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Improved Kick Management During MPD by Real-Time Pore-Pressure Estimation

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Abstract

Pressure maintenance within safe bounds and minimization of influx of fluids from the formation to the well during a kick are basic concerns of well control. Managed Pressure Drilling (MPD) offers improved capabilities over conventional well control methods to address these concerns. In this work we develop a methodology that capitalizes on the improved access to down-hole measurements offered by wired drill pipe telemetry, to maintain pressure within desired bounds during kick management. The objective of this methodology is to improve MPD by reducing non productive time, reducing formation damage and optimizing operational limits for the annular back pressure choke manifold.

The proposed methodology estimates formation pore pressure automatically based on real-time measurements when a gas kick is taken during MPD. The methodology relies on the characteristics of the pressure build-up curve. Implementation of the methodology presumes the availability of standard MPD equipment for automatic annular back pressure control.

A representative North-Sea well is used as test case geometry and an advanced hydraulics model is used as a virtual well in computer simulations that provide the basis for the presented results.

The proposed methodology is demonstrated to both maintain pressure within desirable bounds and reduce formation fluid influx during a kick and thereby prevent the risk of hole stability problems and the cost associated with non-productive time.

Introduction

Managed Pressure Drilling is seen as a promising technology in order to meet the challenges of drilling wells with narrow margin between pore pressure and fracture pressure. This is often the case in depleted reservoirs or deep-water wells. MPD is a general description of methods for wellbore pressure management and includes techniques and equipment developed to limit kicks, lost circulation and differential sticking. The overall objective of Managed Pressure Drilling is to reduce the number of casing strings required to safely reach the target depth. The definition from IADC (2008) states that "*Managed Pressure Drilling (MPD) means an adaptive drilling process used to control precisely the annular pressure profile throughout the wellbore. The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly. MPD is intended to avoid continuous influx of formation fluids to the surface. Any flow incidental to the operation will be safely contained using an appropriate process.*"

So far, main focus within the industry has been on development of automated chokes and on their control algorithm (Roes et al. 2006 and Godhavn et al. 2009), improved flow meters for influx and loss detection (Santos et al. 2005), and on alternative MPD concepts to actively control the pressure profile (Hinton 2009 and Fossli et al. 2008) . The introduction of new telemetry systems for real-time downhole measurements (Hernandez et al. 2008), continuous circulation devices (Jenner et al. 2005) and innovative downhole tools (Bansal et al. 2007) are valuable contributions to the MPD tool box.

However, the issue of developing an *appropriate process* to contain *any flow incidental to the operation* has not yet been addressed thoroughly. Specifically, although MPD does not encourage influx into the wellbore, there is usually a higher chance of receiving formation fluids (a kick) in MPD compared to conventional drilling. This is because the wellbore pressure profile is usually close to pore pressure somewhere in the open hole section. When a kick is detected, the well must be controlled properly in order to stop the influx, circulate out the formation fluid and continue the drilling operation. To control the well during these steps it is advantageous to get an accurate estimation of the pore pressure at the influx zone as quickly as possible.