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Integration of Post-Fracture Pressure Decay Analysis with FDI and Microseismic Data to Evaluate Montney Well-to-Well Interactions

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Introduction

Post-fracture pressure decay (PFPD)[1-5] refers to the pressure decline data collected after hydraulic fracture stimulation at each stage of a multi-fractured horizontal well (MFHW) (**Fig. 1**). This data is routinely gathered, offering a cost-effective way to characterize reservoir and hydraulic fractures at the level of individual stages. The pressure signature during the falloff period is controlled by a combination of changes in leakoff rate and system stiffness. Depending on the length of the falloff period, various reservoir and fracture properties can be extracted from the flow regimes (or flow "zones") observed during pressure falloff. This work aims to compare PFPD results with Microseismic (MS) and Fracturing-driven interactions (FDI)[6] data, with a particular focus on fracture half-length, and to evaluate stage connectivity (Parent–Child or Child–Child) using PFPD analysis.

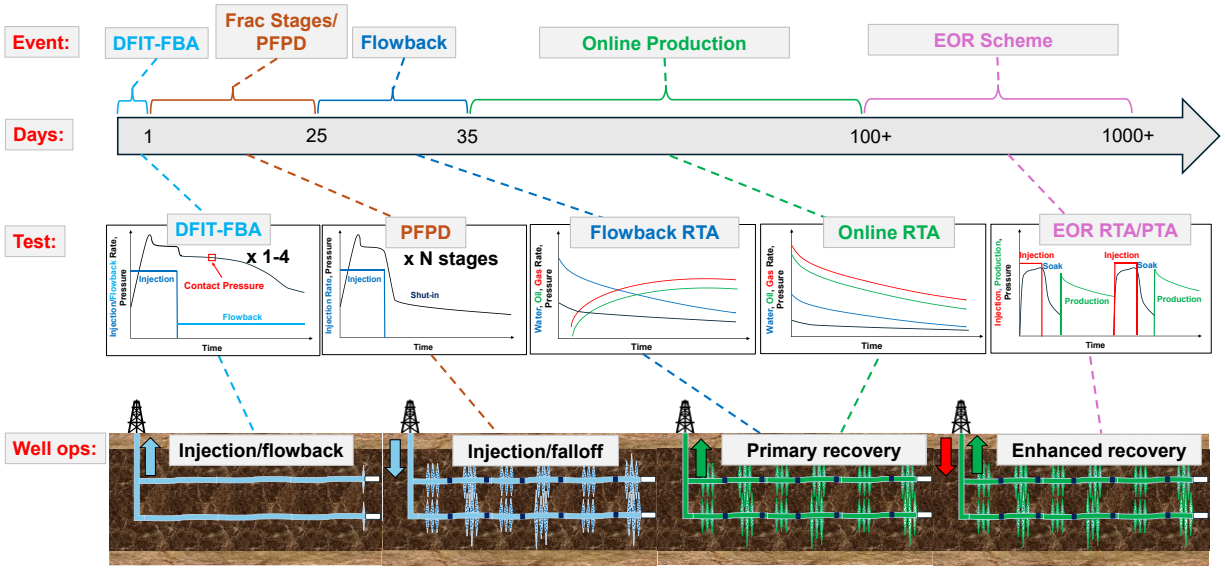


Fig. 1—Full life cycle of a multi-fractured horizontal well (MFHW) completed in a tight oil reservoir, including a possible EOR scheme after primary production. Testing may be performed at various stages of the well life to inform future (well and field) development decisions. Note that multiple MFHWs are often drilled from the same pad, targeting multiple layers (benches) in a reservoir. Communication between wells is commonplace, which may complicate analysis of these tests. Modified from Clarkson et al. (2025)[2].

Theory / Methods / Workflow

There are up to four zones that can be identified (using pressure derivative methods) for PFPD performed in MFHWs with propped hydraulic fractures[1-5]. Zone 1 represents leakoff from an open fracture; Zone 2 represents closure on proppant; Zone 3 represents leakoff from the unpropped portion of the fracture; Zone 4 represents an unpropped closure event followed by formation flow

regimes. Analysis of Zone 1, Zone 3, and Zone 4 to determine reservoir permeability, fracture half-length, total fracture area, unpropped and propped fracture areas, and pore pressure was previously demonstrated using straight-line analysis methods applied to Montney Formation (Canada) and Permian Basin (USA) wells[1], and the injection and production wells at the Utah FORGE EGS site[2]. The latter study provided some insights into the effect of FDIs on the results of PFPD analysis. The production well at Utah FORGE was hydraulically fractured at the point where FDIs (caused by injection well stimulation) were observed, and the resulting PFPD analysis yielded elevated reservoir permeability estimates (compared to the injection well), suggesting that the fracture system in the production well is connected to the fracture network created from the injection well. This observation suggests that the PFPD technique can be used as a diagnostic tool to evaluate connectivity between stages/wells. This study continues to investigate the impact of inter-well connectivity on PFPD analysis, with a focus on the Montney Formation. Zone 1 analysis was performed for multiple Montney MFHWs to determine the impact of stage communication on reservoir permeability and fracture half-length.

Three Montney wells were analyzed for this study: Well A was completed in 24 stages, Well B in 21 stages, and Well C in 21 stages. Multiple DFIT-FBA tests were conducted along the lateral and at the heel in wells A and B to estimate reservoir pressure and the minimum in-situ stress, both of which are necessary for straight-line analysis (SLA)[1-5]. Both MS and FDI data were collected to better understand fracture geometry, fracture growth behaviour, and well-to-well communication during hydraulic fracturing. DarkVision[7] was also implemented; this method offers direct near-wellbore visualization to evaluate cluster efficiency.

Results, Observations, Conclusions

Zone 1 was observed for the majority of the stages in the studied Montney wells. Using DFIT-FBA to constrain estimate of reservoir pressure and minimum in-situ stress along the laterals, fracture half-length and reservoir permeability could be estimated confidently for most stages in the three wells.

For stages without FDIs, fracture half-lengths derived from PFPD were in good agreement with MS. In contrast, for stages with observed FDIs, PFPD estimates of reservoir permeability were elevated due to connections with adjacent well fracture networks; these results are also supported by MS and are consistent with the findings of the Utah FORGE study[2]. For Well A, where there is overlap with the offsetting parent well, derived permeabilities are noticeably higher, suggesting stronger connectivity with the parent well. Wells A and B, which were completed in the same layer (bench), demonstrate strong inter-well connectivity as evidenced by fracture half-lengths that exceed the well spacing.

Novel/Additive Information

This study demonstrates that PFPD analysis can be confidently used as a diagnostic tool to confirm well-to-well connections, offering valuable insights for hydraulic fracture design and optimization.

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