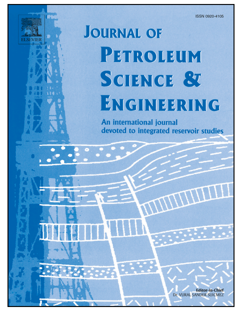
Accepted Manuscript



Experimental analysis of stick-slip in drilling dynamics in a laboratory test-rig

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PII: S0920-4105(18)30585-0

DOI: 10.1016/j.petrol.2018.07.008

Reference: PETROL 5105

To appear in: *Journal of Petroleum Science and Engineering*

Received Date: 10 May 2018

Revised Date: 28 June 2018

Accepted Date: 3 July 2018

Journal of Petroleum Science and Engineering manuscript No.
(will be inserted by the editor)

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Received: date / Accepted: date

Abstract A new test-rig to analyze drilling dynamics is presented in this article. Although simple, the test-rig can represent satisfactorily some phenomena observed in deep water drilling. The test-rig results are analyzed and stick-slip cycles are explained in detail. The explanations are in agreement with available field data found in the literature. One stick-slip cycle is extracted and analyzed thoroughly. Then, other cycles are presented to show the variability of the obtained experimental data. Finally, a model that might take into account hysteric effects is proposed for the bit-rock interaction. The parameters of the proposed model are identified using the experimental data.

Keywords drill-string test-rig · bit-rock interaction model · drill-string dynamics · experimental identification · hysteresis model

1 Introduction

Drill-string is a rotating machine, composed by slender pipes, used for exploitation of oil reservoirs. It has two main substructures: the drillpipes (slender pipes that can be assembled to reach kilometers) and the bottomhole-assembly (thicker pipes together with a drill bit at its bottom, and its length can reach hundreds of meters). Under operation, a top drive rotates the system at the top surface and the torque is transmitted throughout the drill-string to the bit that drills the rock. In addition, drilling fluid is injected at the top inside the pipes, and returns through the annulus area (space between the drill-string and the borehole) in order to transport drilled solids (cuttings) upward, avoiding borehole clogging and cooling the bit.

Therefore, drill-string operation is not trivial and involves high costs, specially in deep water. In most cases, this structure presents several types of vibration and they are detrimental to operation. One of the main concerns is the possibility of torsional vibrations that might lead to stick-slip oscillations [4; 6; 8; 9; 15; 18;

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