SUCKER ROD GUIDE IMPROVEMENTS

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ABSTRACT

Typically, the petroleum industry clings to successful operational practices that were developed long ago. These methods may still have merit, but some improvements should be considered. Sucker rod guides are one example of such practices. Most production companies continue to use rod guide material that was introduced when sucker rod guides were introduced. This presentation shares information about new materials and new applications for sucker rods guides.

INTRODUCTION

Rod guides are inserts made of plastic, rubber, or metal that can be molded on the rods to centralize and keep the rods in the middle of the tubing to reduce metal-to-metal wear. Rod guides are generally run within the deviated section of the well and will wear preferentially compared to the tubing and rods, thereby lengthening the equipment life.

The three available types of rod guides are:

- Molded in place
- Attachable
- Wheeled or roller

Molded guides are the recommended approach for most well conditions. Specifically, non-glass filled guides are required for internally plastic coated (IPC) tubing, and glass-filled guides are used for bare tubing to extend run life. The design of the guides allows fluids to flow up through slots or flutes without impeding production. Tubing and rod rotators are necessary to turn the equipment, preventing unilateral wear from occurring to the rods or tubing. This distributes wear throughout the rod string and extends equipment run life.

To minimize the chance of rod body wear, run one guide for every 50 lb of side load, regardless of material or design. To prevent wear in deviated sections of the wellbore, a minimum of three rod guides and a maximum of eight rod guides are recommended, because the guides need space to mold properly and not interfere.

LIMITATIONS TO EXISTING ROD GUIDES

Guides do not solve the problem of high side load forces; they are merely a temporary solution to increase system run life compared with traditional sucker rod design. Without guides, wear on the either the rod body or the couplings eventually leads to failure of the system as a whole. Regardless of the material used in the rod guide, eventually the material will get worn due to adverse well conditions.

Rod guides do not protect the tubing effectively when dogleg severity exceeds 2 degrees per 100 feet. The increased friction from the application of guides causes compression in the rod string where the rods are unguided. Rod guides containing fiberglass should not be used in IPC tubing because they could damage the lining and lead to accelerated failure.

ALTERNATIVE ROD GUIDE SOLUTIONS

Polyketone rod guides offer more benefits than traditional rod guides. They extend equipment run life because of their excellent impact and wear resistance, low friction coefficient, chemical resistance, and gas barrier properties. Polyketone guides can be molded to any type of rod, inspected or new.

Due to these advantages, polyketone guides are being tested as an alternative to existing rod guide material. We have installed polyketone rod guides on more than 60 wells since February 2017. Of those installations, we have only had two failures in the rod guide section, while the rest have been unrelated failures. We are continuing to gather information on what caused these two failures and how they will shape future installations. The failure rate of the trial wells averaged 1.78 before installing the polyketone guides, and we have not seen any failures after installing them that were related to the guides, and average run time is 200 days, whereas the pre-install mean runtime was 294. Currently, the median run life of the pre-install (191 days) and polyketone wells (188 days) are relatively similar, indicating that most of our wells will exceed the previous run life without the polyketone guides. [PJM1]We are still in initial trials, but the available data look promising.

<u>OPERATING PHILOSOPHY</u>

The majority of failures in beam-pumped wells are attributed to rod/tubing wear in the body. Some of these failures are due to adverse well conditions, such as well deviations, side load forces, and reservoir fluids, which must be considered in the design for effective operation. The remainder of these rod/tubing wear failures occur under normal day-to-day operations, in which intermittent wear over time eventually leads to failure. The preference would be to eliminate the causes of such wear scenarios, but we can design the equipment to mitigate the intermittent wear using improved polymer rod guides. The impact- and wear-resistant material is resistant to most oilfield chemicals, resistant to gas penetration, and capable of reducing rod wear and coupling slap through decreased friction between the rods and tubing. Initial trial wells were selected based on their history of tubing failures due to rod wear.

The improved polymer guided rods should be applied if any of the following criteria are met:

- Guide all rods in unanchored tubing below the TAC[PJM2].
- Failure history contains any wear-related failures within the previous 3 years
- Beam wells in the higher range of Polished Rod Velocity (PRV = SPM x SL[PJM3])
  - Conventional Units > 1000 PRV
  - Special Geometry Units > 800 PRV
- When using the new polymer rod guides to help prevent rod-on-tubing wear in vertical wells, you do not need to conform to typical guided rod designs. You can customize the guide placement on the rod string to meet specific needs based on the wear patterns and pumping conditions. Our recommendations are:
  - 5 guides per rod below the TAC (place a stabilizer bar between any sinker bars used in this area)
  - 3 or 4 guides per rod in the bottom 1/3 of the rod string above the TAC
  - 2 or 3 guides per rod in the middle 1/3 of the rod string above the TAC
  - 1 or 2 guides per rod in the top 1/3 of the rod string above the TAC

On our trial wells, we saw an average reduction in the maximum load of about 240 lb through friction loss and an average increase in the minimum load of about 300 lb due to denser polyketone guides. On proactive trial wells where we replaced only the existing guides with the polyketone guides, we did not see any change in runtime, cycles, or a loss in total fluids. There is no correlation between running improved polymer guides and increased failure rate on wells without large deviations. Because of this and the improvement in the max/min loads seen due to decreased rod/tubing friction, we recommend running guides using the above criteria to mitigate rod/tubing wear. Because of the increased reliability of these improved polymer guided rods, it is important to have a good preventative maintenance program and field oversight of the rod and tubing rotators to extend the system run life.

<u>CONCLUSIONS AND RECOMMENDATIONS</u>

In conclusion, there is an economic benefit in applying improved polymer guided rods in wells where we expect rod-on-tubing wear. Not only will there be extended run times when applying these polymer guided rods in conventional circumstances (e.g., high deviation, high side load forces), but applying the practice for normal operations has the potential to improve run life and mitigate failures. We are currently testing the guides on wells that do not meet traditional rod guide requirements, and initial results look promising.

NEXT STEPS

As additional opportunities present themselves, we will continue applying improved polymer guided rods proactively and reactively to create a larger data set and shape our design strategy going forward. Depending on the results, we will continue to expand using different guide materials and material providers to drive cost efficiencies and extend run times.

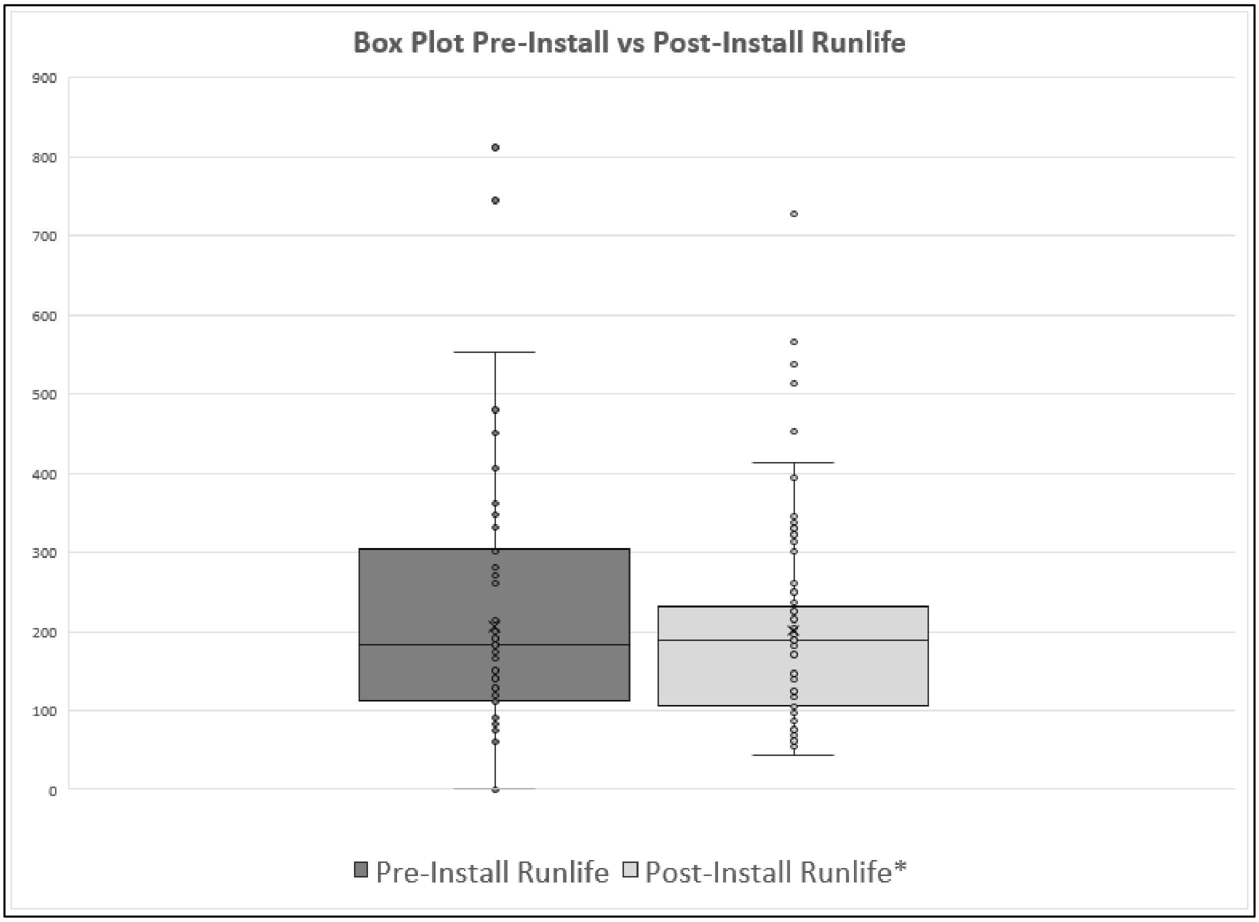

Figure 1 – Box Plot: Pre-Install vs. Post-Install Run Life
*If they have not failed yet, then runtime as of 01/31/19