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Saturn 3D Probe Confirms Mobile Oil in Low-Permeability Sakhalin Reservoir at 85% Water Saturation

Reliable fluid identification at 0.1-mD/cP mobility, where conventional techniques are inconclusive

CHALLENGE

Prove the productivity potential for low-water-content oil from a southern development of Piltun-Astokhskoye field in a low-permeability reservoir at >80% water saturation.

SOLUTION

Conduct interval pressure transient tests (IPTTs) with a large-diameter probe and collect low-contamination oil samples for reliable identification by deploying the Saturn* 3D radial probe with its large, circumferential surface flow area that makes it possible to induce and sustain flow in low-permeability formations without requiring the isolation of intervals by using a dual packer, which also has a much larger storage space than the Saturn probe.

RESULTS

Successfully sampled mobile oil from the reservoir at 85% water saturation and 0.1-mD/cP mobility, which was possible because the low-storage Saturn probe enabled unambiguous fluid identification and quick pressure buildup that reduced the risk of sticking.

Sampling and testing challenges in a low-permeability interval

As operator of the Sakhalin-II project in the Sea of Okhotsk off Sakhalin Island, Russia, the Sakhalin Energy Investment Company Ltd. (SEIC) consortium needed to assess the productivity potential of the southern portion of Piltun-Astokhskoye field. Relative permeability correlations suggested that mobile oil with a low water content could be produced from the relatively lower-quality, low-permeability reservoir. To confirm the production potential, low-contamination oil samples were necessary for fluid analysis along with high-quality pressure measurements for pressure transient analysis.

The expected low permeability conventionally required using a dual packer to isolate intervals for testing, but the strong wellbore storage effect produced by the large interval between the packers can adversely affect pressure measurements and compromise sample quality. In addition, setting the packers and the attendant longer pumping times increase the risk of sticking occurring.

Quickly establishing and maintaining fluid flow in low permeability

Even in low-permeability formations, the Saturn 3D radial probe readily creates true 3D circumferential flow around the borehole. Instead of funneling fluid from the reservoir to a single probe, the four self-sealing elliptical ports have the industry's largest surface flow area of 79.44 in^2 to quickly establish and maintain flow from the entire circumference of the wellbore. The compact design of the Saturn probe also minimizes storage volume effects. The result is quicker cleanup times for fluid sampling and the efficient performance of pressure measurements, especially in low-mobility formations where conventional probes cannot function effectively.

The compact drain assembly of the Saturn 3D radial probe reliably seals to the borehole to directly flow fluid from the formation.

Successfully proving mobile oil producibility at 0.1-mD permeability

A toolstring comprising the Saturn 3D radial probe, a large-diameter probe, and MDT* modular formation dynamics tester was reliably conveyed on the TLC* tough logging conditions system in a sidetracked well with a maximum deviation of 77°. To ensure smooth passage through the 5.8-m casing window, low-contact-area standoffs were installed along the toolstring.

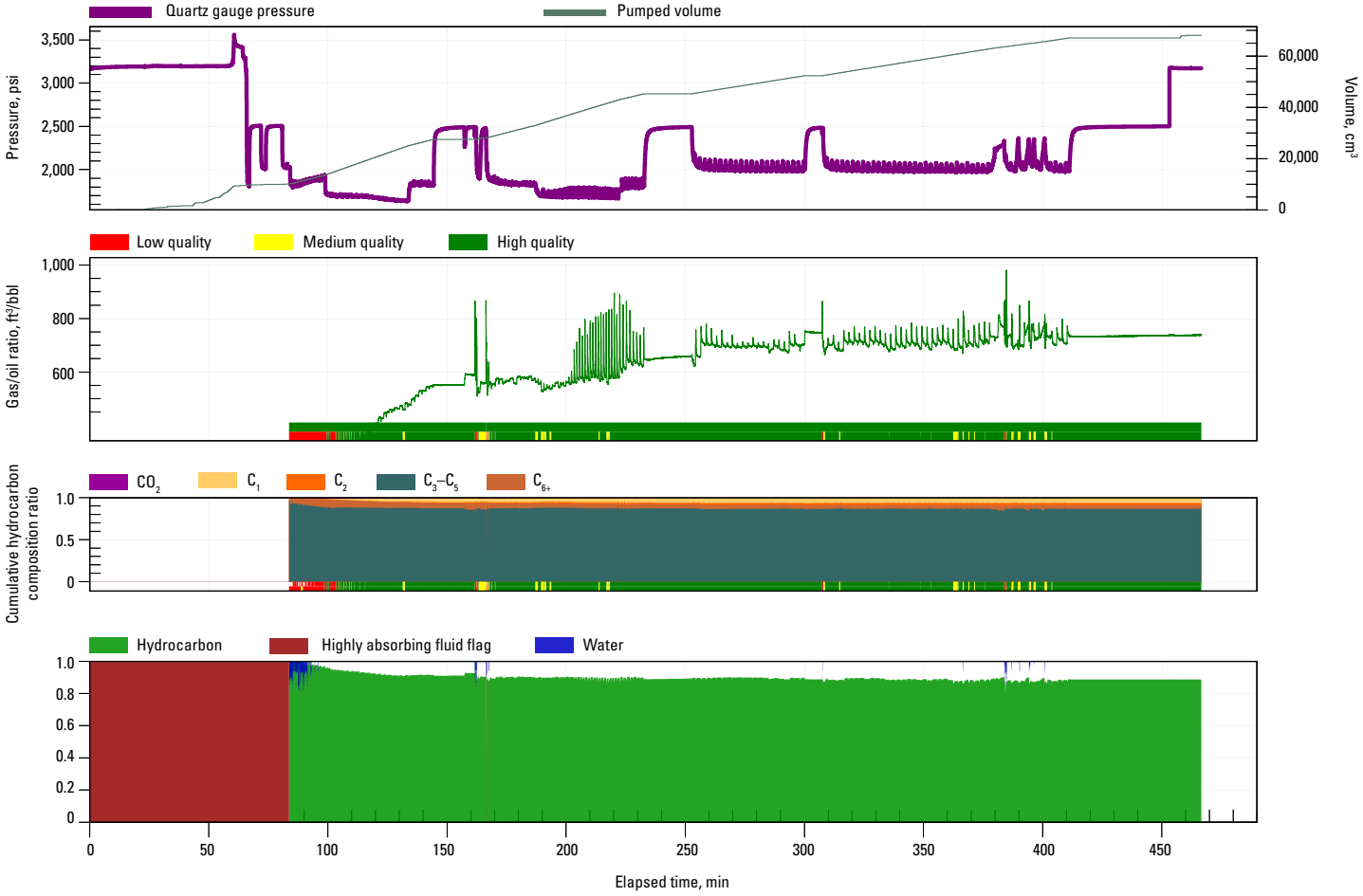
The large-diameter probe was used to conduct IPTTs at each station prior to sampling to determine the mobility. The measurements were used to construct a pressure gradient corresponding to oil at a density of 0.7 g/cm^3 for the interval from 3,924 to 3,940 m.

The Saturn 3D probe readily flowed low-contamination fluid at each of four stations and pumped a total of 274 L of fluid at mobilities ranging from 0.1 to 1,000 mD/cP in 136 h of operating time with zero lost time.

The sticking risk in conditions considered inaccessible with conventional technologies was negligible, even at one station where the Saturn probe's time on station was 9.9 h.

Downhole fluid analysis of the extracted low-contamination oil for hydrocarbon composition, gas/oil ratio, density, and viscosity by the InSitu Fluid Analyzer* system incorporated in the MDT tester proved the validity of the saturation correlation. Mobile oil was confirmed at water saturations as high as 85%.

On the basis of the critical compositional and pressure information delivered in one run of the Saturn probe and MDT tester toolstring, the SEIC consortium was able to better align its approach for development of the southern portion of Piltun-Astokhskoye field.



High-quality samples were efficiently collected from the oil-base mud (OBM) environment of the highly deviated sidetrack well by the Saturn 3D probe at four stations. Monitoring the C_1 composition with the InSitu Fluid Analyzer system clearly distinguished reservoir oil from OBM filtrate, even at permeability as low as 0.1 mD.

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