CASE STUDY

PRODUCTION PROFILE EVALUATION OF HORIZONTAL GAS-LIFT OIL PRODUCER BY THERMAL FLOW, CAPACITANCE & HIGH-RESOLUTION TEMPERATURE ARRAY TOOLS FOR FURTHER OPTIMIZATION OPPORTUNITIES

Location: Africa

Well type: horizontal oil producer.

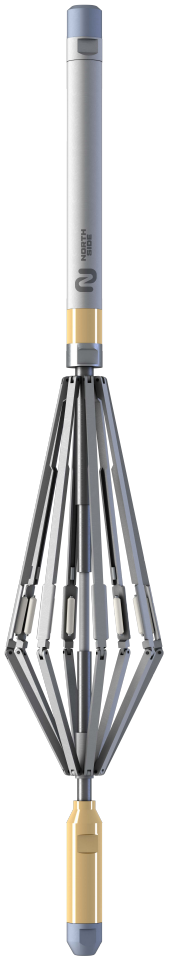
Average production rate: 1,212 bpd

Challenge: Production logging in oil producers with horizontal trajectories is often complicated by segregated flow regimes and different fluid velocities of phases.

Objectives: evaluate the performance of the entire drain hole section of the well and construct the current production profile across the mentioned zone for further optimization opportunities.

Solution: Thermal Flow Array Tool (TFAT) was proposed to estimate the fluid flow inside the wellbore.
Capacitance & High Precision Temperature Array Tool (CAT & HRTAT) is utilized for 3D fluid phase identification and production profile evaluation based on HRT sensors.
The TFAT in combination with the CAT & HRTAT allows the building of a detailed wellbore&reservoir-oriented production profile addressing the segregation of the fluid phases across the lateral section of the wellbore.
Additionally, the tool incorporates FIND technology to verify and distinguish different flow types within the wellbore and reservoir.

ARRAY TOOLS



TFAT

The Thermal Flow Array Tool (TFAT) has 6 miniature sensors installed around the tool circumference on self-centralized rigid arms facing fluid flow at 45° covering the entire cross-section of the wellbore.
The TFAT works on the principle of a thermal anemometer: the sensors are heated-up by the battery current to a temperature higher than the temperature of the surrounding fluid. The fluid flow cools sensors and thereby changes their active resistance, which is inversely proportional to the average linear fluid velocity. Based on the recorded data production profile is calculated.

CAT&HR TAT

The Capacitance & High-Resolution Temperature (HRT) Array Tool consists of 6 miniature sensors installed around the circumference of the tool on self-centralized rigid arms facing fluid flow at 45° covering the entire cross-section of the wellbore. Each sensor includes capacitance and high-precision temperature probes (2 in 1).

T-FLOW (Temperature Modeling)

The math solver allows predicting the heat exchange between the wellbore and the reservoir based on hydro/ thermo-dynamic theory and using as an input a high-resolution temperature data acquired by the High-Resolution Temperature Array Tool. The method provides detailed production profile related to formation flow.

FIND (Flow Identifying Noise Detector)

A low-frequency noise signal is related to wellbore flow response.
A high-frequency noise signal is related to the formation flow response with an ability type differentiation (flow behind the casing, localized/fracture flow, uniform matrix flow/general reservoir flow).

TFT (Thermal Flow Technology)

Measure wellbore flow and create a relevant production profile.

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Results

Two major production zones, at liner shoe and second half of lateral, were detected.

The first production zone is located across the MM liner screen section within 7331.9-7396.5 ft. The mixture of water and oil flow is confirmed by both profiles (temperature-modeled with CAT and TFAT-based). The FIND Channels 3 response reflects flow through screen at low frequency whereas channel 4 captured formation flow behind screen in interval 7370.0-7385.0 ft.

The second production zone related to the MM screen section across 7890.2-8198.5 ft. High-frequency noise anomalies detected by FIND Channel 4 related to the formation flow whereas Channel 3 captured fluid flow through the screen opposite the same depth. T-FLOW and TFAT captured 3 localized production intervals within the second zone. Intervals produce mixture of water and oil.

The first production zone contributes with 63% from total rate, and WC in this production zone is 80.4%. The middle part of logging interval that between depths of 7396.5 and 7890.2 ft doesn't participate to the production. The second production interval is characterized by contribution of 37% from the total production rate and 85.8% of WC.

Major outcomes

- The major production zones were determined
- However, well is characterized by non-uniform production and relatively high WC from both zones