Advanced drilling mechanics: Stick-slip, string vibration, thrusters, drilling dynamics

IADC/SPE 59229

Use of Thrusters in Conjunction with Downhole Dynamics MWD Systems

This paper describes the synergy effects of using the combination of new downhole equipment, namely Thrusters and downhole dynamics MWD systems. Thrusters have been proven to increase the reliability of delicate downhole equipment such as rotary closed loop systems and complex MWD systems. For example, the reliability of the resistivity module in a rotary closed loop system was increased by a factor of 2 during a drilling project offshore Norway.

—D Stolte, Baker Hughes INTEQ GmbH

IADC/SPE 59230

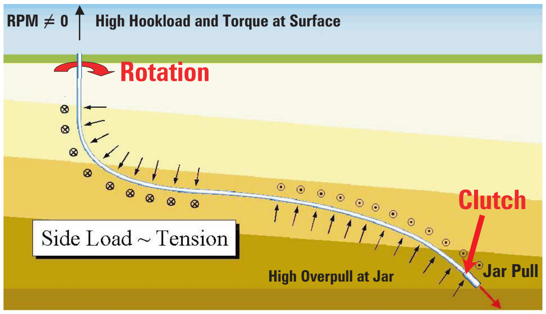
A Stick-Slip Analysis Based on Rock-Bit Interaction: Theoretical and Experimental Contribution

This paper deals with the analysis of stick-slip motion in drilling mechanics. Most previous literature attributed these torsional drillstring vibrations to static friction effect. On the contrary, the purpose of this paper is to explain bit stick-slip motion by theoretical rock mechanics considerations, comforted by field bottomhole data.

2 functioning stages rule drillstring behaviour. The stationary behaviour (small oscillation of the rotation bit speed around its mean value) is described by modal analysis. Experimental frequencies agree with the theoretical natural one. A perturbation of the operating parameters (generally an increasing of the weight on bit) makes bifurc the system towards stick-slip. The dynamical system is now governed by a non-linear autonomous boundary condition, linked to the rock-bit interaction. Rock mechanics considerations justifies such a law.

The last analysis is focused on drill-off test effect. In this operating stage, the rock-bit interaction function changes. Numerical simulations, justified by clearly experimental evidence, shows the benefit effect of such a test, which stabilizes the system.

—N Challamel, Paris School of Mines, *et al*



IADC/SPE 59234: The down-hole clutch is designed to enhance jarring effectiveness, especially in horizontal and other high-drag wells. The tool is placed above the jar.

IADC/SPE 59231

Positive Damping: A New PDC Bit Design Characteristic That Eliminates Bit Generated Slip-Stick

This paper describes the detailed measurement of PDC bit motion related to slip-stick; identifies the specific bit characteristics that contribute to the initiation and propagation of slip-stick; and establishes a set of design criteria that eliminates slip-stick caused by PDC bits.

A range of PDC bits' performance characteristics, particularly in terms of vibration and torsional response to RPM changes, will be presented.

Detailed examination of these neutral and positively damped bit designs allowed a number of their features to be incorporated into other bits known to have a propensity to give slip-stick. These modified bits were then tested, either in the laboratory or the field or both, and demonstrated in all cases a positively damped torque versus RPM response. Additionally, analysis of field run data indicated that no slip-stick had occurred.

—A Murdock and D Jelley, Reed-Hycalog

IADC/SPE 59232

Progress Toward a Cure for Slip-Stick Vibration with PDC Bits

An earlier study identified that the intrinsic relationship between bit torque and rotary speed controls the severity of PDC bit torsional vibration. This latest study has concentrated on establishing the bit torque/rotary speed relationship for a variety or PDC bit types, with the objective of explaining both field vibrational behaviour, and identifying the underlying drivers in the torque/speed relationship. New types of drilling machine and field tests have been used to determine this relationship under real drilling conditions.

Significant progress has been made. The susceptibility of different bit types to failure during slip-stick, and the extent to which different bit types provoke slip-stick have both been explained by interpretation of these results. These behaviours can now be related to particular aspects of bit design. As well as providing the understanding required to avoid premature PDC bit failure, this work is a major step toward the eradication of slip-stick vibration from drilling operations.

—M Fear, BP Amoco, et al

IADC/SPE 59233

State of the Art and Effective Implementation of Drilling Dynamics Technology

This paper will include an overview of detrimental drilling dynamic behaviors and their tangible impacts of drilling efficiencies. This overview will include specific events from field drilling experience. The paper will cite extensive operations in Indonesia and Venezuela.

The paper summarizes basic monitoring methodologies and established interpretation techniques from real-time data.

—R B Chandler, Technical & Quality Solution Inc
—ML Payne, Arco Oil & Gas Co

IADC/SPE 59234

Novel Jar Technology and Jarring Software Development

A new tool concept has been introduced to enhance jarring effectiveness: the down-hole clutch. The down-hole clutch is a tool that is placed above the jar. In the event of getting stuck it can be activated, such that it allows rotation of the drill string above the clutch. The enabled rotation of the drill string allows transfer of large pulls down to the jar, and the jarring effectiveness will significantly increase. Other benefits are improved hole cleaning and reduced risk of sticking. The tool is valuable in horizontal and other high drag wells such as extended reach wells.

—C Wijsman, Shell Intl E&P-RTS
—P Meijers and J Meijaard,
Delft Unverisity of Technology

IADC/SPE 59235 (ALTERNATE)

Lateral Drillstring Vibrations in Extended Reach Wells

In extended reach applications, long sections of the drillstring lie on the low side of the wellbore while rotating. When the rotary speed exceeds a critical threshold the drillstring starts to "wiggle" by sliding up and down the borehole wall. If rotated well beyond the threshold speed, the drillstring will eventually start to "whirl" which can severely damage string components.

This paper gives an analytical solution for threshold rotary speed. It is shown to be in the range of the rotary speeds used in modem extended reach applications.

—G Heisig and M Neubert,
Baker Hughes INTEQ

IADC/SPE 59236 (ALTERNATE)

Drilling Dynamics in the Presence of Mud Flow

A new drillstring dynamics model accounts for the interaction between the drill string and the mud flow circulation. The drill string under consideration includes a Bottom Hole Assembly comprising a PDC bit, mud driven Moineau type motor, thruster and MWD pulser optionally, drill collars and drill pipe. Beside mud flow impact the assembly is forced by axial bit excitation due to a bottomhole pattern, motor unbalance and friction from wall contact. The application helps find critical operating conditions and identify system parameters.

—B Schmalhorst, Baker Hughes INTEQ
–E Brommundt and U Richter,
Technical University of Braunschweig

Safety: Industry's first concern

IADC/SPE 59241

Managing the Client/Contractor Relationship to Maximize Safety Performance

In too many client/contractor relationships, the client demands and the contractor accepts specific behaviors in the pursuit of a safe operation. This makes both parties comfortable, the client because having delivered his instructions he (thinks he) can relax, the contractor because he (thinks he) has been relieved of the burden of thinking.

The flaw is that the client's dominance can lead to the suffocation of the contractor's own ideas, initiative and identity, with the result that the safety behaviors demanded by the client are not tuned to the specific circumstances and culture of the contractor, nor is it possible for the contractor to exert total commitment.

The paper will discuss this conundrum and will demonstrate that safety can be optimized only if the contractor develops his own safety identity, applies his own solutions and totally believes in what he is doing, albeit in cooperation with his client. And this will only work if the client understands and respects the contractor's needs and contribution.

—T Allwright, Tallrite Inc

IADC/SPE 59242

Analysis of HSE-Performance Indicators "Good safety is good business" is more than a slogan, it is a fact!

The management of safety is often seen as a key indicator of a company's performance. It is very important for a company to have some insight into their safety state: the allocation of money, people and resources can be directed to the most urgent problem areas. A variety of monitoring systems exists within the industry. All have some serious pitfalls. This is also the case at **Deutag**, a (land)-drilling contractor. At Deutag the following (monthly) safety performance indicators are currently used:

- Lost Time Injury Frequency (LTIF);
- Total Recordable Case Frequency (TRCF);
- Structure of 'incident pyramid (reporting frequency, shape, STOP cards);
- Accident free days;
- Periodic review Annual HSE plans.

This report will contain a review of the most widely used performance indicators in the industry.

The authorities and industry are aiming at reducing accidents in the oil-and gas-industry (UKOOA/IADC/OCA) by 50% in the coming years. Alternative performance indicators (formulation and achievement of individual safety performance targets) are developed to give support to these initiatives. Case studies have been done on methods to further enhance safety performance. These case studies and initiatives seem all to concentrate on a larger and more effective ways to involve the workforce.

—S Rozendal, Deutag Drilling

IADC/SPE 59243

Feedback is Not Enough: A Innovative Safety Culture Improvement Case Study

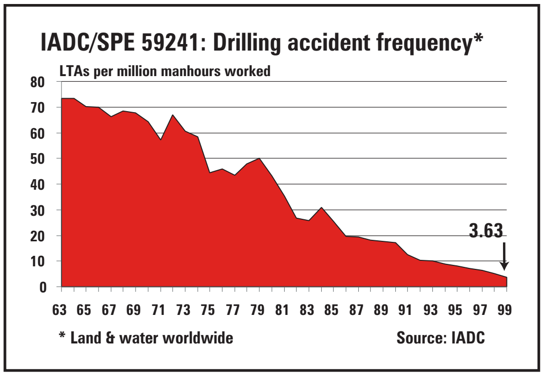
Having a positive Safety Culture is central to good health and safety management. It is an indication of an organisation's determination and competence to control hazards at work. This paper describcs an innovative project undertaken both to measure and to improve Safety Culture within a drilling company operating in the North Sea.

The drilling company has implemented systems and controls to manage and improve the company's HS&E performance. As a result the company's global safety performance has improved. however, inconsistencies in incident frequency have been identified across clients and installations. In order to investigate the possible root causes of these inconsistencies and develop solutions that would sustain continuous improvement, the company sought the long-term involvement of the workforce through a Safety Culture Assessment and Improvement project.

The project involved the use of a newly developed Safety Climate measurement and assessment tool, the use and results of which are presented. The paper details the identification of the problem, the development and implementation of the processes required to investigate and solve the problem, and the solutions. There is a clear demonstration of the benefits of management commitment to improving safety performance, and of workforce involvement in finding the solutions.

The project in itself was innovative, not in that the company recognised the problem and sought to assess it through the use of a Safety Culture survey, but that they also committed to using their entire workforce to help solve or improve upon issues highlighted by the survey. The process used in this project is one that other drilling companies and operators within the Oil and Gas Industry should be using as a method for developing solutions to break the safety cycle and achieve continuous safety improvement.

—R Richardson and R T Watkiss, KCA Drilling Ltd



IADC/SPE 59244 (ALTERNATE)

Well Control in Campos Basin-Brazil

This article presents the actions taken in Campos Basin offshore Brazil to make drilling, completion and intervention operations safer, especially in deep waters.

Firstly, the paper describes the pioneer work called Safety Program for Dynamic Positioning Vessels (DP-PS) in terms of well control which has been implementing in Brazil. This program consists of operational procedures, equipment requirements and practical recommendations for well control in deepwater locations. The paper also shows the current status of the program implementation and the benefits and good results associated with its application in Campos Basin.

Afterwards, the paper presents the structure and the most important aspects of the Blowout Contingency Plan for Campos Basin. The management structure to be established and the responsibilities and assignments of each person involved in a deepwater blowout and during its killing operations are listed. Also are presented the operational aspects related to the three phases of the blowout control operations: early response, blowout containment and killing operations.

Finally, the paper presents the huge effort that has been developing in Campos Basin in order to train and certify in well control all personnel directly involved in drilling, completion and intervention operations.

—O L Alcantara Santos, *et al*, Petrobras