to analyze the DTS 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 data and calculated data coincided. The data were used to determine zonal flow from individual zones and interpret reservoir layer behavior, including formation petrophysical evaluations, layer pressure communication information from wireline formation testers, well test production, pressure transient analyses, and permanent downhole gauge data. The permanent system eliminated the need for costly interventions and deferred production. Moreover, it allowed uninterrupted surveillance for increased reliability.

Eliminate crossflow and optimize future completion design
The DTS data and analysis of the complex zonal commingled production in the stacked reservoir allowed earlier detection and prevention of internal crossflow zones during well cleanup. Zonal pressure and rate profiling optimized the simple zonal completion design with the downhole zonal sliding side door, which enabled better management of the reservoir layer drawdowns and layer inflow split, thus optimizing reserve recovery. The fiber-optic system eliminated the time-consuming and often risky intervention required for cased hole logging. The data also provided valuable feedback for subsequent completion and production strategies, including the use of surface-controllable flow control valves.

The successful results and the cost-effective operation have convinced the operator to install the WellWatcher Neon system in future multizone wells with complex commingled production.

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