SPE 110067

Horizontal Wells in Tight Gas Sands—A Methodology for Risk Management To Maximize Success

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This paper was prepared for presentation at the 2007 SPE Annual Technical Conference and Exhibition held in Anaheim, California, U.S.A., 11–14 November 2007.

Abstract

In general, successful applications of horizontal wells have been limited to high permeability reservoirs and unconventional formations such as coal, chalk, and shale. Conversely, few tight gas sandstone reservoirs that require stimulation have realized sustained success with horizontal completions. One example of such success is the Cleveland Sand of North Texas and Oklahoma Panhandle region. Very recently, some success with horizontals has been observed in the Bossier and Cotton Valley Sands of East Texas and North Louisiana. Horizontal wells are commonly two to four times more expensive to drill and complete than offset vertical wells, yet are theoretically capable of up to three to five times the production. Higher gas prices have lead to potentially better economics for horizontal wells. However, research shows that in practice, many of these wells typically produce only 10 to 30% more than offset vertical wells. With costs more than double those of vertical wells, the economics are obviously unfavorable.

This paper discusses ways to identify and manage risks when planning, drilling, and completing horizontal wells in tight sandstone formations in order to improve success.

Evidence has shown that shortcuts and blanket approaches usually do not work in these completion environments. A multitude of lithological and depletion possibilities exist as risks which need to be identified and managed through appropriate application of integrated drilling and completion technologies. Each risk may require different drilling and completion considerations to succeed. There is simply no magic recipe for repeat success.

A detailed methodology is presented to identify, understand, and manage risk associated with horizontal wells drilled in tight gas sandstone reservoirs. The methodology will address all of the complex subjects that need to be considered for the successful placement and completion of a horizontal well including reservoir description (both static and dynamic), well design, drilling, stimulation, and production. It will also illustrate consequences of what may happen if these issues are not properly considered. Through this methodology horizontal well feasibility and economic results can be determined. If a horizontal well has been determined to be economically viable, this methodology can consistently provide a solution as to what the best completion type (vertical or horizontal) is to recover reserves and enhance recovery efficiency in tight gas sandstone reservoirs.

Introduction

Horizontal wells have had great successes in high permeability oil sands, unconventional gas shales, and carbonates. With the advancement in drilling and completion technologies, there has been a recent trend to drill and complete horizontal wells in tight gas sandstones in North America. Tight rock for this paper will be quantified as sandstone having a permeability of less than 0.1 md. This paper discusses the history and the justification for horizontal wells in tight gas sandstones. It will then go into a broad overview of a methodology to identify and mitigate risk to maximize success when planning, drilling, completing, and producing a horizontal tight gas well. The methodology can be applied to other reservoir types, but this paper will focus on tight sandstone applications.

Background

Looking back throughout history, whenever the gas price has been strong in North America, a pattern evolves. Operators tend to attempt more innovative and inherently riskier investments into natural gas plays which include but are not limited to: new formation plays, varied drilling techniques, and experimental completion attempts. Fig. 1 shows the historical gas price compared with the number of vertical and horizontal wells drilled in East Texas sandstones, including the Travis Peak, Bossier Sand, and Cotton Valley Sand formations.[1,2] In most time periods, favorable gas prices have resulted in rapid growth in horizontal well development, such as the year 2000 on Fig. 1. Unfortunately this has not been sustained when there is a drop in the gas price, as shown by the year 2001. In the twentieth century the technology had not been able to overcome the unfavorable economics associated with these higher risk wells and virtually all operators reverted back to vertical completions. Recent cases suggest that technology is now able to overcome these economic hardships.