Halliburton provided innovative process and comparison for optimizing matrix treatment effectiveness

OVERVIEW

A regional operator in the western United States had several water-injection wells that needed treatment to remove fines and scale that had built up in the near-wellbore pores. Water-injection wells are commonly treated using coiled tubing and a high-pressure nozzle. This treatment helps increase the well’s injection rate. There are two types of nozzles that are primarily used – the rotating-jet nozzle and the pulsating nozzle.

Halliburton recommended its Pulsonix® Tuned Frequency Amplitude (TFA) tool to treat these wells. The Pulsonix TFA tool creates bursts of pulsating pressure waves, enabling pinpoint placement of acid to treat the near-wellbore area and help restore maximum injection. Halliburton treated four wells: two with a traditional rotating-jet tool and two with the Pulsonix TFA tool. The wells treated with the Pulsonix TFA tool demonstrated better long-term performance, proving the value of the technology.

<table>
<thead>
<tr>
<th>CHALLENGE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining injectivity of wells</td>
<td>Pulsonix TFA tool helped increase injection rates</td>
</tr>
<tr>
<td>A build up of fines and scale in the near-wellbore region reduced the rate of injection in these water-injection wells. Halliburton was asked to find an effective and efficient way to penetrate and clean out the near-wellbore region and increase the rate of injection.</td>
<td>The Pulsonix TFA Service penetrates two to six inches into the near-wellbore region, removing deposits from screens, slots, and perforations. Initial injection rates of the wells treated with the Pulsonix TFA tool were almost twice that of the wells treated with a rotating jet.</td>
</tr>
<tr>
<td>Frequent treatments of wells</td>
<td>Pulsonix TFA tool increased time between treatments</td>
</tr>
<tr>
<td>Increasing the cumulative injection of these wells was also a priority. Frequent treatments can be costly, and the operator sought a way to decrease the time between acid treatments to help save time and money.</td>
<td>The Pulsonix TFA tool cleaned out the near-wellbore region with more long-term performance. The wells treated with the Pulsonix TFA tool maintained injectivity longer than wells treated with a rotating-jet tool, increasing treatment intervals.</td>
</tr>
<tr>
<td>Comparing data from different wells</td>
<td>Formula helped normalize results</td>
</tr>
<tr>
<td>Four wells with similar formations and completion histories were treated. However, there were differences that made a direct comparison between a pulsating tool and a rotating-jet tool difficult. A method was needed to uniformly compare results.</td>
<td>An injectivity index formula was created to normalize the results before and after the acid treatment. The injectivity index was calculated as the surface injection rate, divided by the product of the surface injection pressure and the length of the slotted liner.</td>
</tr>
</tbody>
</table>

Operator nearly doubled initial well injectivity with proven fluidic oscillator technology

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Solving challenges™
For an accurate comparison, the results were normalized from each treatment. The “injectivity index” was calculated as the surface injection rate, divided by the product of the surface injection pressure and the length of the slotted liner.

Initial injection rates of the wells treated with the Pulsonix TFA tool almost doubled the initial injection rates of the wells treated with a rotating jet.

The total injection rate of one well treated with the Pulsonix TFA Service increased by 1,000 barrels of water per day (BWPD).
Improving the injection rate of four water-injection wells

The injectivity of water-injection wells can be greatly compromised due to fines, scales and other particles clogging pores or creating a skin in the near-wellbore region. Operators periodically have to treat these wells with acid to increase injection rates. The more frequently these treatments are performed, the more costly it is for the operator.

A regional operator in the western United States had several water-injection wells it wanted to treat and was looking for a cost-effective and efficient way to treat these wells. The operator contacted Halliburton, which recommended its Pulsonix® TFA Service.

Pulsonix TFA Service is a reliable, efficient well intervention method

The Pulsonix TFA tool is a fluidic oscillator that creates bursts of pulsating pressure waves within the wellbore and formation fluid. The tool contains no moving parts, making it extremely reliable and simple to operate. Its high pulse amplitude creates powerful jets for more effective cleaning than rotating-jet tools. The tool, when used with coiled tubing or jointed pipe, penetrates two to six inches into the near-wellbore region. It removes deposits from screens, slots and perforations. The Pulsonix TFA Service is excellent for a wide variety of vertical and horizontal wells, both openhole and cased hole.

Comparing Pulsonix TFA tool with rotating-jet tool

The operator decided to compare the Pulsonix TFA tool with a rotating-jet tool, the other preferred method for near-wellbore cleanouts. However, to do such a comparison would require finding wells with similar histories and formations.

The operator selected four wells in the same field for this comparison test. All four wells had similar reservoir quality, completion methods, production history, and injection history. The wells were completed in thick sandstone, with a similar average porosity. The wells were all drilled vertically and completed with uncemented 7-inch pre-slotted casing. All four were originally oil production wells and recently converted to a water-disposal service. Injection rates in each well had decreased due to fines and scale forming a skin in the near-wellbore pores.
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**Formula helped normalize data collected**

In an effort to create a proper comparison and provide accurate data, an injectivity index formula was created to normalize results. The injectivity index was calculated as the surface injection rate, divided by the product of the surface injection pressure and the length of the slotted liner. This index removed any potential for variations in the injection rate caused by fluctuating wellhead-injection pressures. All four wells received the same acid treatment, two with the Pulsonix TFA tool and two with the rotating-jet tool.

Baseline injection rates and pressures were established over a 200-day period before and after the rotating-jet and Pulsonix TFA acid-stimulation treatments were pumped. The acid design consisted of a typical sandstone mud-acid system. When treated, Halliburton used coiled tubing at the highest rate and pressure possible below frac pressure to place the acid. Therefore, the only difference in the treatment was the type of nozzle used.

**Pulsonix TFA tool outperformed rotating-jet tool**

The results from these treatments showed that the wells treated with the Pulsonix TFA tool performed better than those treated with the rotating-jet tool. Initial injection rates of the wells treated with the Pulsonix TFA tool were almost twice the initial injection rates of the wells treated with a rotating jet. The total injection rate of one well treated with the Pulsonix TFA tool increased by 1,000 barrels of water per day (BWPD), while the best performing well treated with the rotating-jet tool only increased by 400 BWPD. The Pulsonix TFA tool also helped increase the longevity of the acid treatment, increasing the time between applications.

**Test proved effectiveness of Pulsonix TFA Service**

The improved results from the wells treated with the Pulsonix TFA Service proved the tool’s effectiveness. The Pulsonix TFA tool also aided in the placement and penetration of the acid, lowered the amount of fluids pumped down the well and reduced the overall footprint of the treatment. The Pulsonix TFA tool improved the initial injection rates of the treated wells and the time between treatments, helping the operator save time and money.