Horizontal Development Optimization through Multi-domain Reservoir Modeling Study: Permian Basin

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Abstract

Objectives/Scope: Horizontal well development for unconventional stacked plays, like the Permian, has been one of the most discussed topics in recent years. There are many variables at play making development optimization a challenge. For this study, an integrated approach through reservoir simulation was taken to understand the optimal development design for an upcoming unit with large parent-child impacts. The lessons learned in this study help understand the impact of drilling child wells offset to existing parent wells.

Methods, Procedures, Process: To fully characterize reservoir development, a good understanding of fluid flow and parent depletion is needed. The study was divided into two parts: 1) test the frac fluid compatibility and fluid flow (using liquid SSK) on core and 2) calibrate parent well depletion through numerical simulation to model different sensitivities for the future infill wells. The numerical simulation included modeling the drainage from the original parent wells (hydraulic fracture and numerical simulation), updating the stress profile from the depletion, hydraulic fracture modeling the future infill wells, and forecasting expected production.

Results, Observations, Conclusions: Frac fluid compatibility testing shows high incompatibility resulting in a completion fluid damage of 70-90%. These results were calibrated by production history matching the parent wells in the study. After accounting for the depletion and resulting stress changes, future infill scenarios were modeled. The original development program was compared with completion sensitivities for multi-well and multi-bench development. During the study, it was found that a unique completion design for different vintages of parent-child depletion is optimal. Several sensitivities for different completion properties were evaluated with and without parent well depletion and will be further discussed in this paper.

Novel/Additive Information: Multi-domain reservoir studies have been well documented throughout literature. The uniqueness to this study is that it used liquid steady-state permeability measurements on core to calibrate the numerical model. This completion fluid damage has been observed in shale plays because of incompatibilities with completion fluids and the reservoir rock. This damage is often overlooked by many in the industry because of the difficulty in the measurement. Calibrating the model with this additional data provides a more useful tool that is representative of field conditions.