Development of 1-D Mechanical Earth Models for Wells in the Starfish and Dolphin Fields, ECMA, Trinidad

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Abstract

Wellbore instability occurs during drilling operations and can result in increasing drilling cost or well failure. The causes of wellbore instability can be classified as mechanical due to failure of the rock around the wellbore which is caused by high stresses during drilling, low rock strength, or inappropriate drilling practice and from chemical effects due to the swelling of clays that are present in shales (sloughing shales) which is caused by the drilling fluid. Wellbore stability analyses are therefore required before performing any drilling operations especially for deviated, extended reach and horizontal wells and to minimize drilling time and cost. The most common approach taken by drilling operators is to examine in-situ stresses from offset wells from which safe operating mud weight windows are generated to ensure wellbore stability. In this study the workflow used to generate 1D Wellbore Stability Models for wells drilled in the Starfish, Dolphin and Dolphin Deep Fields located off the East Coast of Trinidad is presented. The workflow involves assessing drilling, completions and geological reports to evaluate instability occurrences from wells drilled. Well log data were then used to calculate rock mechanical properties and in-situ stresses. Log data such as sonic and density were used to compute dynamic rock properties such as Poisson Ratio, Young's Modulus, Unconfined Compressive Strength and Friction Coefficient. Minimum horizontal stress was then interpreted from Leak-off Test (LOT) and Formation Integrity Test (FIT) while maximum horizontal stress was estimated from stress polygon analysis and calliper/image log data. Mohr Coulomb Failure Criterion was also applied but with limitations. The pore pressure and fracture pressure were predicted using Ben Eaton and Hubbert and Willis relationships. Applying the in-situ stresses and rock properties calculated, 1D Wellbore Stability Models were generated for wells in the aforementioned fields. The 1D models were used to postulate safe operating mud weight windows for each well by applying Aadnøy et al theory for each borehole section. Risk assessments for the wells were formulated by assessing the instability occurrences in each well according to the corresponding depth, hole size, formation type and drilling fluid. The workflow can be used as a template for modelling wellbore instability for wells drilled worldwide.

Keywords: Wellbore Stability; Mechanical Earth Models; Rock Strength Properties, Mud Weight Windows, Elastic Rock Properties, ECMA Trinidad.