Real-Time Monitoring and Evaluation of Actual vs. Simulated Torque and Drag in Deviated, Long Lateral, Open-Hole Gas Wells*

Ahmad Kadura[1], Roberto Vega[1], Ahmad Atef Hashmi[2], Roberto Duran[2], Bilal Tariq[2], and Carlos Parra[2]

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[1]Halliburton (Ahmad.Kadura@halliburton.com)
[2]Saudi Aramco

Abstract

This article describes the implementation of a system for evaluating actual torque and drag when running multistage hydraulic fracturing (MSF) completion equipment in long, open-hole (OH) lateral sections. The process uses an important evaluation tool to compare with results from simulated scenarios, which helps with real-time decision making when actual parameters differ from those simulated.

Torque and drag (T&D) were simulated using different friction coefficients. Actual torque and drag data collected while performing a previous reaming trip were combined with caliper logs to evaluate the running-in-hole (RIH) of the OH MSF completion equipment. Real-time monitoring of the actual run and continuous evaluation provided important information that helped in avoiding sticking, as well as the high-circulating-pressure scenarios that led to loose OH laterals in similar previous wells. Using the evaluation tool significantly increased the success rate of running the OH MSF completion equipment in gas wells.

The torque-and-drag simulations enabled ease of operation when running the OH MSF completion equipment to the target depth. Various techniques are presented that were used in the torque and drag simulations to accurately predict real-time parameters and properly anticipate downhole variables while running in hole. Logging data from a caliper run performed on the OH formation were uploaded into the torque-and-drag software, which enabled a more realistic simulation. This helped to pass through expected tight spots and washouts in the OH. Additionally, the previous reaming trip provided valuable data concerning friction-factor coefficients; a torque-and-drag simulation of the reaming trip was performed, and the differences in parameters while running in hole were monitored. The friction factors were adjusted to match the actual parameters of the reaming trip, and those same friction factors were then used to simulate the OH MSF completion. This technique provided a more suitable reference in terms of expected parameters.

Running OH MSF completion equipment in a long, lateral OH poses significant risks for sticking or decreased circulating capability, particularly in wells drilled in the minimum stress direction. Adding the evaluation process to the existing real-time monitoring system allows for predicting adverse scenarios before they become irreversible; thus, the modeling increases the likelihood of successful system deployment, which, in turn, allows for a quicker turnaround to production.

Introduction

Running OH MSF completion equipment in a long, lateral OH poses significant risks for sticking or decreased circulating capability, particularly in wells drilled in the minimum stress direction (Malik et al., 2016). When first introduced to certain gas fields, the operator had great success running this specific OH MSF completion, with over 50 jobs being deployed successfully without any issues. However, over time, many of the completion runs resulted in failures getting to bottom. As limits and boundaries of the operation were pushed, the given practices and procedures became less successful. The failures helped in bringing about positive change to improve the chances for success. Many ideas were put forth regarding the actual preparation of the equipment and operation; however, new methods for real-time monitoring using torque-and-drag simulations and modeling proved to be the most effective.

Methodology

The previous methodology was to run the T&D simulation based on the actual tally received from the rig and then to monitor and check for any fluctuations in weight. The same open-hole friction factors were used, and the open-hole size was kept constant, regardless of the condition of the open hole. When entering the open hole, the operator on the rig floor would record the weights every 1,000 feet. If the weights were more or less than 10 klb of the simulated values, the simulation would be updated to match the actual values by adjusting friction factors, drillpipe weights, etc., as shown in Figure 1.

This method worked when running the liner hanger, but proved to be extremely inefficient for multi-stage hydraulic fracture equipment. Deployment of downhole completion tools in a slim hole (5-7/8 in.) can be challenging, as the clearance or annular space between the outside diameter of the tool and the hole size is narrow, which can increase the equivalent circulating density (ECD). In addition, drilling in the minimum stress direction using viscous fluids filled with bridging material has the potential to compromise the circulation of the oil-based mud (OBM) around the swellable packers. The longer it takes to get the completion to final depth, the higher the chances for the bottomhole assembly to face wellbore-stability issues.

Operational improvements were made to deploy the completion to final depth successfully. Although these improvements helped, more had to be done given the recent failures. A method was developed to first evaluate the reaming trip that was performed right before running the lower completion. The reaming trip evaluation was then used to simulate the lower completion run. The new methodology helped save valuable time when running the MSF completion to bottom.

Procedures

The reaming BHA was modeled using T&D software prior to the reaming trip to compare with actual data while RIH (Figure 2). While RIH, the operator would keep track of weights every 1,000 feet. The weights were then compared to the simulation; if any discrepancies were observed, then proper updates were made to the simulation in order for it to match with the actual data. More often than not, the actual open-hole friction factors differed from the simulations. Data used from the updates were then applied to the simulation of the lower completion. For example, if the open-hole friction factors were modified in the reaming run, then the same friction factors were inputted into the second simulation as a baseline reference. Essentially, the change in variables that were updated during the reaming trip simulation to accurately reflect the actual loads (friction factors, drillpipe specs, etc.) were directly applied to the MSF run simulation.

Along with the real-time monitoring data, another strategy was applied to the simulation. Before every reaming trip, an open-hole mechanical caliper log was run to evaluate the best placement for the swellable packers. These same open-hole caliper logs were incorporated into the simulation to give an accurate model of the actual open-hole size by importing the file into the software (Figure 3).

Knowing the changes in the open hole and having a better idea of the wellbore geometry also enabled the operators to anticipate any tight spots and act accordingly. After all the updates to the simulation, the operators on location would still monitor the weights every 1,000 feet in both cased and open holes to monitor any changes to the conditions of the hole. However, with the new methods in place, there were hardly any fluctuations of the actual data with the simulation. This boosted confidence enabled the operation to run much more efficiently, thereby saving valuable time.

Results

Because of the high need for the success of the MSF completion to reach bottom, time had to be saved. After the new method was implemented on the first well, the rig set a new record for the operator as the fastest deployment of an MSF completion. The teamwork between the service company and operator greatly contributed to this success. Since introducing the improvements to the real-time monitoring, over 10 MSF systems have been successfully deployed in similar fields without issue.

Conclusion

Saving time, while maintaining optimum service quality, is the main factor in avoiding high circulation rates and stuck scenarios when deploying MSF completion systems with swellable packers. Adding the evaluation process to the existing real-time monitoring system permits predicting adverse scenarios before they become irreversible; thus, the modeling increases the likelihood of successful system deployment, which, in turn, allows for a quicker turnaround to production. After changes were implemented, the success rate increased, and the number of jobs with unwanted circumstances decreased. It is clear that these new innovations set a standard for all MSF completion jobs moving forward. The operator has enjoyed much success with the new processes in place, opening more opportunities in the future.

Reference Cited

Malik, A.R., J.A.L. Jauregui, M.A. Asiri, et al., 2016, Overcoming open hole multistage acid fracturing challenges in Saudi Arabian carbonate reservoirs with swellable packers, best practices and dynamic evaluation: SPE-178159-MS presented at the SPE/IADC Middle East Drilling Technology Conference and Exhibition, Abu Dhabi, UAE, 26-28 January.

Figure 1. Hookload graph of liner hanger run with input of actual loads.

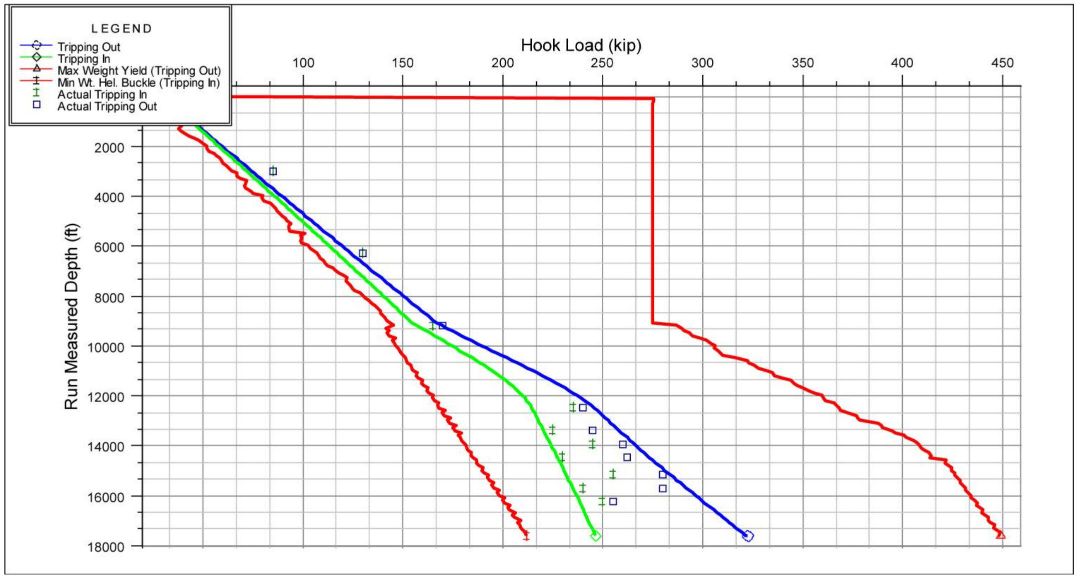

Figure 2. Hookload graph of reaming trip with input of actual loads.

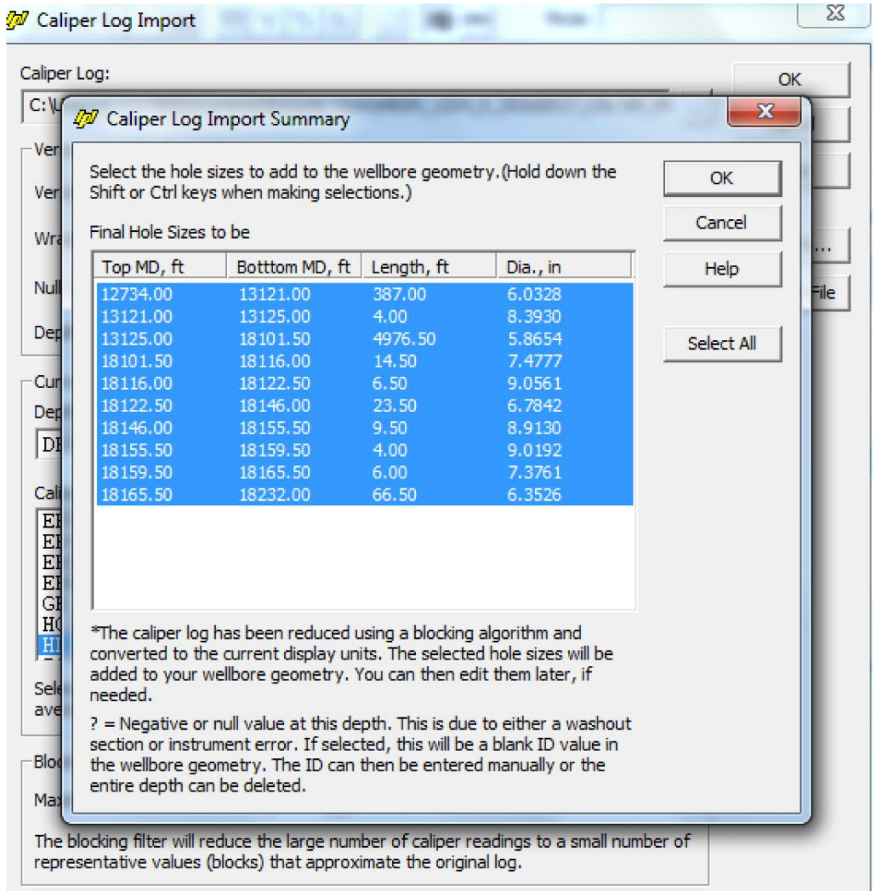

Figure 3. Importing of open-hole caliper log.