Use of Real-Time Rig Sensor Data to Improve Daily Drilling Reporting, Benchmarking and Planning - A Case Study

Abstract

State of the art drilling operations analysis is mostly dependent on conventional daily activity reporting. However, these activity reports are based on human observations and judgment. This fact implies a number of limitations such as the coarse level of detail and subjective coding systems. To overcome these problems a rule-based system has been applied to autonomously analyze real time surface sensor data. The system evaluates the sensor data stream and acquires crucial process information as a basis for further analysis. Scope of the system is the recognition of drilling operations, such as tripping, making connections, reaming, washing etc. to extend and enhance standard reporting. This way a standardized and objective categorization of the drilling process can be achieved at a level of accuracy and detail not reached so far. Another benefit is the automated reporting feature. By the recognition of the rigs current state, the system is able to propose an impartial process description. This automatism leads to a reduction of the time spent on reporting and leaves more time to focus on unexpected events and lessons learned. Analysis of field data allowed introducing new key performance indicators (e.g. wellbore treatment time per depth interval) for benchmarking, which are determined automatically during the evaluation process. This type of benchmarking does not rely on company specific activity coding systems. This way cost and time-consuming data management effort e.g. to compare operated and non-operated wells are eliminated. The new system was applied to wells drilled in the Vienna Basin during the past year. As a conclusion it can be stated that the application of this system significantly improves the accuracy and resolution of the drilling process description reducing data management effort. The objective categorization of process information is a key enabler for benchmarking specifically when identifying hidden lost time.

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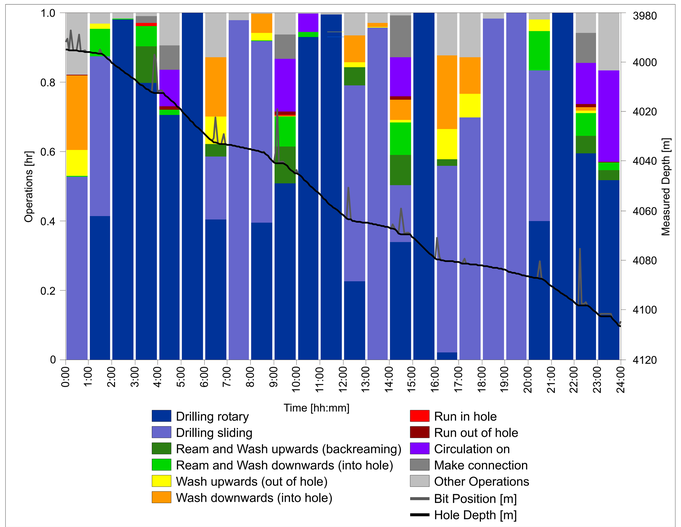


Start MD	End MD	Start Time	Duration	Description
3991	4017	2005-03-27 00:00	5	Drilling
4017	4017	2005-03-27 05:00	0.5	Add DP, ream hole
4017	4017	2005-03-27 05:30	0.5	MWD - measurement
4017	4081	2005-03-27 06:00	10	Drilling
4081	4081	2005-03-27 16:00	1	Add DP, ream hole
4081	4081	2005-03-27 17:00	1	MWD - measurement.
				SCR: Pump 1. 60 strokes 74 bar at 4042m Drilling in sliding mode: 4033m - 4037m, 4065m - 4068m
4081	4105	2005-03-27 18:00	6	Drilling

Daily Activity Breakdown

The table above shows the time breakdown of a conventional daily drilling report. In contrast to this table the figure above shows the results for the same day derived from sensor data using operations recognition.

Each bar on the graph represents one hour. The different colors within one bar represent the fraction of the activities within that hour. The measured depth of the hole and the bit depth are also displayed.

Using such a chart in addition to the conventional daily drilling report provides an objective and accurate description of the drilling time breakdown as basis for further analysis. This data processing step reveals exact numbers about drilling ROP (net and gross), tripping speeds, connection times, etc.

BHA Run Report

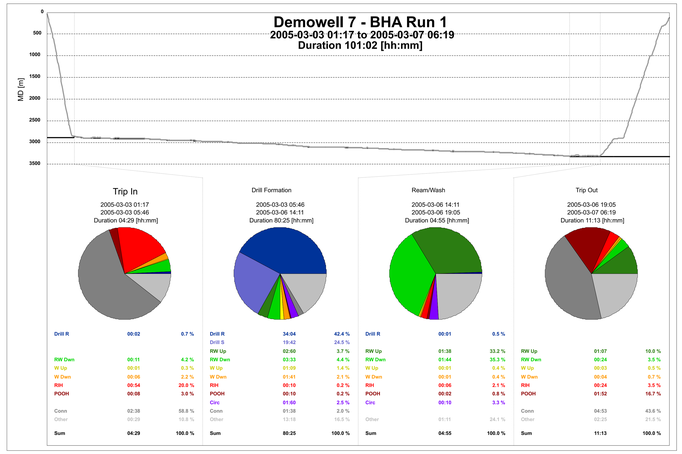
Based on detailed description of the drilling process the BHA Run Report can be generated. Typical process steps of a run are defined and measured such as Trip In, Drill Formation, Wellbore Treatment, and Trip Out are defined. The individual process steps are broken down into operations, which are then used to characterize and evaluate the run.

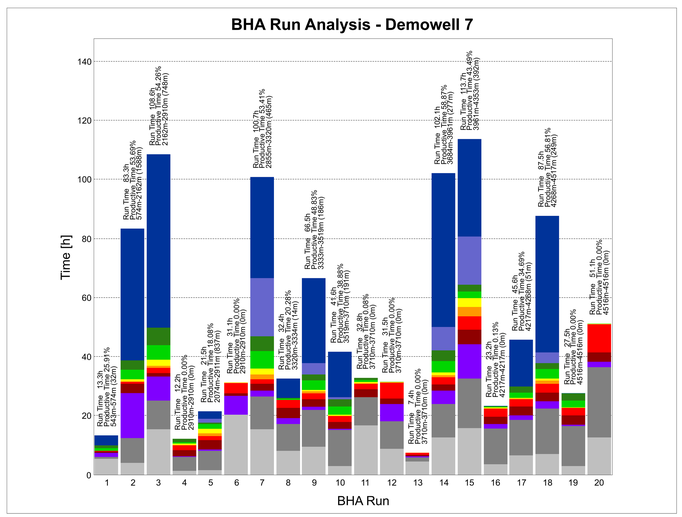
On the top of the graph the bit position is shown together with the measured depth of the hole to link this information with a time versus depth view of the run.

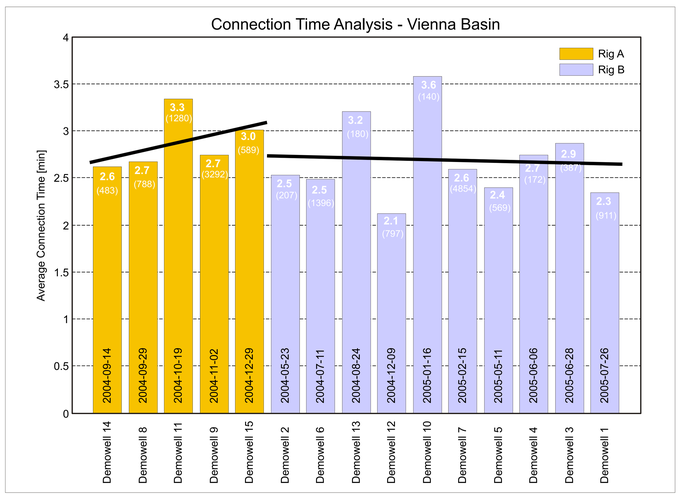
Connection Time Analysis

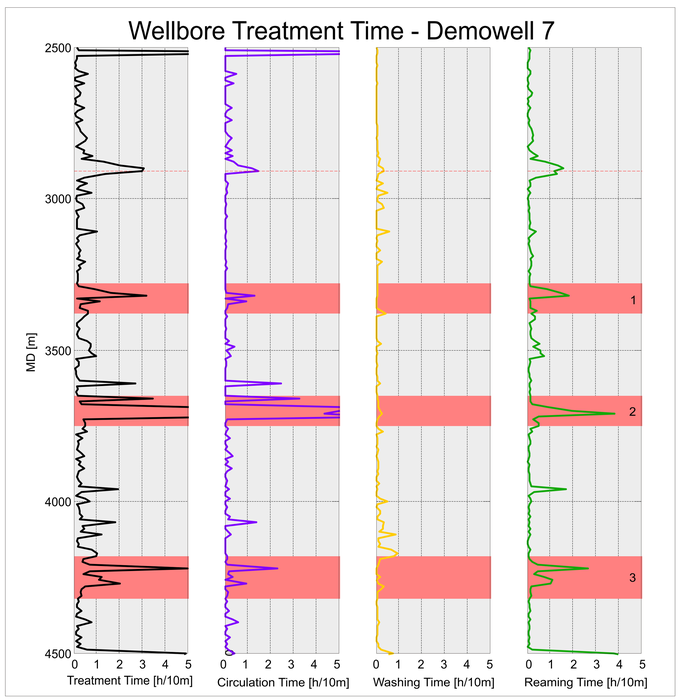
With the help of the results of the Automated Operation Recognition the average connection time for wells is analyzed. The white numbers display the average connection time of the well, the white numbers in parenthesis the number of recognized connections per well.

Comparing the measured connection time shows a savings potential in rig time of approximately 1.7% for a set of shallow wells (2500 meters depth). A similar analysis for deep wells (+5000 meter) showed a savings potential of as much as 8% of the rig time comparing to best historic performance.









Wellbore Treatment Time Analysis

The bottom graph to the left represents circulating time, washing time and reaming time, and the total wellbore treatment time. The dashed red horizontal lines mark the casing shoe position.

At the casing shoes, indicated in horizontal red lines, increased wellbore treatment time is expected. This is different for the zones marked by the three red shaded depth intervals. These peaks mark potential trouble formations, since increased wellbore treatment time was necessary there. These peaks consider all reaming times, even those, which typically are not reported, e.g. 15 minutes or less of reaming washing or circulation. Times are accumulated every time the bit passes that zone and summarized for 10 meter (30ft) intervals.

This information allows identifying zones of wellbore instability and bad wellbore quality. Based on that information wellbore health monitoring can be performed which shows the development of overpull and slack-off weights over time for individual wellbore sections. Using time based hookload measurements and trend analysis, an advisory system is able to inform the driller if reaming for a certain interval is necessary or can be avoided.