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The Successful Application of a Compartmental Completion Technique Used To Isolate Multiple Hydraulic-Fracture Treatments in Horizontal Bakken Shale Wells in North Dakota

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Abstract

Completing the Bakken shale in North Dakota presents options that are varied and complex. To achieve optimum recovery, the Bakken formation needs to be drilled horizontally and hydraulically fracture-stimulated. If the wellbore is drilled in the orientation to achieve a longitudinal fracture treatment, only one fracture treatment is needed and the issue of frac-stage isolation is not an issue. If the stress orientation is unknown, or the wellbore is drilled in the orientation for transverse oriented hydraulic fracture direction, then frac-stage isolation is an important decision. In the past few years, numerous methods have been tried to achieve good frac-stage isolation in the Bakken. A brief review of completion success in the Bakken identifies one method that has the highest degree of success when completing transverse-oriented hydraulic fractures. The best wells have an uncemented liner and a compartmental completion technique. These compartments can be tailored to cover specific areas of the borehole so the treatment is placed near the best shows. The frac compartments are created with the use of swellable external casing packers and ball-actuated stimulation sleeves. In one pumping event, multiple frac-stages are pumped, separated by opening individual stimulation sleeves selectively from the toe to the heel. The completion of two wells are discussed that show positive proof of this concept from a completion and production perspective.

Introduction

The first Bakken production was established in North Dakota in 1953 in the Stanolind Oil and Gas Corp, Woodrow Starr #1 (LeFevre 1991). Since that time, the Bakken has seen several cycles of activity. The first boom was vertical well completions with minimal stimulation. The 1990s saw a horizontal drilling boom with the horizontals in the Bakken shale itself. The current Bakken boom is targeting the Middle Member and/or the Sanish/Three Forks formations for their lateral wells. The completion practice in these horizontally-drilled wells is an evolving technology.

In the past eight years, a plethora of completion practices have been used to complete the horizontal wells drilled to capture oil from the Bakken formation. A brief survey of the available literature published concerning the Bakken formation records the ongoing debate over which completion practice is best. Options include: transverse or longitudinal horizontal orientation; single or multiple laterals; short or long laterals; cemented or uncemented; and openhole or cased-hole laterals. However, the key to finding the best practice in the details of the frac job could be: diversion method; proppants; or fluid types and volumes. It could also be a matter of having the best acreage.

With this variety of options in mind, a study was conducted using publicly available completion data from the North Dakota Industrial Commission, Department of Mineral Resources, Oil and Gas Division, Montana Board of Oil and Gas and production data from HPDI, LLC and Whiting Petroleum. This study only investigated the horizontal Bakken wells drilled since 2000 and included complete data sets for 423 laterals in 301 wells from Montana and North Dakota. The goal of this study was to identify the completion technique that resulted in the best production from the lateral completions. The production metric used in this study was 3-month cumulative, barrels of oil equivalent (BOE) from the maximum producing month. Three month cumulative total fluid produced was also used for some of this analysis. The production metric and stimulation data were normalized by foot of lateral for comparison purposes. The data was further subdivided into nine producing areas that fall in line with the USGS assessment units to evaluate the conclusions of the overall study to location-specific examples.