Shale Gas and Light Tight Oil Reservoir Production Results: What Matters?

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ABSTRACT
Shale Gas and Light Tight Oil plays have revitalized the oil and gas industry in the United States by bringing in wells on land with production numbers unheard of for decades. It seems well understood even by many lay people that horizontal drilling and hydraulic fracturing are key technologies required to produce results. However, there is much more to be considered in maximizing production from unconventional wells.

Large scale data-mining projects performed on such reservoirs as the Barnett gas shale and the Middle Bakken oil play have been used to identify key variables that drive production results. Such variables include reservoir quality proxies, along with well architecture, completion, stimulation, and sometimes production practice parameters. The work has evolved from single-variable statistics using spreadsheets and cross plots to map-based Geographic Information System (GIS) analysis combined with multivariate statistical modeling using multiple linear regression and boosted-tree models.

Key conclusions are that variation in reservoir quality is one of the main drivers in both tight oil and gas shale. Beyond that, operational practices matter, from well completion to stimulation treatment parameters. The presentation will show highlights of key lessons learned in the different studies.

KEY WORDS: Barnett; Bakken; data mining; hydraulic fracturing; unconventional reservoir; shale; production

INTRODUCTION
Successfully drilling, completing, stimulating, and producing an unconventional oil or gas well is a complex task, and many individual geological and engineering decisions must be made along the way. The consequences of certain of these decisions have the potential to yield results ranging from very profitable to economic disaster. The purpose of the work on which this paper is based is to identify the relative influence of the different known and measurable variables that impact shale gas and light-tight oil production results.

The work focuses on two legacy unconventional plays. The first is the Barnett Shale of the Fort Worth Basin, near Fort Worth, Texas. The second is the Middle Bakken play in the Williston Basin of Eastern Montana and North Dakota.

Data-mining techniques spanning the range of spreadsheets and cross plots for univariate statistical analysis to geographical information systems (GIS) mapping applications, to full multivariate statistical analysis have been used to attempt to answer the question of, “What geological and engineering parameters impact production results?”

Short-term production proxies, variously including best month’s gas or oil production, normalized cumulative production, and production decline rate are used as the metrics to determine the influence of the different independent variables on the outcome. Some parts of studies used production efficiency metrics, such as production per foot of lateral length and production per unit mass of proppant pumped in stimulation. The major categories of independent variables in unconventional reservoirs have been systematically divided into reservoir quality, drilling, completion, stimulation, and production practices.

Data were gathered from publicly available sources, particularly IHS Energy’s US Well database. The North Dakota Industrial Commission’s (NDIC) database was also used to gather some of the data on the Bakken formation. These data were quality controlled and suspect data flagged prior to GIS and statistical modeling. Combinations of analyses were used to obtain insights into key production result drivers that were difficult or impossible to adequately interpret using single-variable methods.

Conclusions drawn from studies on the Barnett and Bakken Formations are that reservoir quality is the most important factor influencing production results. Well architecture and completion variables such as stage length may also impact production quite significantly. Stimulation parameters such as treatment size, injection rate, and materials may have varying degrees of influence on the outcome.