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Formation Testing While Tripping Conducts Successful High-Permeability Interval Pressure Transient Testing

Longer tests and better data than possible with conventional formation testers, pumping large volumes at overbalance, Norwegian Continental Shelf

CHALLENGE

Acquire higher quality data and for longer duration while conducting formation transient testing in highly permeable formations than what conventional wireline formation testing tools can achieve and concurrently significantly improve efficiency while reducing testing costs.

SOLUTION

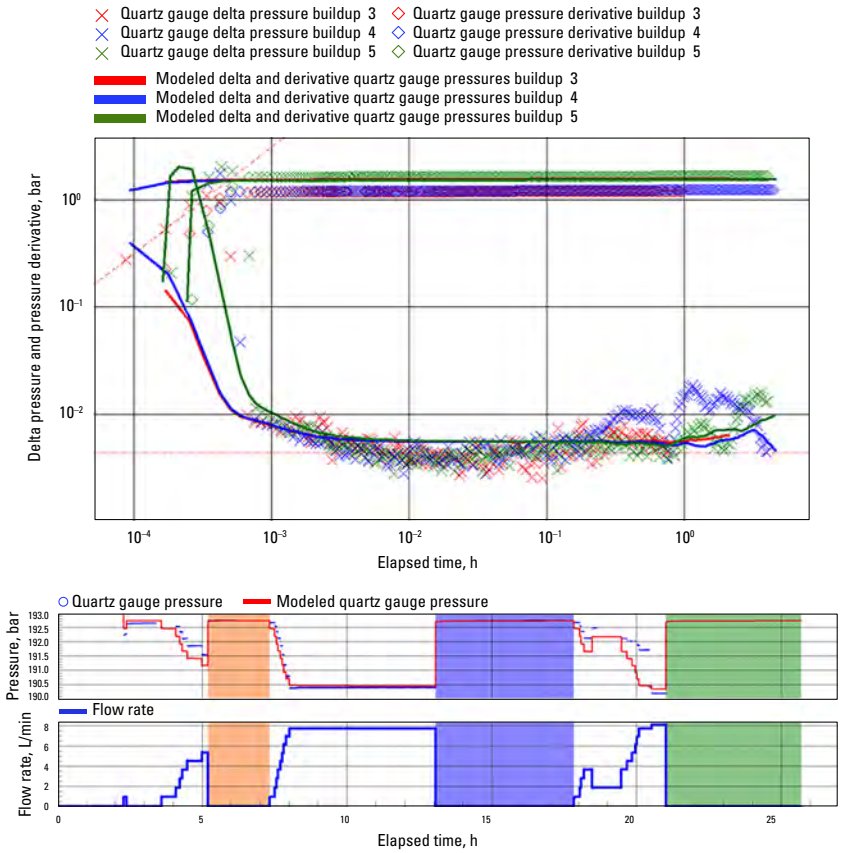
Develop formation testing while tripping (FTWT) technology, which enables conducting interval pressure transient testing (IPTT) at flow rates up to 130 cm^3/s [0.05 bbl/min] to extend the evaluation of reservoir properties to hundreds of meters beyond the wellbore while consistently keeping the well in overbalance as all extracted hydrocarbons are circulated out during the test.

RESULTS

Confirmed a radial flow pattern from a 6-hour test that investigated 576 m into an 11-darcy-permeability sandstone where a conventional IPTT would have achieved only a 200-m radius of investigation.

Formation testing challenges in high-permeability reservoirs

IPTTs in high-permeability reservoirs were not providing sufficient information for an operator in the Norwegian Continental Shelf. Although IPTTs are a proven method for efficiently determining the permeability and permeability anisotropy of formations, they are conventionally conducted with a wireline formation tester (WFT). The maximum flow rate at which WFTs can pump formation fluid limits their use to low- and medium-mobility formations, where enough drawdown can be achieved to produce a measurable pressure transient laterally and vertically for tests involving observation probes. An additional constraint is that only a relatively small amount of fluid—tens to hundreds of liters of formation fluid—can be pumped by a WFT into the wellbore before a wiper trip on wireline is required to maintain well integrity and drilling fluid quality. Furthermore, the radius of investigation is limited to tens of meters, which is usually not sufficient for determining reservoir boundaries and the presence of faults.



As shown in the lower history plots, there were three FTWT flow periods, the longest of which was 6 hours, each followed by a buildup. In the top plot, the radial flow regime was easily determined for the high-permeability reservoir from the extended test duration and high-quality data delivered by the FTWT technique. The overlay of the derivative data of all three buildup periods increases confidence in the data quality. The late-time discrepancy in the derivative data shows some pressure fluctuations caused by ongoing losses in the well. The losses were handled reasonably well by the bypass lines of the system.

High flow rates with new formation testing while tripping

To extend testing capabilities, the operator teamed with Schlumberger to develop a new pipe-conveyed WFT technology that easily manages the high flow rates from high-permeability reservoirs. Flow rates up to 130 cm^3/s [0.05 bbl/min] are achieved by FTWT to pump thousands of liters of formation fluid, making it possible to evaluate reservoir properties hundreds of meters away from the wellbore. The hydrocarbons pumped from the formation to the wellbore are reliably circulated to the surface to be appropriately managed while maintaining well control and drilling fluid quality.

FTWT employs a dual packer or quad packer to isolate an interval for testing or it can be paired with the Saturn* 3D radial probe. The packers isolate single zones or multiple layers for testing. The wellbore-induced noise that interferes with sensitive pressure measurements is significantly reduced because the annular BOP can be closed during testing.

Extended test range through long pumping times

FTWT was deployed in the Norwegian Continental Shelf to conduct an IPTT in a sandstone with 11-darcy permeability. Total station time was 26 hours, and one of the longest flow periods was nearly 6 hours at a rate of 128 cm^3/s. For assumed radial flow, the 6-hour FTWT flow period produced a 576-m radius of investigation, the distance where a 0.01-psi pressure drop could be detected. A conventionally conducted IPTT for 2 hours at 30 cm^3/s would have achieved only a 200-m radius of investigation with that sensitivity.

By achieving a longer transient with FTWT, the operator was able to efficiently investigate deeper into the high-permeability reservoir than was possible with a conventional IPTT.

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