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Control of Drilling Operational Risks Through Real Time Monitoring

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ABSTRACT

Currently in industry, real time drilling (RTD) is primarily used to improve efficiency and drive down costs. However, this is a secondary issue to hazards avoidance and well containment, which can be achieved by the correct use of the same data. It is considered that this technique is going to be widely used in future drilling activities since it could reduce drilling costs and minimize probability of encountering problems due to working with optimized parameters.

This work is intended to identify all possible risk and respond immediately, carry out drilling safely and economically, real-time management and visualization of drilling data and also secure monitoring of rig site operations. RTD can be used in newly drilling well, directional drilling and onshore and offshore. Real-time data not only can improve process safety but can also improve decision quality around issues such as management of change and risk management.

1. Introduction

In real time monitoring we monitor the well remotely and controls the processes to optimize drilling, while increasing safety and reducing risk. These centers use real-time geo mechanics surveillance, drilling optimization, formation evaluation, and well placement service to fulfill specific client needs. Real-time well monitoring offers pressure, temperature, flow, fluid density, and wellbore stress data. These data enable a better understanding of well behavior while minimizing your operational and HSE risk and overhead. In the oil industry real-time well drilling monitoring is an important issue. As there is HSE risk in an oilrig and the drilling cost is very high, this process will help to decrease the HSE risk and to minimize the operating cost.

It has been found that drilling rate of penetration could be modeled in real-time environment as a function of independent drilling variables such as weight on bit, rotation speed of the string, drilling fluid weight, and formation characteristics. The ability to have the drilling rate of penetration with respect to depth characteristically with certain parameters for specific formations on real-time basis could bring new insights to the nature of drilling optimization studies. Any significant departure of the actual rate of penetration from the predicted rate of penetration trend could have important indications, which could be detected beforehand in real-time. Thus, being able to reduce the risks in the drilling process is fundamental to the oil industry. Real-time drilling monitoring is more than just visualization. It necessitates timely interpretation for the optimization of drilling operations and, more importantly, the prevention of material and human accidents. Real-time drilling monitoring can improve decision-making based in the geological model, avoiding possible problems and increasing efficiency.

2. Materials and Methods

In order to optimize the parameters in the field, a computer network is required to be developed. The computer network will keep the piped data directly from the data source, and continuously be collecting the new data to be fed. A database present at the central computer will be continuously calculating the developed model parameters by means of multiple

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regression technique and inform the team at the field. The field engineer will transmit the current drilling parameters back to the central computer. Therefore, there will be a real-time-monitoring process.

1. See the handover list (in this RT operator is required to document and notify the following: ticket raised, issues with software, issues with real time well i.e., depth jump, gaps or missing curves, new well started during the shift, side tracking, well that have reached TD).

2. Well monitoring- primary checks (check that all the well that have to monitor should be open with relevant plot)
   - Make sure that every log is updating with respect to time and depth.
   - To keep track of any issues with the hole depth (such as depth jumps, depth stoppage) the use of monitoring sheet to record these values at regular intervals is important.
   - We need to ensure that the curves in the log plots are as complete as can be and that they are clearly visible within the tracks. We there for need to look out for gaps, straight lines and curves values out with the scale presented.

3. Well monitoring- Secondary checks (status of the wells)
   - Drilling
   - Circulating
   - Tripping
   - Standby
   - Well TD

Drilling

While drilling all displays need to be monitored. The type of displays depend on the services required for real-time. This can range from basic surface parameter displays to lithology displays, survey/trajectory displays and logging tool displays. This section will outline what to look for when monitoring each of these types:

There are two methods to drilling a well, Rotary and Slide drilling (or Sliding as it is most commonly called). Depending on the mode of drilling, there are distinguishing characteristics of the two methods that need to be taken into consideration.

Rotary Drilling

- Drilling can be identified as when the bit depth in the time log matches the hole depth and ROP (Rate of Perforation) is greater than 0. If WOB (Weight on Bit) has a value greater than 0, we also know that drilling is going on. Another easy way to determine if a well is drilling is by looking at the Block Position curve in a time display. When drilling, the block position will gradually decrease from the length of one stand (about 100ft) to zero. When it reaches zero, the block will be raised again to connect a new stand (connection). After the connection the process repeats itself.
- Drilling is said to be in Rotary mode when RPM (Revolutions per Minute) is being applied to the drill string. Torque readings should also be greater than 0
- When the rig is on bottom drilling, all channels in the log should be updating.
- During drilling the following parameters must be updating and they must have valid values (see Appendix D): Bit Depth, Hole Depth, Block Height, Gain/Loss, Hook Load, Mud Flow In/Out, Pump1/Pump2, Pump Pressure, ROP, RPM, Surface Torque, Tank Volumes, WOB and Total Gas.
- In some cases Total Gas will not be received, which indicates that there is no mud logger on the rig site or the gas sensor on the pit line is not installed. If there is no indication of either in the job WIKI (see On Time), an incident ticket should be raised and escalated as appropriate.

Lithology

Depending on the type of real-time we are providing, we may also have to monitor the lithology data provided by the mud log service company. This is data that is manually entered into the lithology transmission device by the mud loggers after the well cuttings have been inspected at the rig site.

- In real-time displays the lithology is represented as a column in one of the display tracks. There are two types of lithology columns: Cuttings (lithology is represented in percentages; 30% Shale Grey, 40% Sand, 30% Limestone as shown in the example below) and Interpreted lithology (100% Shale Grey for example) which is the mud loggers interpretation of the rock drilled.
- There will be a lag as cuttings take a while to reach the surface (depending on the mud flow rate and depth of the well). The lithology is manually updated by the mud loggers and should be done at regular intervals. If the lag is greater than 100ft and ticket should be raised.
- The time taken for the cuttings to be gathered, rinsed and inspected will add to this lag difference. If a lag of more than 100ft is observed, an incident ticket should be raised.

Survey / Trajectory

While monitoring survey data or trajectory displays the following parameters should be updating: Survey Depth (MD and TVD), Azimuth and Inclination. These parameters must also have valid values (see Appendix C for details of valid values).

Survey Depth

- Survey Depth (MD) is the distance of the surveying tool sensor to the surface along the bore hole. While drilling is in progress it should update at roughly 30ft or 90ft intervals.
- If a survey reading has not be received after 100ft + survey offset from the hole depth, an incident ticket should be raised. The survey offset is recorded in the On Time job wiki.
- Survey data in TVD displays must be checked to ensure that the parameters are available.

Inclination

The deviation from vertical expressed in degrees, irrespective of compass direction. A perfectly vertical well will have the inclination of 0 degrees, while a perfectly horizontal well will have an inclination of 90 degrees.

Azimuth

The compass direction of a directional survey or of the wellbore, usually specified in degrees with respect to the geographic or magnetic north pole.

Logging Tools

If logging tools are used while drilling, the clients will likely require MWD or LWD real-time displays.

Measurement While Drilling (MWD) logging can take several measurements such as Gamma Ray, Borehole Pressure, Temperature, Vibration, Shock, Torque, etc. They will also include survey data such as Inclination, Azimuth, Tool Face (direction which the drill bit is pointing towards).

Logging While Drilling (LWD) logging is an enhancement of MWD logging and enables more measurements to be made such as Density and

Photoelectric Index, Neutron Porosity, Borehole Caliper, Resistivity, Sonic, Borehole Images, Formation Tester and Sampler, Nuclear Magnetic Resonance (NMR) and Seismic While Drilling (SWD). Gamma Ray is also included. This is by no means a complete list and more measurements are being added each year as LWD technology develops.

Gamma Ray

- GR is the measurement of the total amount of natural radiation from radioactive elements (potassium, thorium, and uranium) in the formation the sensor is in.
- It is one of the most important curves in real-time displays; gaps and straight lines therefore must be reported and dealt with as soon as possible.
- As rock formations change along the wellbore, the GR readings can fluctuate wildly and may lead to spikes in the curves displayed. However, multiple spikes within a narrow range is indicative of an issue with the tool. Any spike in Gamma Ray should therefore be questioned and an incident ticket created.

Circulating

When noting this status in the monitoring sheet, we are actually combining a couple of possible statuses, as they are similar in terms of parameters expected to update. These are Circulating and Reaming. The distinguishing characteristic is that the drill string will move up and down a stand (usually about 90ft) during reaming operations, while the drill string will be pulled up 10-20ft from the bottom and then remain stationary while circulating the well.

Circulating Bottoms Up

- After a well section has been drilled to its planned depth, an operator will often 'Circulate Bottoms Up'. This is one last effort to clean the wellbore and remove any cuttings before tripping out of the hole to run Wire line and/or run casing.
- While circulating there will not be any WOB or ROP, nor will there be any change to Hole Depth. The following parameters will however be updating: Block Position, Gain/Loss, Hook Load, RPM, Mud Flow In/Out, Pump1/Pump2, Pump Pressure, Tank Volumes and Total Gas.

Reaming

This operation is performed to enlarge a wellbore that has already been drilled. This may be done for several reasons, but commonly is it because the hole was not drilled as large as it should have been at the outset.

If there are any missing channels, null values or invalid values during either of these operations, an incident ticket should be raised.

Tripping

When this status in the monitoring noting sheet, we are again combining a couple of possible statuses. These are Running In Hole (RIH) and Pulling Out Of Hole (POOH).

RIH

While RIH there will be an increase in bit depth and gradual increase in Hook Load as the drill string becomes heavier. The Block Position will go from the length of a stand (approx. 100ft) to zero as a new stand is connected and lowered into the wellbore. The process repeats itself until the string reaches Hole Depth.

Standby

We use this term when we are not aware of what operation is going on the rig. These operations could be Casing, Cementing, Maintenance, Wire line logging, Nipple Up/Down of BOP (Blowout Preventer) for example.

Other checks

To keep track of any issues with the hole depth (such as depth jumps (increase or decrease) or depth stoppages) the use of a monitoring sheet to record these values at regular intervals is important.

Depth Jumps: These occur when incorrect hole depth data is transmitted because of bad data manually entered by the service contractor, or of poor sensor calibration, or during RIH operations prior to restarting drilling. If this condition is observed and the hole depth from a depth based log is now greater than the hole depth from a time based log, an incident ticket (see Appendix B for sample ticket) should be raised and escalated as appropriate.

Depth Backshift: These occur when the service provider has reset the depth, often during POOH after completing a drilling run. They may also occur when the client decides to ream the well or conduct a sidetrack of the well. If this condition is observed and the hole depth in the time-based log has become less than the hole depth in the depth based log, an incident ticket should be raised and escalated as appropriate.

Gaps: If any gaps are identified in the curves of the depth-based displays, an incident ticket must be raised. We are not concerned with gaps in Time based plot, so these can be ignored. For depth-based gaps, it may be possible to patch them with LAS files provided by the service provider.

Straight Lines: If any curves appear as straight lines in a depth-based plot, an incident ticket must be raised. Real-Time curve values by their very nature fluctuate both over time and depth. We are not so concerned with straight lines in time-based data, but if a straight line over 50 feet interval in a depth-based display is observed, it is an indication of an issue with data provided by the service company.

3. Results and Discussion

The data we get from the rig site is in binary format or wits which is unreadable by human so the company convert this wits into a graphical format which can be understandable by human and the company persons can easily monitor the process going on the well to identify the unconformities or abnormalities so that they can take preventive action for safe drilling for oil and gas.

As we know that drilling for oil &gas is the second hazardous operation, we have to keep regular update of drilling parameters to avoid blowout and other accidents. By using real time monitoring we can monitor the drilling plots and we can spot the issues very easily in the console.

4. Conclusion

Real Time Drilling (RTD) for use during drilling and completions operations support better decision-making and better planning. RTD contributes to reducing occurrences of major drilling dysfunctions and improving the overall well efficiency by permitting geologically optimized productivity. Real-time reservoir evaluation revolutionizes the well delivery process by enabling both well testing and reservoir evaluation to be carried out during the drilling phase, as opposed to after reaching total depth or after completion. Real Time Drilling focuses on maintaining system optimal conditions subject to the reservoir and surface facility model and physical constraints, and repeating it continuously, within the time-constraints of the system, i.e.in real-time. Continuous data acquisition allows geological model update, and new models may imply revised exploitation plans. Collaborative web portals, integrated engineering and subsurface data models are key components to maintain live the RTD workflow.

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