NCS MULTISTAGE | CASE STUDY

NCS MultiCycle frac sleeves breathe new life into legacy waterflood

Quick sleeve closure cut water production in half and boosted oil from 20 to 950 bbl/day

Situation

An operator seeking to improve production in a waterflood field that had been producing for several decades identified reservoir sections that appeared not to be swept effectively by the current waterflood program. Focusing on a high-oil-potential target area that had not been fully exploited, the operator devised a program to improve sweep efficiency. The program called for converting three existing producing wells to injectors and drilling one new vertical injector well. The operator also drilled two new horizontal producer wells, mindful that water-bearing zones above and below the target zone presented a risk of impaired oil production should induced fractures connect to the water zones.

MultiCycle sleeves and pinpoint fracturing

Anticipating the possibility of future water breakthrough issues, the operator completed the new producer wells using NCS MultiCycle® frac sleeves, which can be closed with a simple coiled tubing intervention to isolate problem zones. During stimulation, a frac-isolation assembly was deployed on coiled tubing to locate and open the sleeves sequentially, starting at the toe. At each stage, proppant and fluid were pumped down the coiled tubing/casing annulus. Unlike other stimulation methods, NCS single-point fracturing enables precise control of frac location, frac rate, fluid volumes, and frac growth, greatly reducing the risk of fraccing into the nearby water-bearing zones.

Chemical tracers

The operator also deployed NCS Multistage frac-fluid tracers for both well completions, pumping stage-specific tracers into each of the first 20 stages. Produced tracer concentrations then served as a proxy for water volume, indicating relative water production from the traced stages.

Challenge

When the production wells were brought online, flowback data from the first 20 days revealed dramatically different production profiles. Well #1 behaved as expected, producing 900 BOPD at day 12. By contrast, well #2 oil production was much lower and came in three days later. In addition, casing pressure was significantly higher, and there were indications of significant water inflow somewhere along the lateral. By day 15, well #2 was producing 700 BOPD less than well #1.

Confident that no fracs had breached the adjacent water-bearing zones, the operator sought to understand the reasons for the contrasting well performance in order to prepare a remediation plan.

Laboratory analysis of well #2 production samples revealed high tracer concentrations from stages 16 through 20 at the heel of the well, with stage 18 showing the highest concentration (Fig. 1).

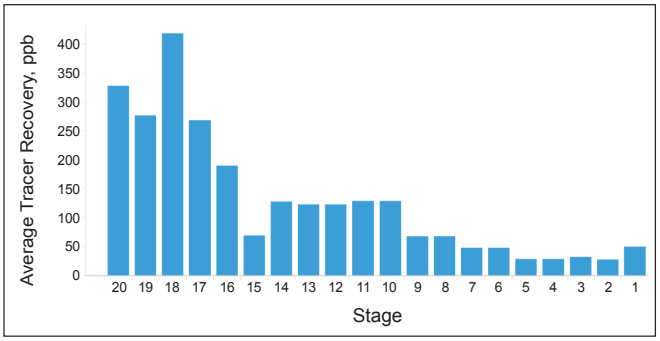

Figure 1. *Water tracer results at 9 days of flowback, before the sleeves were closed, showed heavy water inflow at heel stages 16 through 20, with the highest flow at stage 18.*

A production log confirmed the tracer results, with both spinner and temperature data indicating significant water inflow at stage 18. Finally, a geological review revealed that an offset injector well intersecting stage 18 near the primary fracture azimuth angle was likely the source of the water.

Solution

Based on the tracer and production log results, the operator decided to close the sleeve at stage 18 to promote oil production from the rest of the wellbore. There also was concern about cement integrity at stages 17 through 21 based on an ultrasonic imaging log, so it was decided to close those sleeves, to prevent water channeling to them from stage 18. All five sleeves were closed in a single operation using a standard NCS Multistage frac-isolation assembly deployed on coiled tubing.

Results

After the five sleeves were closed, water production fell by half, and oil production went from 20 BOPD to as much as 950 BOPD before production was interrupted for nine days to install an ESP (Fig. 2). After that, oil production declined steadily to approximately 430 BPOD, well above the initial rate before sleeve closure. Tracer results after the sleeves were closed showed much more even distribution of water production across the rest of the lateral (Fig. 3).

By utilizing NCS MultiCycle frac sleeves, the operator has been able to de-risk new horizontal producers in existing waterfloods where water breakthrough is a concern. For this project, closing the MultiCycle sleeves to shut off water added new inventory and prolonged the life of a brownfield waterflood.

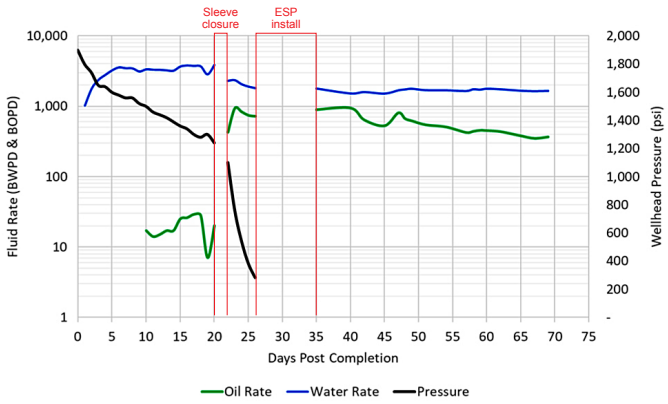

Figure 2. *Well #2 production data shows a dramatic jump in oil production after the five MultiCycle frac sleeves were closed.*

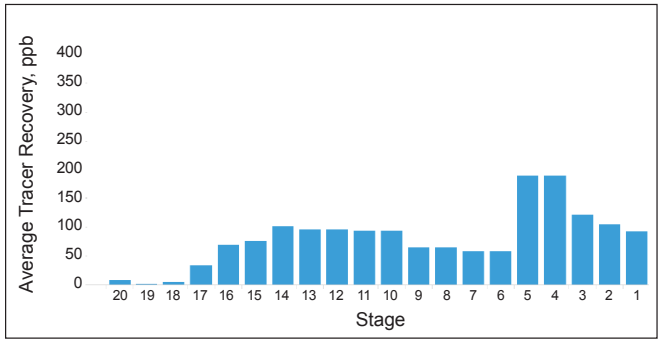

Figure 3. *Water tracer results after sleeve closure showed greatly reduced water inflow in the heel stages. The toe stages continued to show high tracer concentrations because they had not been adequately drawn down when heel-stage water flow dominated production and casing pressure was abnormally high.*

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