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First Downhole Water Sink with ESP Improves Oil Recovery and Production Rates for KOC

New technology uses a shrouded ESP to draw water away from the oil/water contact, reducing coning and increasing oil production by 15%, Kuwait

CHALLENGE

Improve oil recovery and reduce water production and coning for a well completed near the oil/water contact (OWC) in a naturally flowing well.

SOLUTION

Install downhole water sink (DWS) technology below the OWC to divert water from oil zone and inject it into a lower aquifer.

RESULTS

- Increased oil production by 15%.
- Reduced water cut from 74% to 70%.
- Extended production of well without artificial lift.
- Reduced water treatment load on surface facilities.

"This pilot application of the downhole water sink technology to this North Kuwait water-driven reservoir opened up immense opportunities for comparable recovery improvements in similar and even larger water-drive reservoirs in other assets within the company."

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Kuwait Oil Company

Water coning reduces oil recovery and increases surface costs

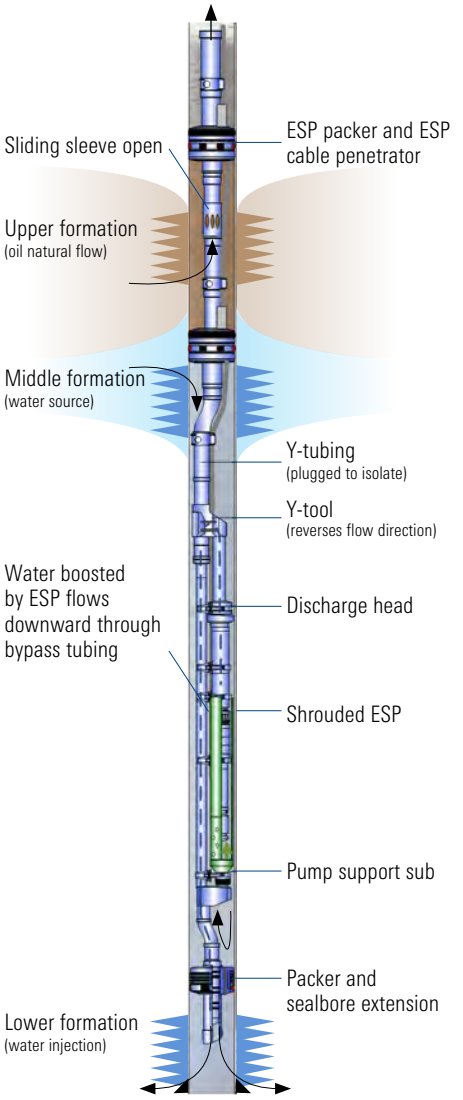
For naturally flowing oil wells with strong aquifer support, one of the most significant challenges for extending productive life is high water production caused by coning. Producing the water too soon reduces net oil production from the naturally flowing well in the long term and increases surface water handling requirements in the short term. Increasing surface water handling capacity incurs additional costs; therefore, production must be limited to sustain production within the limited capacity of surface water facilities.

For Kuwait Oil Company (KOC), the conventional solution to early water production is to partially perforate across the oil column above the OWC and install tubing sized to maximize the natural flow life cycle. However, water cut still tends to increase.

In Well A, only 55% of the oil column was perforated, but production still reached 53% water cut within 6 months and 74% water cut after 4 years. To extend the natural flow of the well, KOC investigated an alternative technical solution.

New technology draws water away from the oil zone

DWS technology improves oil production in vertical or moderately deviated wellbores (<60°) by creating a pressure differential to draw water away from the perforated interval. The fundamental principle of the technology is to create an equivalent pressure drawdown or pressure sink ΔP at or just below the OWC, within the water layer, that is equal to or marginally less than the ΔP across the perforated interval within the oil layer. This drawdown reduces the progression of the water cone into the oil column and is achieved with a high-volume ESP.



Downhole water sink technology created a pressure drop below the oil/water contact, drawing water into an ESP that reinjected it in a lower zone. The technology reduced the water cone, improving oil production and reducing water cut.

The pressure sink creates a preferential flow of bottom water or edge water, parallel to the bedding plane, just under the OWC. The water can then be injected directly into an underlying aquifer or produced to surface for processing and reinjection in a disposal well.

Water cone reverses, improving oil production

Designing the first DWS using an ESP for a naturally flowing well in Kuwait added some engineering complexity. The main challenge was that the well already produced more water than the standard DWS technology was designed to handle. A specialized inverted ESP could handle the additional water, but as a proof-of-concept installation, the completion string for Well A had to be designed with equipment available in country and with standard ESP technology. As a result, the reinjected water flow rate had to be limited to 4,000 bbl/d to minimize the risk of erosion damage to ESP equipment inside the shroud.

Before the DWS system was installed, new perforations were shot just below the OWC (to enable water flow into the pressure sink) and in the lower aquifer (to enable water reinjection). After installation, the ESP was operated for 2 weeks for water reinjection to start water cone reversal before restarting oil production. After full production started, oil production increased by 15% while water cut consistently decreased to stabilize at 70% water cut.

For additional details, see IPTC-18754.

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