

Simultaneously Producing Oil and Injecting Water Saves KOC at Least USD 4 Million

ESP technology with dual concentric tubing completion improves the economics of water injection by eliminating the need for separate wells, Kuwait

CHALLENGE

Reduce drilling and completion costs related to water injection for pressure maintenance of depleting reservoirs.

SOLUTION

Engineer a completion system to enable oil production from one zone with an electric submersible pump (ESP) while simultaneously injecting water from surface into another zone of the same well.

RESULTS

- Eliminated the need for two separate injection wells at a cost of USD 2 million to 2.5 million each, and improved utilization of rig equipment in higher-value work.
- Stabilized production at 2,300 bbl/d with ESP before injection started.
- Injected water into the first two wells without detrimental effects on the ESP or on oil production.



Water injection wells extend field production—at a high cost

Pressure depletion is a common problem for oil wells in mature waterdrive reservoirs and results in reducing oil production. It can also result in additional issues such as increase in unwanted gas and sand production. Usually to overcome this production decline, operators drill additional pressure support wells for water injection.

Drilling and completing injectors incur significant costs and tie up drilling assets that could be used elsewhere to increase production. To reduce costs while improving production, Kuwait Oil Company (KOC) needed a new technical solution in North Kuwait.

Modified ESP completion system provides a solution

Schlumberger proposed to engineer a simultaneous injection and production system based on a field-proven dual concentric ESP system that enables an operator to produce two zones with an ESP for each zone. The modified system would use a concentric tubing arrangement to create two independent flow paths and a single ESP, enabling KOC to produce oil from one zone with the ESP while injecting water from surface into another zone in the same well, saving the cost of an additional well.

Designing this novel ESP system presented several engineering challenges. First, in some KOC wells the production zone is above the injection zone; in others, the zones are reversed. This meant that the engineering design had to be flexible to accommodate both configurations.

Second, the high surface injection pressure would result in high downhole pressures that the completion design would have to accommodate. The pressure profiles would be dynamic, depending on the ESP operation, and result in larger pressure differentials than normally experienced in ESP wells.

Finally, the system would have to be able to operate in three modes: injection only, production only, or injection and production. Each mode would produce unique flow rates, temperatures, and pressures acting on the completion and tubing strings, resulting in significant differences in forces and relative tubing movements due to expansion and contraction.

After extensive tubing stress analysis using Schlumberger TDAS* tubular design and analysis system software, a new stinger with anchor mechanism was designed to maintain the inner tubing string seal even when the outer tubing string moves. Engineers also recommended a longer tailpipe seal assembly to locate into the lower completion and accommodate potential relative tubing movements. In addition, new flow crossover, pod, and cable penetrators were developed to accommodate the expected differential pressures.

Before running the system into the first KOC well, Schlumberger performed a system integration test (SIT) in a test well to verify equipment functionality and optimize the assembly procedure.

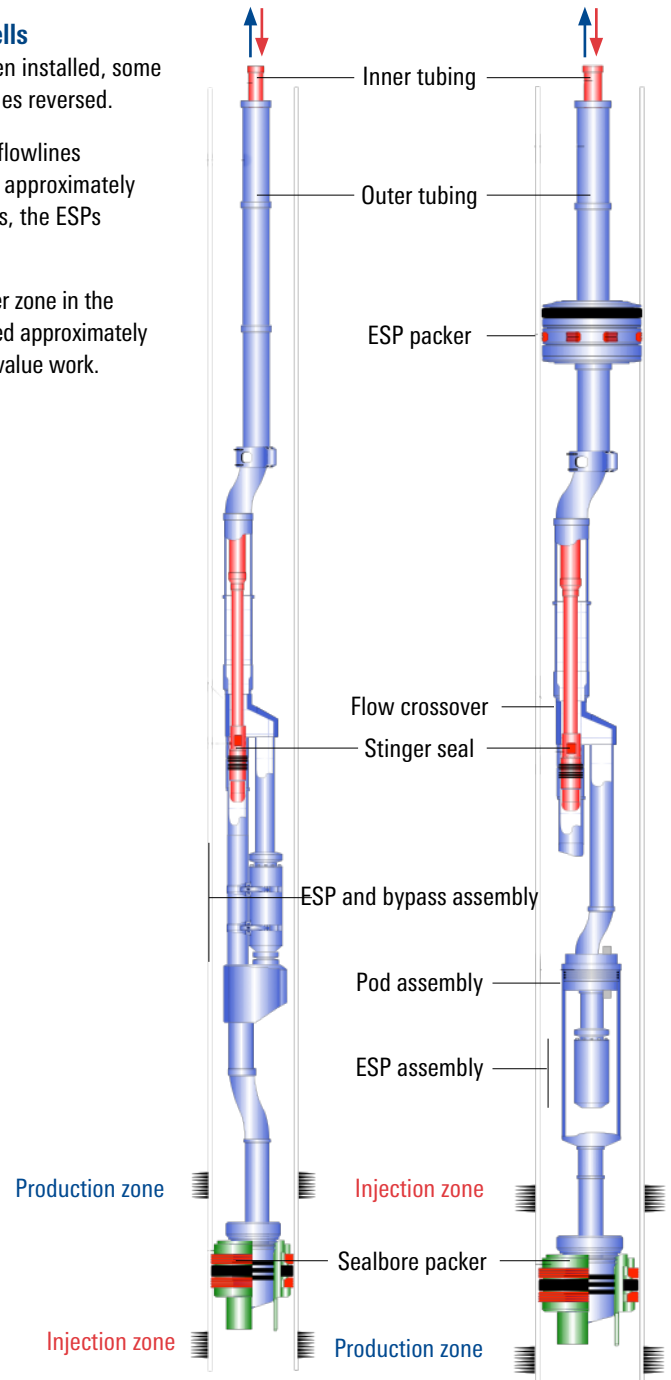
CASE STUDY: Concentric tubing strings and an ESP enable oil production and water injection in the same well, Kuwait

Simultaneous production and injection eliminate dedicated injector wells

The first system was installed in early 2017. Since then, several systems have been installed, some in wells with the injection zone above the production zone and some with the zones reversed.

Initially the systems were operated in ESP-only mode while the surface injection flowlines were installed. The ESPs were operational for 3 months with stable production of approximately 2,300 bbl/d before injection commenced. As injection started in the first two wells, the ESPs continued to operate at the same rate and zonal isolation was maintained.

The system has proved that ESP production with simultaneous injection into another zone in the same well is possible. Eliminating the need to drill two separate injection wells saved approximately USD 2 million to 2.5 million per well and freed up drilling equipment for more high-value work.



Flexible but robust engineering design enables KOC to produce oil and inject water simultaneously in each well, regardless of whether the production zone is above or below the injection zone. As a result, KOC manages reservoir pressure with fewer high-cost, low-value injection-only wells.

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