Multi-Disciplinary Integration for Lateral Length, Staging and Well Spacing Optimization in Unconventional Reservoirs
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Abstract

How long a lateral to drill, how many stages to complete and how far apart to place laterals to optimize recovery and economics are the foremost questions for effective reservoir management in any unconventional play. We present an approach to answer these questions via reservoir simulation on a geocellular model of a micro darcy range tight gas formation in East Texas. Two reservoir simulation models were built from the geocellular model, one to understand internal depletion between the fracs and another to understand the external depletion taking place in the region outside the fracs. Fraccable lateral lengths (distance from first to last port in an open hole completion) from 4000 to 6000 feet with 8 to 20 stages were simulated to understand internal depletion between the fracs. From these simulations we conclude that for this reservoir: 1) incremental recovery decreases as more stages are added; 2) For a set number of stages longer laterals yields more production due to less fracture interference; 3) Fraccable lateral lengths greater than 5000 ft have better IRRs and 4) Highest NPVs are obtained at a stage spacing between 360 and 385 ft. To better understand external depletion, we modelled three wells with the spacing between the middle lateral and two offset laterals increasing from 1000 to 2500 ft in 500 ft increments. From these models we conclude that for this reservoir: 1) ~57% higher EUR could be obtained by increasing well spacing from 1000 to 2000 ft; 2) Well spacing around 2000 ft is optimum; 3) Impact of additional stages is negligible at close well spacing and 4) Mainly internal depletion takes place in the first 3 years followed by mainly external depletion at well spacing greater than 1500 ft. The lessons learnt through this study are being applied to our East Texas assets for effective reservoir management.

Introduction

There are two kinds of depletion taking place in a horizontal well, internal and external depletion. Internal depletion is one which takes place inbetween the fracs and external depletion takes place in the region outside the fracs. For a horizontal well in any reservoir, initially internal depletion takes place followed by external depletion and the extent of internal depletion between stages increases as more stages are stimulated in a well. External depletion is impacted by the spacing between wellbores and the size of the hydraulic fractures pumped. As wells are placed closer to each other the external depletion experienced by each well increases. Thus stimulating more stages in a well and placing wells further apart from each other are possible ways to increase recovery but doing this may result in higher total well costs and this approach may not be the most efficient way to develop acreage. This multi-disciplinary study utilizes reservoir simulation on a geocellular model of the field to optimize well design in a Lower Cotton Valley (LCV) reservoir. The approach presented here could be applied to optimize well design in any unconventional reservoir.

Production and Completion Analysis

To ensure a reliable representative model of the Lower Cotton Valley Taylor sandstone is built, an area of the field was chosen having reliable petrophysical, completion and stimulation data from several wells. The wells differed in their vintages, their stimulation methods and some of the wells were commingled with the Upper Cotton Valley