Optimized ICD Design Triples Oil Production While Nearly Eliminating Water Cut

SIMULATIONS FINE-TUNE ICD DESIGNS FOR RESERVOIR PERMEABILITY AND WATER PRODUCTION VARIATIONS, RESULTING IN IMPROVED COMPLETION PERFORMANCE

ARABIAN GULF

CHALLENGES

Water breakthrough in two heterogeneous sandstones presented a significant completion challenge to cemented liner completions. Al-Khafji Joint Operations wanted to change to inflow control device (ICD) completions to delay water production, but a tailored design was required to match the characteristics of each reservoir.

SOLUTIONS

To select the best ICD completion for each zone, NETool™ software was used to simulate the performance of various ICD configurations and positions along the completion, and to compare the resulting well productivity.

RESULTS

Optimization of the ICD design for each sandstone reservoir tripled oil productivity compared with offsets, and also reduced water cut by more than 90 percent.

PROJECT OVERVIEW

Wells producing from cemented liner completions in two Al-Khafji field sandstones were quickly watering out. To help the horizontal wells flow at their full potential, the Al-Khafji Joint Operations (KJO) proposed a change to nozzle-based inflow control device (ICD) completions to delay water breakthrough and improve production.

The client used NETool™ software to design the completions by modeling fluid flow through various ICD design configurations. The complex designs considered a wide range of variables, including ICD nozzle sizes, ICD positions along the lateral, water breakthrough from the high-permeability interval, and fluid movements between annuli.

The resulting completion design tripled oil productivity while reducing water cut by more than 90 percent.
The ICD design for Reservoir A was engineered for water control in a heterogeneous reservoir with minimum backpressure. The completed section was not entirely horizontal and exhibited different pressures and higher permeabilities. The NETool model was used to run simulations of various ICD designs in different scenarios, including high water saturation in the high-permeability interval.

The selected design isolated the high-permeability zone and used fewer ICD nozzles than the rest of the horizontal section. The design increased oil production almost three times compared to offset non-ICD wells, and water cut was almost completely eliminated.

In Reservoir B, the design was for a horizontal well with a 270-foot (82-meter) shale section that had to be isolated behind blank pipes, and high permeability at the toe. NETool software was used to analyze variations in drawdown along the horizontal section to determine the best combination of ICDs. Simulations also were run to examine water breakthrough in the high-permeability interval.

The installed ICD design resulted in better influx distribution with improved oil production, along with more than a 90 percent reduction in water production (source: IPTC 17171).

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<thead>
<tr>
<th></th>
<th>Reservoir A</th>
<th>Reservoir B</th>
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<tbody>
<tr>
<td>Water-Cut Range – ICD Wells</td>
<td>0–15%</td>
<td>0–15%</td>
</tr>
<tr>
<td>Water-Cut Range – Non-ICD Wells</td>
<td>60%–64%</td>
<td>&gt; 50%</td>
</tr>
<tr>
<td>Oil Production Rate Range – ICD Wells (B/D)</td>
<td>2,560–2,910%</td>
<td>2,100–6,000%</td>
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<tr>
<td>Oil Production Rate Range – Non-ICD Offset Wells (B/D)</td>
<td>125%</td>
<td>170%</td>
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<tr>
<td></td>
<td>900–1,535%</td>
<td>1,000–1,965%</td>
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The ability to optimize ICD completions yielded a significant performance improvement compared to non-ICD offsets.