DFIT Provides One Method To Analyze Formation Data

Data collection related to unconventional reservoirs in North America is expanding rapidly. However, for many folks, integrating these data into day-to-day operations sometimes can prove daunting. Like many technologies and industry best practices, there is no shortage of opinions, techniques, and controversy surrounding the interpretation and analysis of this data.

One method of collecting reservoir data commonly used in unconventional reservoirs is the diagnostic fracture injection test (DFIT). As the name implies, this process involves injecting fluid into the producing reservoir at a rate just high enough to create a small hydraulic fracture. This provides pressure fall-off data that can be analyzed to gain information related to in-situ stresses, reservoir fluid flow and pore pressure, to name a few. Essentially, DFIT helps engineers paint a more detailed picture of what is going on down hole, and hopefully will help operators design more optimized completions.

This test has been used for many years. However, as unconventional reservoirs have become the norm, DFIT has played a key role in understanding and developing these unique reservoirs.

In October, I served as a session chair for a Society of Petroleum Engineers workshop titled, “Diagnostic Fracture Injection Test: Processes and Applications.” The first-of-its-kind SPE event was held on the BP campus in Houston, and was led by Prue Smith from BP and David Cramer from ConocoPhillips. The workshop was divided into sessions on job design and execution; theories, concepts, and concerns; data signatures; data utilization; modeling and data integration; and vertical pilot wells.

Each session featured presentations from experts in hydraulic fracturing and data analysis. Since there are varying opinions regarding how the DFIT process is designed, implemented and analyzed, each session stimulated passionate debate regarding individual ideas on what worked and what didn’t.

Day one began with Michael B. Smith from NSI Technologies in Tulsa posing a simple question: “Why are we Doing This?” Smith outlined the traditional information that many folks are looking to obtain when they pump a DFIT. Among these data are fracture parameters such as closure, geometry, and fluid efficiency; and formation parameters such as reservoir pressure and permeability.

Smith suggested that rather than diagnostic fracture injection test, perhaps DFIT should stand for diagnostic formation injection test, since the formation really is what engineers are interested in evaluating. He contended that if one was looking for closure pressure, performing a DFIT on an unconventional reservoir really was not necessary. He said injection pressure could be found with a simple five-minute injection test, and that pressure analysis often was negated by multiple fractures, lack of measured bottom-hole pressure, and near-well tortuosity. He said fluid efficiency was not important for designing water frac treatments.

Smith went on to argue that the critical data were system permeability, reservoir pressure, and any indications of stress-sensitive natural fissure permeability, asking, “Are our test procedures masking these critical data?”

He then outlined case studies suggesting that conducting a DFIT in an open-hole environment could provide more favorable results, avoid lost data, and provide indications of natural fissure permeability.

Later that day, Robert D. Barree from Barree & Associates in Lakewood, Co., presented “DFIT Data Signatures: Welcome to the Real World.” Barree highlighted multiple case studies on DFIT signatures and their interpretation. Using examples, he discussed identifying instant shut-in pressure and the fracture extension gradient, as well as wellbore compression and blowdown effects on pressure decline. Later, while looking at the G-Function plot, he asked what “derivative hump” meant, and whether it was caused by some sort of wellbore mechanism.

Additionally, Barree looked at some potential causes of G-Function “derivative belly” shape. Finally, he discussed after-closure analysis, looking at pore pressure in linear and pseudo-radial flow, as well as determining reservoir transmissibility.

Finally, in a presentation titled, “Applying a Discrete Fracture Network Simulator to Understand Non-Ideal DFITs and Fracture Closure,” Mark McClure of McClure Geomechanics discussed simulation work he conducted with Hojung Jung and Mukul Sharma from the University of Texas at Austin, and Dave Cramer and Sean Oakes from ConocoPhillips. In this project, researchers compared detailed numerical simulations of DFITs with field data. While the group achieved a close match to the field data before, during and after closure, McClure said they were surprised to learn that using conventional methods to pick closure were not accurate, compared with the simulation.

These were only three of the many quality presentations provided at this important event, and while there were many disagreements over the course of the workshop, the discussion around this topic definitely will propel this event forward as one of the more important events to attend in the coming years.

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