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Horizontal Well Fracturing: Technology Challenges

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Abstract

Hydraulic fracturing of horizontal wells has played a dominant role in the tremendous growth of the North American energy industry during this millennium. Through mostly trial and error and good engineering judgment we have been successful in producing large volumes of oil and gas from formations that only two decades ago were classified as non-productive and uneconomical. What has made this success possible is the intensity of fracturing operations in horizontal wells. Today, we routinely create tens of fractures in a single horizontal well. Often the number of fractures in a single nears or exceeds one hundred. While our empirical approach and trial-and-error system has proven successful to date, the next step change in our progress requires development of new and more accurate understanding of what goes on during a fracturing process. The large volume of data collected during the many fracturing operations point to several technical challenges. Among them are:

- Fracture dimensions. Field investigation of horizontal well fracturing indicates fractures extending far beyond our present theoretical expectations. With our development philosophy of creating transverse fractures, we often encounter fractures that intersect adjacent offset wells, sometimes more than half a mile away and traversing multiple parallel horizontal wells. In fact, due to high frequency of this occurrence, the standard practice of the industry is to shut-in offset wells while fracturing to avoid flow of fracturing fluid from them. But this situation does not occur in every fracturing stage. This points to significant interaction and possibly interference between fractures created in the same well. The mechanics of this interaction and its effect on production remain a technological challenge.
- Well and fracture spacing. Given the fact of interaction between fractures in horizontal wells, what is the proper spacing between wells, and between fractures in the same well? The correct answer to this question offers huge financial benefits by optimizing the cost of development operations. The general trend of the industry has been towards shorter well and fracture spacing. This practice has proven successful for enhancing the short term well production. But the financial implications are too large for us to have to wait the long term results of trail-and-error approach.
- Fracture design and treatment size. These include fluid types and volumes, proppant types and weights, injection rates, and use of various additives. What has made the decision process more challenging is the wide variety of completion systems in use today. The existing practices are wide-spread and again based mostly on trial-and-error. The technology needed to mix-and-match these variables will have a substantial impact on economic recovery of oil and gas from unconventional reservoirs.