A Novel Method for Analysis, Prediction and Control of Directionally Drilled Wellbores using Mechanical Specific Energy

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Abstract

The presentation covers work completed at Texas A&M University and presented in SPE paper 170979 regarding an innovative method to quantify the rate of change in a wellbore trajectory using mechanical specific energy or MSE. The use of MSE to anticipate the rate of change is a fresh approach to wellbore trajectory prediction using sur-face drilling data and is shown in our work to be an accurate predictor of dog-leg severity.

The use of horizontal drilling has expanded at an almost exponential pace as it has been applied to unconventional reservoirs, and yet, the process is still done in a reactive fashion. This is to say that, many horizontal drilling decisions are still made by the directional driller using only his tally book with simple records showing the results of his prior actions. Using the correlation presented in this paper, a system has been developed which allows for accurate prediction of the rate of change of wellbore deviation while a drillstring is being rotated ahead.

Predictive models, typically centered on WOB or RPM, have been in existence for many years. However, one parameter whose effect on wellbore deviation has not been investigated is mechanical specific energy or MSE. MSE is a measure of the efficiency of the drilling process and has primarily been used for vibration analysis and rate of penetration optimization. Using published experimental data, a correlation was developed which shows a clear relationship between the dog-leg severity, rate of penetration (ROP) and MSE. The correlation requires only a few hundred feet of drilling before it is able to be tuned to match an individual well's results. With minimal tuning throughout the drilling of a well, good results can be obtained with regards to fore-casting dog-leg severity as the wellbores were drilled ahead. The correlation was tested using data from multiple, geo-steered wells drilled in a shale reservoir. The analysis of the correlation using real-world data proved it to be a robust and accurate method of predicting the magnitude of dog-leg severity.

This work is a part of the overall industry push to understand the mechanics of what is occurring downhole and their effect on the many aspects of the drilling process. The correlation allows for the prediction of what is now becoming a vital part of many of the wells we drill: the wellbore's trajectory while rotating. It works particularly well in horizontal or near-horizontal portions of the well, which is where the wellpath trajectory matters the most with regards to overall well productivity. In addition, there are no special data requirements, only standard surface drilling parameter data. Overall, the use of this correlation results in a smoother wellbore, drilled with a faster overall ROP with a better chance of staying within the geologic targets.