IPTC 12787

Smart Formation Testing – A Reliable Approach to Evaluate Reservoir Compartmentalization and Fluid Gradients

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This paper was prepared for presentation at the International Petroleum Technology Conference held in Kuala Lumpur, Malaysia, 3–5 December 2008.

Abstract

Formation testing, whether on wireline (WL) or logging while drilling (LWD), represents a challenging operation, which requires pre-planning, incorporation of local best practices, and good communication between the operator and the services company. Even considering the above practices, the success rate of acquiring representative pressure tests is limited, since formation artifacts such as sanding, washouts, or supercharging when testing in very tight formations can lead to misinterpretation.

Today, many aging oil and gas fields are being redeveloped to target remaining hydrocarbon. Formation pressure, fluid gradients and the determination of whether or not compartments are in communication are important information when analyzing such a reservoir.

This paper discusses an approach that facilitates understanding the above challenges while drilling, even in difficult environments. A smart test function reduces storage and shock effects while drawing down on tight formations, but also avoids sanding in highly unconsolidated formations. Performing self-learning, optimized test sequences improve the accuracy of the pressure and mobility data and lead to higher operating efficiency.

The operator cost efficiencies of acquiring valid formation pressure data while drilling are becoming more influential in deciding the value proposition of a wireline reservoir characterization program. Cost efficiencies may indeed be pivotal but importantly, the benefit of acquiring accurate pressure data in real time warrants equal consideration, as a number of novel applications now exist.

Case histories and recent improvements, such as testing on wired pipe or longer test times, are included in this paper and demonstrate the applicability to conventional formation pressure applications, such as compartmentalization evaluation or fluid gradient analysis, traditionally acquired with wireline formation testers.

Benefits for drilling and subsurface teams, such as mud-weight (MW) management, safe selection of casing points, calibration of pore pressure predictions, selection of wireline sampling points, reservoir monitoring, geo-steering, and obtaining data in high-risk wells, are equally important and the reasons why LWD formation testing becomes a cross-functional discipline.

Introduction

Wireline formation pressure testing has been routinely used as a valuable reservoir characterization tool and its results are generally well regarded (Chen 2003). Initially introduced primarily as a drilling safety and MW/ECD (equivalent circulating density) optimization enhancement through real-time formation pressure measurement, LWD formation pressure testing has yet to fully prove its effectiveness in reservoir evaluations.

In recent years, as the result of continuing improvements in tool design and downhole technology, LWD pressure testing has gained more acceptance among reservoir engineers, geologists and petrophysicists. In cases where wireline formation pressure testing is unfeasible, such as in high angle and horizontal environments and with high rig costs to run wireline, LWD pressure testing provides an indispensable alternative to its wireline counterparts. Important information, such as reservoir fluid types, gas/oil/water contacts, and production and depletion history, can now be evaluated by LWD, thus providing timely data for preparing a completion strategy and design.