Integration of RTA Based Reservoir Surveillance and Analytical Flow Simulation to Forecast Production in the Haynesville Shale

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Summary

A comprehensive reservoir surveillance program was carried out in the Haynesville Shale, supporting analytical simulation efforts and developing a new method to forecast future production for this overpressured reservoir where forecasting with modified decline curve analysis is challenging. The key concept involved constraining non-unique history matches through utilizing Rate Transient Analysis (RTA) characterization of the reservoir and completion designs with early well performance to guide subsequent modeling of the reservoir.

The three step approach consisted of 1) identifying observed and anticipated flow regimes through Rate Transient Analysis diagnostics, 2) incorporating these into an analytical model to match production history, and 3) generating production forecasts with the history matched analytical model, with verification by numerical modeling on representative wells.

More than 325 wells with production and pressure data were evaluated. In each well, different flow regimes were identified with rate transient analysis diagnostic plots, capturing the product of the cross sectional area of flow and square root of permeability ($A\sqrt{k}$), time to the end of linear flow (Telf), and the Area of Stimulated Rock Volume (SRV). Petrophysical and geomechanical properties for the model were interpolated for each producer, sourced from a regional 3D geologic model which integrated more than 130 pilot wells with petrophysical analysis and 55 wells with core analysis.

As a result of the integration of geological modeling, reservoir surveillance and analytical simulation efforts a new forecasting methodology was generated and confirmed by correlations between well performance, Estimated Ultimate Recovery (EUR) and $A\sqrt{k}$. Furthermore, an alternative fracture efficiency approach was derived from the Telf and depth of investigation from the linear transient equation. The results of this calculation suggest that previous completion designs generated few, but long fractures, consistent with evidence of frac hits in the field.

Introduction

The Haynesville Shale is a Jurassic aged, prolific gas producer underlying parts of northeast Texas and northwest Louisiana (Figure 1). This deep, dry gas play has a technically recoverable shale gas resource of approximately 75 tcf (EIA, 2011), lies at depths between 11,000 and 13,500 feet, is overpressured with a gradient of approximately 0.9 psi/ft and exceeds reservoir temperatures of 300°F (Wood Mackenzie, 2014). In 2008, Petrohawk (acquired by BHP Billiton Petroleum in 2011) and other operators began to aggressively lease acreage and develop the field (Wood Mackenzie, 2014). Wells targeting this formation are characterized by both high initial production rates and high initial decline rates. In order to optimize recovery, operators, such as BHP Billiton Petroleum, have established robust surveillance programs and studied the effects of choke management, varying lateral lengths, different completion designs, and numerous production styles. The results from these initiatives coupled with an evolving...