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Flowback to productivity: semi-analytical tools for predicting well performance in tight reservoirs

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Summary

Quantitative characterization of flowback dynamics is essential for evaluating multi-stage hydraulic fracturing, yet remains challenging due to multiphase interactions, reservoir heterogeneity, complex geologic features, and varied completion practices. Can flowback data reliably predict well performance? Does choke-size management during flowback influence long-term productivity? This research introduces a semi-analytical workflow as an early-time diagnostic tool that leverages two-phase flowback data to: 1) assess water recovery and completion efficiency, 2) define new metrics for flowback recovery efficiency, and 3) establish correlations between recovery efficiency, choke management, and long-term well productivity.

Theory / Method / Workflow

We analyze 5,500 MFHWs in the Montney and Cardium Formations. Rate-normalized pressure (RNP) diagnostics classify wells by formation-water mobility. A semi-supervised clustering workflow groups wells by completion intensity based on stage count, injected water, proppant concentration, and cluster density. For each cluster, flowback recovery is evaluated using a power-law relation between cumulative water and oil production. Two characteristic parameters are defined: α (initial cleanup volume) and β (cleanup efficiency exponent). Diagnostic plots correlate α–β with load recovery, GOR, first-year hydrocarbon rates, and ultimate recovery. Finally, α and β combine into a flowback performance index (FBI) to quantify cleanup efficiency and its optimization through choke-size management.

Results, Observations, Conclusions

Over 60% of wells show negligible matrix water influx, indicating a pseudo–steady-state flow and a closed-tank system for fracturing water. Across all completion clusters, α and β exhibit an inverse relationship, confirming that initial cleanup influences recovery efficiency. The α–β diagnostics identify optimal α and β values correlated to higher load recovery, GOR, and hydrocarbon productivity as shown in **Figure 1**. Load recovery shows an asymptotic response with increasing FBI, approaching a plateau that marks transition from fracture- to matrix-dominated flow, where early plateau behavior signals water trapping. Choke-size analysis reveals a bell-shaped relation with FBI and normalized productivity, defining an optimal choke range that enhances long-term performance and varies with completion intensity.

Novel/Additive Information

This study introduces diagnostic plots that correlate α–β characteristic parameters with key well performance indicators. FBI is proposed to quantitatively assess cleanup efficiency during early flowback and to serve as an early performance diagnostic, highlighting its correlation with choke-

size management. These tools establish a direct link between early two-phase flowback data, completion design, and long-term productivity. By integrating recovery dynamics with completion practices, the workflow provides petroleum engineers with actionable diagnostics to optimize hydraulic fracturing operations and improve well performance.

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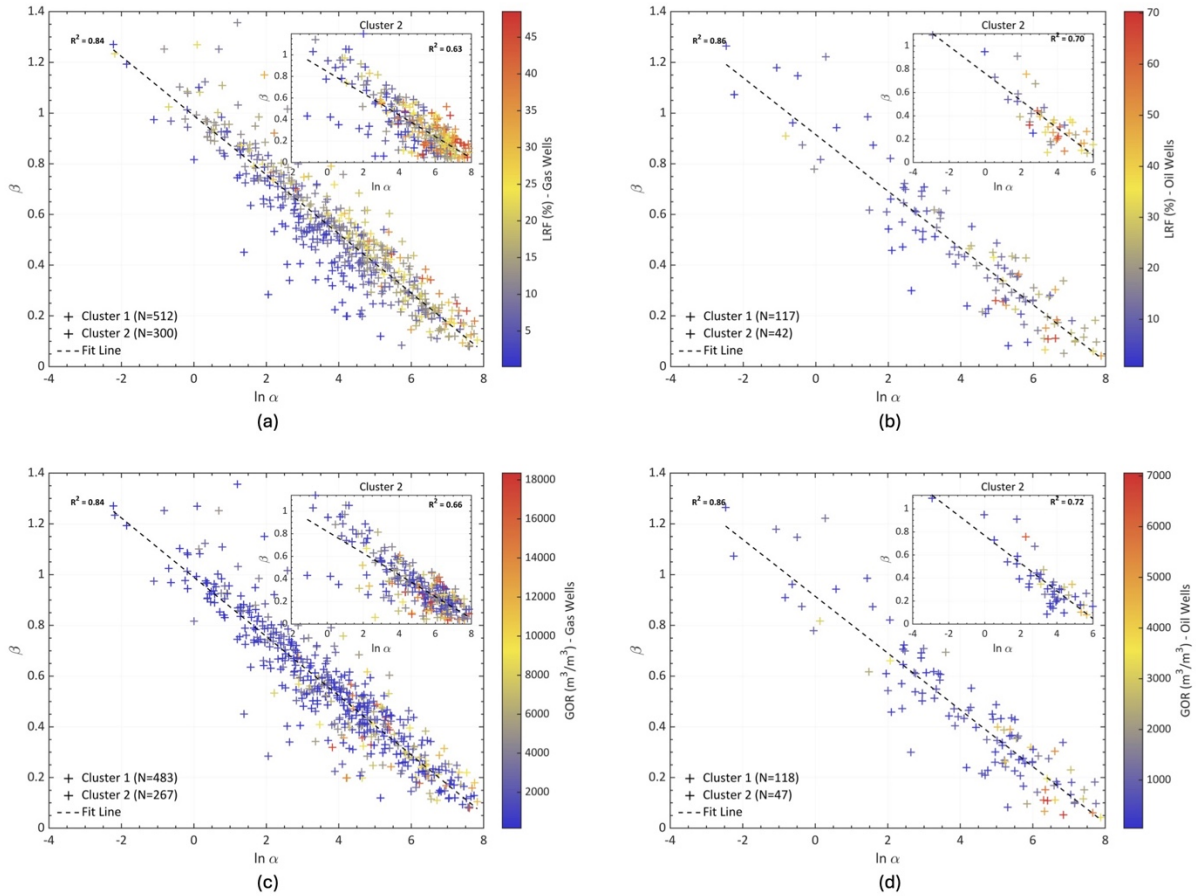


Figure 1 - Diagnostic plots for Montney wells by fluid type (gas: left; oil: right). **(a–b)** colored by Load Recovery Factor, show wells concentrated in the bottom-right quadrant with higher recovery. **(c–d**) colored by flowback-period GOR, indicate that stronger stimulation and faster cleanup correspond to higher GOR and earlier hydrocarbon breakthrough.