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Integrated Fracture and Production Modeling Study in the Lower Cotton Valley Sands, Northern Louisiana

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Abstract

The Lower Cotton Valley (LCV) sands in northern Louisian are a complex reservoir system consisting of multiple, low permeability layers. In this area, wells are hydraulically fractured to achieve economic gas production. However, due to the high-stress environment, fracturing pressures are typically very high, in most cases close to or above overburden stress. This presents significant challenges for stimulation effectiveness.

This paper discusses well performance evaluations and possible answers as to why wells are not performing as expected. Possible causes of wells exhibiting steep production declines within the first few months after completion and solutions to improve well performance and well completions as well as field development strategies are addressed. The results of fracture modeling and detailed single-well production modeling are presented.

All wells in the study area show evidence of damaged hydraulic fractures. Potential damage mechanisms are discussed including high production drawdowns and large effective stresses on the proppant in conjunction with high temperature, fracture complexity, dipping fractures, and formation collapse.

Introduction

Figure 1 shows the location of the subject field in Bienville Parish, Louisiana, where the wells involved in this study are located. The target reservoirs are LCV gas sands at depths of roughly 12,500 ft to 17,000 ft (approximately 4,500 ft in gross thickness). **Figure 2** shows a typical LCV sand interval which consists of multiple, low permeability layers. The main productive layers are LCV D1, D2, C1 and C2, which represent lower shoreface deposition. The secondary reservoir layers consist of LCV A and B sands deposited in shallow marine shelf environments. The LCV sands are highly over-pressured and vary from about 9000 psi in the LCV A (shallow interval) to roughly 13,000 psi in the LCV D (deep interval). Pore pressure gradients are estimated to be about 0.7 psi/ft to 0.84 psi/ft. The reservoir temperature is very high ranging from 320 to 425^{o}F. The subject field is bounded to the north by a major normal fault down to the south.

The low permeability LCV sands require major fracture stimulation to produce gas. The completion includes multi-stage cross-linked gel treatments of the principle LCV sand intervals. Each stage targets multiple sand layers with clustered perforations covering gross intervals up to 300 ft. Most wells in the study area exhibit rapid production declines in the first few months. **Figure 3** shows a typical production profile from fractured (vertical) wells. The initial gas rate is about 10 MMscf/day. After producing for about 7 months, the gas rate drops to 3 MMscf/day. **Figure 4** shows the wellhead flowing pressure corresponding to the data presented in Figure 3. Wells typically produce at a minimum surface flowing pressure of 1,000 psi with correspondingly low bottomhole flowing pressures as a result of low liquid yields.

The objective of this study was to evaluate post-frac well performance, provide possible answers as to why wells are not performing as expected, identify solutions to improve the well productivity and develop better field development strategies. A total of twenty-four fracture stages in seven wells were evaluated in this study. All these wells showed rapid production declines after the initial fracture stimulation. Re-fracs were performed in some wells to improve production, but the effort has indicated mixed results.