Paper D: Bottomhole Pressure Control During Pipe Connection in Gas-Dominant Wells

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Abstract

To obtain an underbalanced pressure condition, nitrogen gas can be injected into the drillstring. Simultaneous injection of liquids and gases leads to a highly dynamic flow system. During pipe connections, pressure transients can cause the bottomhole pressure to rise above the pore pressure of the reservoir or fall below the reservoir collapse pressure. Migration of gas during pipe connection and in-flow from the reservoir will also cause bottom-hole pressure changes.

This paper presents a methodology for controlling the bottom-hole pressure during pipe connection in gas dominant wells. The methodology incorporates a dynamic model of the well fluid flow and the well-reservoir dynamic interaction. Available control actions during the drilling process are the gas injection rate prior to the pipe connection and choke valve settings during the pipe connection. Measurement of the pump rates, pump pressures, choke pressure and the bottomhole pressure are also available to support the control actions. However, during pipe connections and in the event of transient signal failures, the bottomhole pressure measurements will be suppressed.

The control methodology used is based on a non-linear model predictive control system, which predicts the near-future behavior of the well, and uses these predictions to obtain the optimal choke settings and pump rates. The model parameters are calibrated using measurements from the well, to ensure that the model is suitable for the predictions.

A field based case with gas injection has been examined using this control methodology. The results indicate that model based control can be utilized in developing an automated and integrated pump rate and choke control system for underbalanced drilling operations.