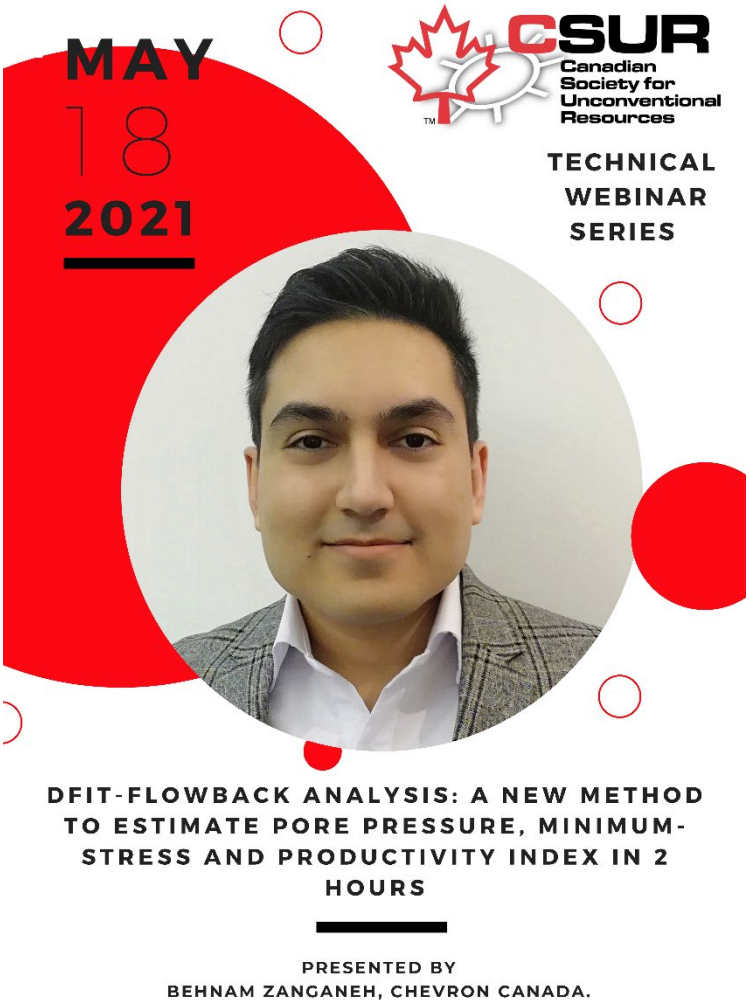
May 2021 – CSUR Technical Webinar #2

DFIT-Flowback Analysis: A New Method to Estimate Pore Pressure, Minimum-Stress and Productivity Index in 2 Hours



The unconventional sector, and indeed the entire energy sector, continue to innovate and potentially find better ways of conducting their operations. This is also true for the Diagnostic Fracture Injection Test (DFIT), which has typically utilized an injection / falloff design for both heavy oil (cap rock integrity) and shale & tight reservoirs. With sustained focus on optimization or finding more effective ways of conducting this type of testing for tight & ultra-tight reservoirs, our presenter for May 2021's 2nd Technical Webinar, Behnam Zanganeh (Ph.D.) - Reservoir Engineer with Chevron Canada, provided in depth details of a new DFIT Technique that he and his team at the University of Calgary's Tight Oil Consortium (TOC) designed, developed and have field tested (initially in 2018). Since then, over 30 field tests have been conducted using this technique in several unconventional shale / tight reservoirs.

During his presentation, the speaker first reviewed the mechanics of a conventional DFIT (injection / falloff) and the impetus behind the new design. He indicated that the main drawbacks to conventional testing were potentially long test durations, costly operations, and continued test interpretation debates (minimum in-situ pressure or Sh_{min} picks for example). The alternative procedure proposed by the speaker incorporates an immediate controlled flowback period after the injection period. Although this technique leads to the loss of critical after-closure data, including the capability to directly estimate the matrix pore pressure, the speaker suggested that this design results in more representative Sh_{min} values compared to conventional DFIT results.

In lieu of the missing falloff data, the alternative design (DFIT-Flowback) method calls for an analysis of the flowback portion (rate & pressure data or rate-transient analysis) to estimate reservoir pressure and productivity index (which can potentially be used to calculate transmissibility or permeability). However, the speaker noted that this evaluation, like with conventional DFIT work, is reflective of only the portion of the wellbore that was tested. As such, this quick injection-flowback analysis method could be conducted at several points along the lateral to identify "sweet spots" for

subsequent completion operations or to specifically design a completion for each interval along the horizontal wellbore. The rapid DFIT data could also be used to ascertain the stress and pore pressure profile for frac containment purposes. In addition, this alternate method could be employed in a vertical well to identify a target layer for the lateral section by conducting a sequence of quick DFIT-Flowback tests at different depths.

For the final portion of his presentation, Behnam illustrated the benefits of this technique using a series of field examples and how the specific objectives of each field case were fulfilled by designing the appropriate alternate test (DFIT-Flowback) procedure. Where available, he compared the in-situ stress and reservoir pressure estimations from both analyses (conventional vs. DFIT-Flowback). Generally, the results were well within test measurement and interpretation accuracy. Therefore, as indicated by the speaker at the onset, the main advantages of this methodology appear to be time and cost effectiveness. The analysis and critical frac & reservoir parameters can be obtained in a matter of hours (especially if real-time testing is utilized) and likely at a lower cost!

Summary

Diagnostic Fracture Injection Tests (DFITs), which are a sequence of injection-falloff, have become commonplace in unconventional shale and tight reservoirs to obtain parameters used in hydraulic fracturing design, geomechanics and reservoir characterization; including closure pressure, a proxy for minimum in-situ stress, reservoir (pore) pressure and transmissibility. The main issue with conventional DFITs, specially with regards to estimating pore pressure, is long test durations that range from days to weeks or months.

The author has recently introduced a new procedure and analysis method to address this issue. The new procedure, DFIT-Flowback Analysis (DFIT-FBA), consists of two steps: 1) injection to initiate and propagate a mini hydraulic fracture and 2) immediate flowback of the injected fluid on surface at about 5% to 10% of the injection rate using a choke management system. The well flowing pressure and flowback rates are monitored throughout the flowback period. Rate Transient Analysis (RTA) methods are then applied to the flowback data to estimate pore pressure, closure pressure and well productivity index.

In this presentation, the analysis method is presented. The practical application of DFIT-Flowback in exploration and development of unconventional resources is demonstrated with several published field trials. The overall test duration is only few hours, making it very time and cost effective; and reduces the total cost significantly. The new method helps operators in characterizing the formation without delaying the hydraulic fracturing operations and development plan.

PRESENTER: Behnam Zanganeh, Chevron Canada.

Behnam Zanganeh is a reservoir engineer with Chevron Canada. He holds a PhD degree in petroleum engineering from the University of Calgary, and an MSc in petroleum engineering from the University of Alaska Fairbanks. His technical expertise and interests include pressure and rate transient analysis, hydraulic fracture modeling, reservoir simulation and diagnostic fracture injection tests. He has authored over 20 technical papers and presentation on these topics.

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