

# **Paper C: Underbalanced Drilling: Improving Pipe Connection Procedures Using Automatic Control**

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## Abstract

Controlling the well pressure in the reservoir section during underbalanced drilling is of paramount importance for successful underbalanced drilling operations. Transient events caused by pipe connection lead to challenges in controlling the well pressure. Simple, manual procedures are used today to keep the well pressure in the reservoir section below the reservoir pore pressure.

In this paper we investigate the possibility of using an automatic control methodology to maintain the well pressure in the reservoir within critical limits, using a transient well/reservoir model. This model is used to predict the future pressure conditions based on the present status of the well. The results from a model-based control method are investigated and compared with those of conventional control methods.

The transient model combines a dynamic well model based on a drift-flux formulation, and a near-well transient reservoir model. Our focus is to maintain an underbalanced condition along the reservoir zone using the combined model, by controlling the choke setting and the pre-connection fluid flow rates in the well.

The nonlinear model predictive control method estimates the states and parameters along the well and within the reservoir, based on the available measurements and the information from the combined model. Based on these estimates of the well and reservoir parameters, the future behaviour is predicted using the combined model. The optimal choke settings and fluid flow rates prior to pipe connection are found.

The methodology has been applied to two different field based cases. The results indicate that the methodology is very promising as a tool to control the well pressure while performing pipe connections during underbalanced drilling.