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Optimizing Completions in Unconventionals: What We Know Now

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Abstract

During the past decade, there has been a continuing surge in the production of unconventional resources, accompanied with which is the great challenge and opportunities in unconventional resources research. Hydraulic fracturing technique is used to create fractures, enhance permeability and therefore economical production of the unconventional resources. The resulting fractures and their spacing (density) inside the stimulated reservoir volume (SRV) is a key factor in economical production from these very low permeability resources. It is believed that gas production enhanced by increasing fracture density resulted from hydraulic fracturing. However, there is no study about effect of fracture density on production from gas condensate unconventional resources. Eagle Ford shale is considered as one of the most important oil and gas shale plays in North America. In this study, we focused on finding the optimum fracture spacing (density) to maximize the production from the Eagle Ford gas condensate window.

In this study, we modeled a SRV in the Eagle Ford gas condensate window. Based on MICP experiment results and pore-throat size distribution of an Eagle Ford shale sample, the pore volume of the reservoir around the hydraulic fracture was divided into five regions. The physics of multiphase flow of gas and condensate were modified in order to take into account the effect of pore size on phase behavior, permeability and non-Darcy flow and therefore production from Eagle Ford gas condensate window. For each pore size, a specific permeability and PVT properties were assigned. Organic and inorganic pores with different wettability preferences were randomly distributed in the model with activated desorption mechanism in organic pores. We considered fracture spacing of 160ft, 80ft, 40ft, and 20ft inside the SRV and analyzed the effect of fracture density on production.

Results indicated that the non-Darcy flow and desorption mechanisms are absent in the early stages of production where the pressure is significantly high. However, as the reservoir depletes, slip and transition flow occurs, which results in an increase in apparent permeability and the adsorbed phase starts to desorb from the rock surface. Moreover, decreasing fracture spacing from 160 ft to 20 ft increases cumulative gas production. On the other hand, there exists an optimum fracture spacing for condensate production. Low fracture spacing (20 ft) caused more condensate drop-out because of significant pressure drop. Thus, while the general belief is that higher fracture density results in higher gas production, the results of this study revealed that cumulative condensate production decreases for higher fracture densities in long-term production due mainly to the condensate drop out effect.