SPE 141988

Stick Slip Mitigation Plan to Improve Drilling

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This paper was prepared for presentation at the SPE Asia Pacific Oil and Gas Conference and Exhibition held in Jakarta, Indonesia, 20–22 September 2011.

Abstract
Drilling performance becomes inefficient by the presence of vibrational effect which is stick and slip. This situation is a source of failure which reduce penetration rate, increase operating time, and contribute to increase drilling operating costs.This is due to the surface alternating between sticking to and sliding over each other, with a corresponding change in the force of friction. Only if kinetic friction is bigger enough to encounter this static friction, it can cause a sudden jump in the velocity of the movement, condition characterized by fluctuations in the rotational speed of BHA.The main objective is to come out with a solution in reducing stick and slip.First, the problem is encountered by means of the alignment of different drilling parameters, such as rotary speed, drilling torque and weight on bit. This conventional control technique required expertise from driller. Second, by introducing a roller reamer, the more effective control methodology.Roller cutters from the roller reamer rotate around the wall and it is able to provide low torque point of stabilization. It transforms the interaction between borehole and contact points by introducing a low-friction bearing between BHA and borehole wall.As a result, implementation of roller reamer shows the constant transmission of rotational energy, thus able to improve the weight to the bit. Two offset wells have been selected for this case study, with well #1 exercising conventional method while well #2 makes use of roller reamer. Stick slip effect reduces from 180% srpm to 30% srpm. Furthermore, it is able to save 40% of drilling time on that particular section. This paper focuses on the practical solution by implementing roller reamer to mitigate stick slip effect base on actual field scenario. A comparisons and conceptual models are provided as well as the illustration of its configuration.

Introduction
Different types of vibrations can take place while drilling, namely lateral, vertical and torsional vibrations. This paper will focus on torsional vibration and more precisely on their most violent extend, the so called stick and slip.
Stick and slip as indicated by its name, is characterized by a period succession of sticking phase where the BHA is stops for a finite time interval and slipping phase where its angular velocity Ω increases up to two or three times the imposed velocity Ω_o. This oscillation can last for several minutes and sometimes could go longer than that. However, some study found that the occurrence of stick and slip corresponds to about 50% of the on-bottom drilling (Henneuse, 1992, Elf-Aquitaine).
Its have been observed to occur mostly under large weight on bit and low angular velocity (Brett, 1992).Thus , an increase of the applied weight on bit and low angular velocity which normally we called it RPM can trigger instabilities leading eventually to stick and slip. The decrease of the applied weight on bit or an increase of imposed velocity Ω_o can stop stick and and slip.Manipulating different drilling parameters as increasing the rotary speed, decreasing the weight on bit (WOB) or modifiying the drilling mud characteristics as shown in the field to suppress stick and slip motion (P.Sananikone etc al,1993).
In today's drilling community, stick and slip phenomenon well known as associated with drill bit. However, it is not a phenomenan that is strictly associated with the drill bit. The condition and tortuosity of the wellbore, the type of formations being drilled and the lubricity of the drilling have a significant influence on stick and slip as well. There are a few control methodologies in order to compensate drilling stick and slip either classic control techniques or sophiscated techniques. While the roller reamer always seen to mitigate tight hole condition, this study will show how the roller reamer could become an alternative approached to decouple stick and slip problem.

Stick and slip reduce by using Roller Reamer
Today's challenging drilling environment demands superior performance of tools in BHA especially for 3D, high angle and extended reach wells. Common drilling problems could be minimized by running correct tools downhole in combination with ideal drilling parameters and best drilling practises.

The decision to include Roller Reamer in BHA has been proven to be a simple yet reliable technology to minimize drilling risks in wells with associated problems.

At the contact points between BHA and wellbore, there is always side-loading force exist thus make the whirl in the BHA cannot be eliminate. However, roller reamer with a rolling cutter at the contact points changes this interaction. It reduce the friction between the BHA and borehole wall using it low friction bearing which made from Tungsten Carbide Insert(TCI). As such, the magnitude of the torque generate by BHA whirl force is greatly reduced.

Case Study

In this study, we analyze the change of torsional vibrations with a difference drilling BHA. Two well have been used for a case study to observe the phenomenon of stick and slip. We used MWD real time data to see any discrepancieas. These two well were offset wells and have similar lithology. Since both well have same lithology, it is expected to give the same drilling behavior.

Drilling 8.5in hole section in well#1 becomes more challenging when stick and slip capture at severe level. Regardless on bottom or off bottom, the same intensity was shown. A wide range of parameter was applied to eliminate this problem but there were no success.The conventional BHA was use to drill well#1(refer figure 1.1 for BHA schematic).8.5in PDC bit combine with Rotary Sterable System- Power Drive 675 was utilize in this well. 8.25in stabilizer was placed on top of the BHA.

The operator expecting to receive the same problem while drilling well#2. To eliminate this problem, the BHA for well#2 was proposed with Roller Reamer. This roller reamer was added below the BHA replaced the stabilizer place in BHA well#1.Decision to add roller reamer in the BHA was made since operator believe the changing in nature of the interaction between the BHA contact point and the wellbore could help to eliminate stick and slip problem (refer to Figure 1.2 for BHA schematic).

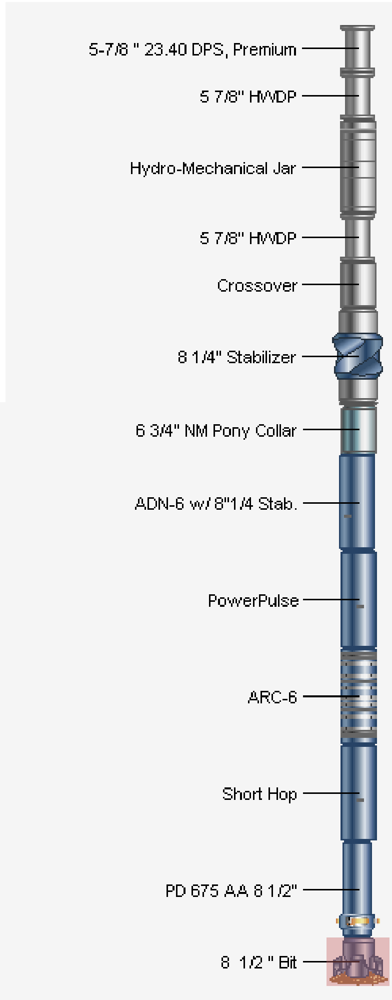

Figure 1.1 : BHA for well#1

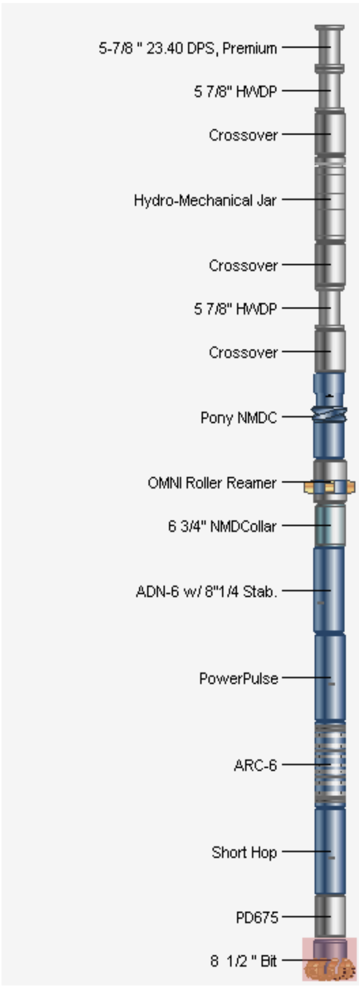

Figure 1.2 : BHA for well#2

Well Overview

For Well#1, the profile of the well is a build and hold at inclination of 72 degree and hold towards total depth (TD). This well was designed with a graduated build up rate (BUR) of 1.5 to 3.0 degree for every 30 meters to end of built at 748 meters. The tangent is maintained all the way to 1200 meters 13 3/8" casing setting depth, continued tangent in 12 ¼" hole section to 9 5/8" depth at 3400 meters and final TD at 5073 meters.(Refer figure 2.1 for well trajectory).

The profile of well#2 was a build-turn, hold and build-turn towards TD. Kickoff was in the 17 ½ hole section at 190 meters with 4.72° of inclination, with a graduated build-rate of 1.9 degree, 2degree, 2.5 degree and 3degree per 30 meters dog-leg severity (DLS) to end-of-build at 988 meters with inclination of 71.76 degree. The tangent was maintained all the way to section TD at 1400 meters. In the 12 ¼" hole section, the tangent was maintained to 3183 meters where a final kickoff at 2 degree per30 meters, ended at 3850m, 81.24 degree inclination and 136.13degree azimuth. The tangent was being kept all the way to 4214m final plan TD.(Refer figure 2.2 for well trajectory)

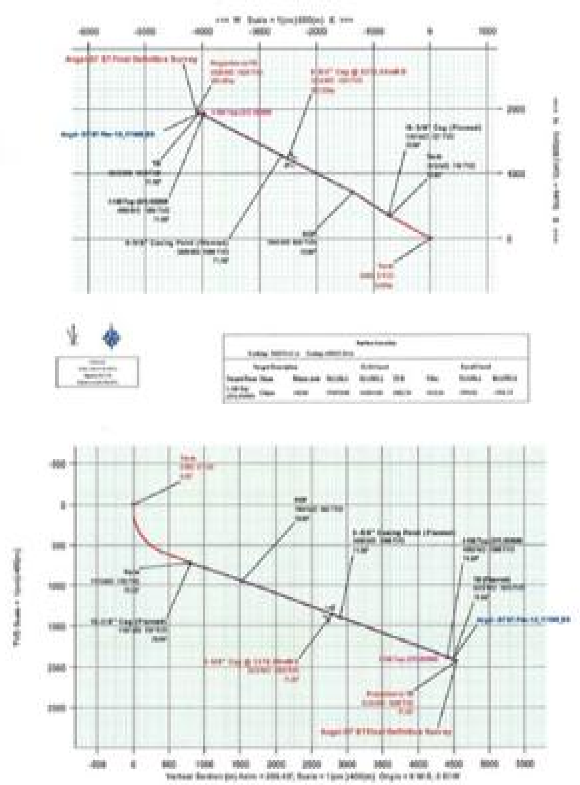

Figure 2.1: Well#1

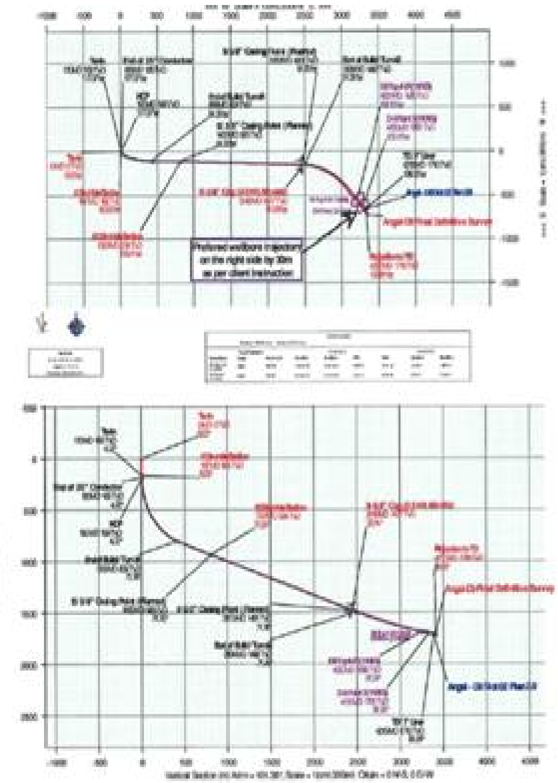

Figure 2.2: Well#2

From field experience, normally WOB will be a solution for stick and slip oscillation even for low velocity Ω.Increasing the velocity of the drilling might lead to lateral vibration, thus the manipulation of the WOB can be an alternative to attenuate stick and slip oscillation.

In well#1, WOB applied was played from 5 to 35 klbf in order to find the best position where stick and slip will not become severe.The velocity for this well was played around 150 c/min to 170c/min .Stick and slip was recorded at range 250 to 280 c/min while RPM was limited to 150 c/min.This is believed due to to torsional vibration generated by coupled lateral vibration. The side force was applied uniformly across the stabilizer.

The torsional excitation can give rise to enormously destructive fluctuating torques in the drill-string that, once out of control; invariably cause damage to the bit or drill-string. Even small amplitude slip-stick vibrations are thought to be a major cause of bit wear.In well#1,after pull out of hole and tools was on surface, it was measured the dull bit grading is 1-2-CT-T-X-I-WT-TD. This is believed due to torsional excitation in the drill string.

Stick and slip was measured directly by accelerometer in MWD tools.This accelerometer sensor recorded 50 times the acceleration due to gravity. A very large side force at the contact points could be produce in such acceleration in the BHA. As per Schlumberger stick and slip chart, the severity of stick and slip was measure in percentage which present by below formula

(stick slip / angular velocity(RPM) * 100) [1]
For well#1, we could said the stick and slip severity is 187% which derived from formula [1]
Stick and slip severity in well#1 = (280/150) *100
= 186.66%
This severity is consider very high and could lead to tools damaged and fatigue failure for drillstring.

In well#2, the bit and BHA configuration were not changed unless replace stabilizer with Roller Reamer.Drilling progress with roller reamer was more efficient since the rolling cutter at Roller Reamer body allowed more useable torque to transfer to bit. As a result, in well#2, weight on bit was observed higher a compared to well#1.
Stick and slip was recorded at 25 to 50 c/min while RPM is still maintain at 150 c/min. This is a huge reduction in stick and slip. For a severity percentage, it was calculated as 33% using formula [1].

Stick and slip severity in well#2 = (50/150) *100
= 33.33%
Roller reamer change the interaction between the borehole and contact points between the BHA and wellbore, thus effect to reduce the magnitude of the torque generated by BHA whirl forces. Futhermore, the wellbores were smoothers and utilize less energy to drill.
Please refer figure 3.1 and 3.2 for drilling parameter comparision.
The low level of torsional vibration in this well indicate the bit condition after come out of hole for this well section where the dull bit grading is recorded as 1-1-CT-N-X-I-No-TD.

Conclusion

1- Roller reamer eliminate torsional vibration which called stick and slip in the BHA.
2- The used of roller reamer will reduced torque fluctuation create by contact point at the BHA and wellbore.This will allowed more torque transfer to bit.
3- Roller reamer could replace stabilizer at the contact point with high lateral loading as it will reduced most of the capacity of torque generations.

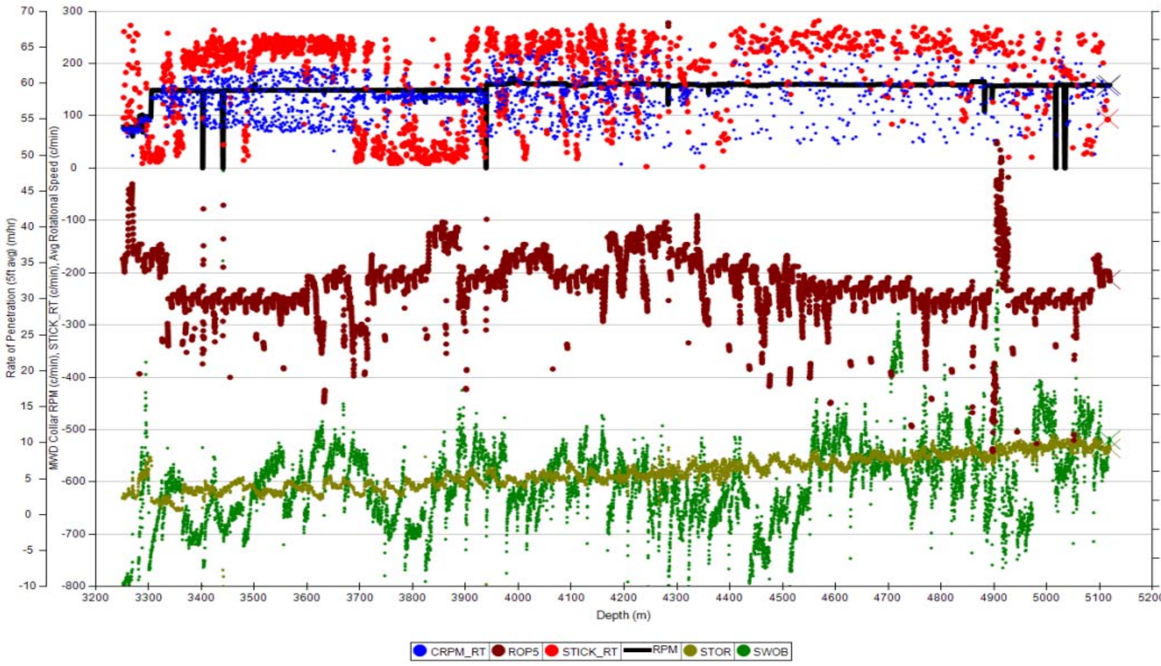

Figure 3.1: Drilling parameter for well#1

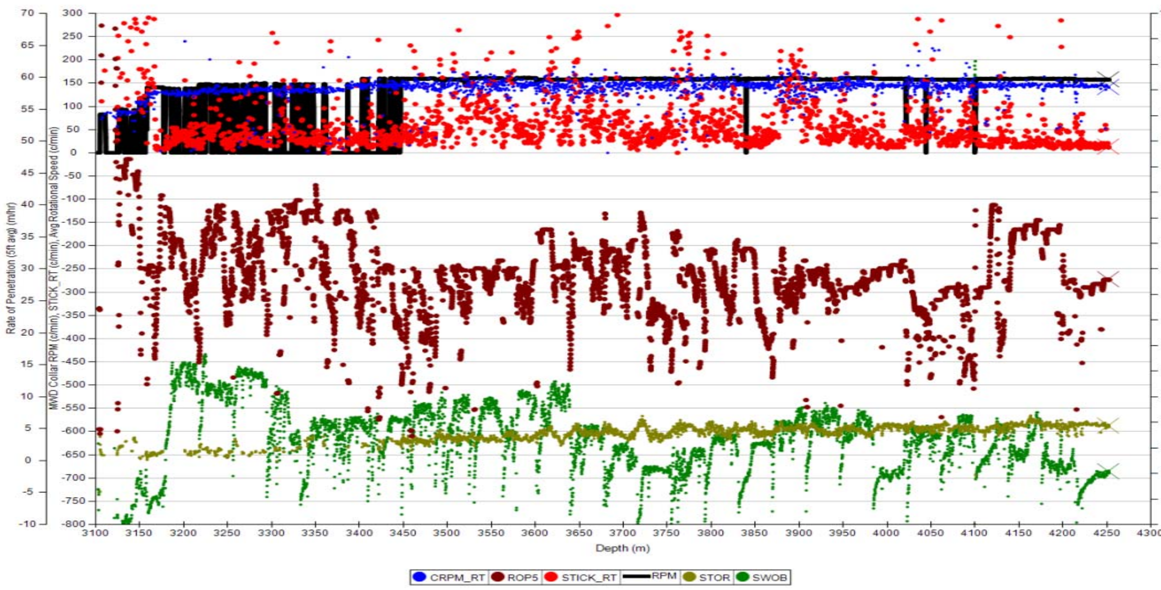

Figure 3.2: Drilling parameter for well#2