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Multivariate Analysis Using Advanced Probabilistic Techniques for Completion Design Optimization (SPE – 185077)

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Summary

A multivariate analysis methodology for completion optimization was developed to identify key input parameters and visual patterns that communicate the nuances of production performance correlations and how they change over the range of input values. This methodology was suitable for testing any input's impact on a performance measure, for all play types and scalable for datasets of greater than 1000 wells down to as few as 80 wells.

Introduction

Efforts to identify optimal completion technology and design parameters are complicated by the compounding impacts of broad statistical variability in operations, reservoir/fluid and completion/wellbore design. There are several analysis approaches available to identify and optimize key completion design parameters. Each approach offers limited insight on its own, but combining a set of approaches into a disciplined methodology can collectively present a unique understanding of optimal completion technology and design. Traditional parallel coordinates visualizations offer strong visual cues of correlations, but in datasets with broad statistical variability they often convey a lack of correlation and fail to distinguish statistical trends. Statistical methods are unique in their ability to provide insights into non-continuous correlations where upper and lower thresholds exist; however, they are not effective at providing a deterministic measure of an individual input's effect on an outcome. Modelling and regression analysis can provide a means to measure the effect of several input variables on an outcome, but lack transparency and are often perceived as a "black box" solution with outcomes that have limited supporting evidence, or supporting evidence that is difficult to understand.

Theory and/or Method

We demonstrate a robust multivariate analysis methodology using a hybrid approach involving the principles of parallel coordinates, dimensional normalization and advanced probabilistic techniques. One of the benefits of this approach is that it can yield statistically significant insights on sample sets as small as 80 wells. The methodology involves six steps that offer transparency to the analysis and facilitate a narrative of understanding:

1) Selection of a performance measure set
2) Analogue well selection
3) Selection of numerical completion design input parameters
4) Parallel Coordinates Distributions: input parameter impact analysis
5) Evaluation of analogue fitness and subset selection
6) Input Optimization Distributions: input optimization process

Examples

In this paper we apply and test this methodology on three major resource plays in the Western Canadian Sedimentary Basin: a gas play, a liquids-rich gas play and an oil play.

Conclusions

We found that appropriately understanding the dependencies between inputs can dramatically reduce the number of inputs that need to be considered. The use of consistent dimensional normalization on both inputs and outcomes better isolates the impact of an input parameter. The shape and position of distributions can illustrate nuances of impact that are lost in other multivariate approaches. The methodology was suitable for testing any input's impact on a performance measure, for all play types and scalable for datasets of greater than 1000 wells down to as few as 80 wells.

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References

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