HiWAY Technique Increases Initial Gas Production Rate by 500%, Reduces Water Volumes By 20%

Flow-channel fracturing technique improves production from tight reservoir in the Ordos basin, China

**CHALLENGE**
Exploit low-permeability oil and gas clastic sandstones to unlock reservoir potential.

**SOLUTION**
Deploy the HiWAY\* flow-channel fracturing technique to optimize reservoir inflow performance by creating infinite-conductivity paths for fluid to flow from the reservoir to the wellbore.

**RESULTS**
- **Improved production** by performing 65 treatments on 7 vertical and 5 horizontal wells.
- **Increased initial production index (PI)** by 2.4 times the field average in oil wells when compared with 180-day accumulated production figures.
- **Increased initial gas production rate** by 4 to 5 times while reducing proppant volumes by 38% and water volumes by 20%.
- **Increased operational efficiency** with zero screenouts.
- **Reduced proppant requirement** by 70% and fluid requirement by 47%.

Exploit low-permeability oil- and gas-bearing clastic sandstones
PetroChina Chang Qing needed to unlock the reservoir potential of and exploit low-permeability oil- and gas-bearing clastic sandstones. The Chang-6 formation usually has a thin barrier between the sandstone layers, and the wells drilled in the formation usually require two fracturing stages performed in the upper and lower layers.

The reservoir’s high heterogeneity quality and limited pressure drive often impacted the hydraulic fracturing performance by reducing the effective hydraulic fracture half-length and fracture conductivity due to partial cleanup. Likewise, the limited reservoir pressure restricted the amount of pressure drawdown that can be created during production operations.

Improve reservoir inflow performance
The HiWAY flow-channel fracturing technique was initiated in the first three vertical and S-shaped wells, which were selected based on the initial well assessment and their proximity to surrounding wells to allow for the proper production comparison.

The successful application of the HiWAY technique within the different oil blocks enabled the final phase of the field trial to be attempted in the gas block. Initially, two vertical and S-shaped wells were selected to evaluate the technology—one with four fracturing stages and the other with three stages. The number of stages was based on the geology and reservoir quality, which included the He-8, Shan-1, Shan-2, Taiyuan, and Benxi formations.

Within the tight gas reservoirs, most of the net pay zones are very thin without a strong barrier that would allow for proper fracture confinement. In some cases, depending on the fracture propagation, there can be fracture confinement issues resulting in higher-than-expected near-wellbore height. When several techniques are compared with the simulated hydraulic fracture geometry using the actual well model, conventional crosslinked gel fracture treatments could result in more height growth in the near-wellbore vicinity and less overall fracture length.

A hybrid design could result in less height growth due to a low-viscosity fluid pumped in the pad stage, whereas the HiWAY technique would enable an increase in the effectiveness of the fracture geometry half-length and reduce the potential screenout due to high leakoff or creation of pinch points. In both load simulation scenarios, the volume of proppant for the conventional and flow-channel fracturing technique was the same, but the hybrid treatment required an increment in fluid volumes.

**Reduced proppant by 70% and fluid requirement by 47%**
The 180-day cumulative production showed that wells stimulated with the HiWAY technique performed better than 85% of offset wells that were completed with the conventional fracturing treatment. The wells completed with the HiWAY technique performed similarly to horizontal wells, yet the average fluid and proppant requirement was 47% and 70% less, respectively.
After all well flowback, production testing was performed for both the conventional fracturing treatment and the HiWAY technique based on a reduced proppant volume design. These results indicated that the HiWAY technique allowed for lower drawdown at a given production rate and higher fracture conductivity or more effective fracture geometry to allow for fluid inflow.

A comparison of P10, P50, and P90 using each stimulation treatment demonstrates that by using the HiWAY technique, performance often exceeds 85% of the wells that are completed with conventional hybrid treatments.

Absolute open flow tests conducted with a 30-mm choke indicate that the two wells stimulated using the HiWAY technique have similar performance to that of an offset horizontal well and product at rates 5 times higher than the field average for offset vertical wells. Likewise, production rates and wellhead pressure under normal production conditions show that channel fracturing wells produce at similar rates to the offset horizontal well and 4.3 times higher than offset vertical wells.

The implementation of the HiWAY technique resulted in substantial material savings for both vertical and horizontal wells. These volumes become significant when there is an operational intensity factor, such as high well counts encountered in a field development program, high fracturing activity as a result of horizontal well completions, or both.