NHT ROD GUIDES EXTEND LIFE IN HIGH TEMPERATURE WELLS

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ABSTRACT

Synthetic Polyphthalamide (PPA) has greater resistance than many plastics to a broad range of chemicals and is widely used in the manufacture of sucker-rod guides when operating at depths where temperatures can reach 300°F (149°C). However, while rated to 400°F, field experience has shown that under certain conditions, the service life of sucker-rod guides constructed of this material can be adversely affected at depths with temperatures as low as 220°F in continuous use. After extensive research, followed by nearly two years of field testing, the solution was found: a new type of molded-plastic sucker-rod guide, with a proprietary polyether ether ketone (PEEK) blend. The new PEEK-blend sucker-rod guide is an ideal replacement for synthetic polyamide models in shale wells because PEEK is a thermoplastic that retains its mechanical and chemical-resistance properties even at high temperatures.

INTRODUCTION

Synthetic Polyphthalamide (PPA) has greater resistance than many plastics to a broad range of chemicals. It is widely used in the manufacture of sucker-rod guides. This quality, along with high strength and stiffness at high temperatures, is why PPA has been preferred over metal and other plastics when operating at depths where temperatures can reach 300°F (149°C).

However, while rated to 400°F, PPA is not rated for that temperature during continuous service. Field experience has shown that under certain conditions, the service life of sucker-rod guides constructed of this material can be adversely affected in continuous use temperatures as low as 220°F. When combined with the varying types and amounts of fines, solids, and corrosive elements in the production tubing, rod guides will wear faster than in a well with lower temperatures.

Previously, maximum temperature limitations were based on dry, controlled-environment testing conditions. Current industry practice for rod-guide polymer selection is based on Continuous Use Temperature (CUT). Characteristics of the environment, such as bottom hole temperature, chemicals used, side loads, duration of operation, water cut, the viscosity of fluid, and deviation are key parameters, which reduce the CUT for PPA guides.

PPA-based compounds can experience rapid degradation, with greater than 50% loss of strength, after six weeks of continuous exposure to water at 250°F and complete disintegration after one week of constant exposure to water at 400°F. The combination of chemicals in an aqueous solution at elevated temperatures causes oxidative degradation of the molecular structure.

Premature and excessive wearing of sucker-rod guides in high temperatures pose serious problems. Sucker-rod guide failure leads to coupling and tubing wear, ultimately a potential hole in tubing (HIT). In extreme cases, sucker-rod guides can begin to disintegrate and incorporate small pieces into production fluids. In such an event, fragments can enter the pump and plug flow lines causing substantial issues. Both cases result in costly downtime and deferred production.

CHALLENGE

Starting in 2015, a major U.S. shale operator, experienced a series of sucker-rod string failures in the Eagle Ford area. In the third quarter, eleven (11) strings failed, with a Mean Time Between Failure (MTBF) of 471 days. All of the failed strings were equipped with PPA sucker-rod guides. Bottomhole temperatures ranged from 270°F to 295°F. Failures occurred at depths of 6,950 ft. to 10,756 ft. Levels of H2S ranged from 5 to 2,000 ppm. Maximum side load in the failure section ranged from 80 to 115 lb./rod. Sucker-rod guide failure was attributed to the exposure of PPA guides to an aqueous solution, at elevated bottomhole temperatures.

DEVELOPMENT

After extensive research, followed by nearly two years of field testing, the solution was found: a new type of molded-plastic sucker-rod guide, with a proprietary polyether ether ketone (PEEK) blend. The new PEEK-blend sucker-rod guide is an ideal replacement for synthetic polyamide models in shale wells because PEEK is a thermoplastic that retains its mechanical and chemical-resistance properties even at high temperatures. In fact, PEEK melts at a very high temperature (650°F /343°C) when compared with most other thermoplastics.

When blended with other plastics, PEEK has shown that it contributes to reliable performance in operating temperatures as high as 480°F (249°C). This performance fits perfectly into the sweet spot for sucker rod guides used for continuous duty in deep, high-temperature shale wells.

The manufacturing process for the new PEEK-blend sucker rod guides is more demanding than for those constructed of synthetic polyamide. Also, more strenuous manufacturing controls are required, and there is a higher cost for materials. As a result, the new-technology, PEEK-blend sucker rod guides are roughly 33% more expensive than traditional PPA guides. However, this cost difference is more than offset by an increase in ROI, performance, well uptime, and service life.

Norris incorporated manufacturing process improvements such as new-design injection molding machines, with chilled molds and raw material dryers. These process improvements, as well as tighter controls, reliably produce guides with a homogenous microstructure, which is a critical requirement.

Proprietary PEEK-blend Norris NHT sucker-rod guides, with a higher maximum temperature rating than traditional PPA guides, were offered after a year of field testing to test in new well applications. The high-temperature guides offer better durability in challenging bottomhole environments, where temperatures are greater than 250°F.

SOLUTION

Initially, NHT guides were installed in 17 test wells. Six wells had alternating guides: one rod with PPA guide material then one rod with NHT guide material in the highest temperature zone. The other 11 wells were all NHT from approximately 7000 ft. to the pump.

CASE STUDIES

Well A:
Downhole Temperature: 264°F
Maximum Side Load: ± 890 lbs
Minimum Polish Rod Load 10,143 lbs /Peak Polish Rod Load 36,735 lbs
Solids: 39,107.47 mg/L
Specific Gravity 1.027 g/cm³
pH: 7
Rod Rotator
168” Stroke, 6.5 SPM
RM912-427-168 90110RM Cranks (C’wise)

Pump Depth 8,942’
Pump: 25-150-RHBM 20-5-4-2
170 BPD
200’ 1-1/2” C Sinker Bars
300’ ¾” KD 2124NHTS
300’ ¾” KD 2124PPAS
500’ ¾” KD
300’ ¾” KD 2124NHTS
2300’ ¾” KD 2124PPAS
1500’ 7/8” KD 2124PPAS
600’ 7/8” KD
600’ 7/8” KD 2124PPAS
800’ 1” KD
1500’ 1” KD 2124PPAS
1-1/2” x 36’ Sprayed Polished Rod
Rod Load 111 to 133%
Well produced 490 days with no issues.
No issues noted with NHT Guides, re-ran NHT guides every other rod for 600’ above the pump and 600’ above the unguided section.
Through 2/28/18 Run Time: 645 Days

Well B:
Downhole Temperature: 263°F
Max Side Load: ± 270 lbs
Minimum Polish Rod Load 11,679 lbs / Peak Polish Rod Load 35,327 lbs
Solids: 38,452.39 mg/L
Specific Gravity 1.026 g/cm³
pH: 7.5
Rod Rotator
139” Stroke, 7 SPM
RM640-365-168 90110RM Cranks (C’wise)
Pump Depth 8,753’
Pump: 25-175-RHBC-20-5-4.00-0.25
156 BPD
200’ 1-1/2” C Sinker Bars
800’ ¾” KD 2124NHTS – ran every other rod for 1600’ above the pump
1000’ ¾” KD 2124PPAS
550’ ¾” KD
2100’ ¾” KD 2124PPAS
125’ 7/8” KD
275’ 7/8” KD 2124PPAS
350’ 7/8” KD
1150’ 7/8” KD 2124PPAS
250’ 1” KD
2000’ 1” KD 2124PPAS
1-1/2” x 30’ Sprayed Polished Rod
Rod Load 94 to 138%
Through 2/28/18 Run Time: 702 Days

RESULTS

Mean Time Between Failure (MTBF) improved to 674 days on the average. NHT guides nearly eliminated premature sucker-rod guide failures in high-temperature environments in the test wells.

Another South Texas operator also experienced similar benefits from NHT sucker rod guides. One of this operator's wells had conditions of 300°F, 20 ppm H2S, with 150 lb. to 275 lb. predicted side load. After the rod string was pulled at 238 days for pump repair, the string was run in with NHT sucker-rod guides. The result: NHT guides outperformed reaction set polymers, PPS, PPS-X—all tested conventional organic polymers—and thermoplastic resins in terms of material loss and chemical permeability.

A second well of this operator, with conditions of 300°F, 140 lb. to 200 lb. predicted side load, and 50 ppm H2S experienced severe pump tagging and fluid pounding. At 261 days, the rod string parted. NHT guides installed on the new string outperformed reaction set polymers, PPS, PPS-X—all tested conventional organic polymers—and thermoplastic resins in terms of material loss and chemical permeation.

CONCLUSION

By extending sucker-rod service life and preventing premature tubing wear caused by guide failure, an investment in NHT sucker-rod guides can have a substantial return. For example, in a typical Eagle Ford or Bakken well, remediation cost including pulling the tubing string can exceed $80,000. This does not include the value of deferred production. NHT Guides eliminate these remediation costs and increases the MTBF for the well with a small additional cost of premium NHT rod guides.

Although the initial cost of NHT sucker-rod guides is roughly 33% higher than ordinary designs, the investment has paid off handsomely for these operators, and other operators with wells producing under similar conditions.

While some operators prefer to run NHT guides from top to bottom, for ultimate reliability, costs can be minimized by using PPA guides to the high-temperature zone and then NHT guides from there. Either way, operators can eliminate costly well-intervention, and keep the well online and producing.

Selecting a proven, field-proven sucker-rod guide for high-temperature applications will reduce your rod-pumping expenses. Regarding ROI, there are few better places in artificial-lift operations to invest money than in NHT premium sucker-rod guides.

ADVANTAGE

Norris NHT sucker-rod guides incorporate numerous advantages, including:

- Reduced tubing wear vs. other high temp plastics – wear characteristics similar to base PPA material

- 500°F max rating

- Superior chemical resistance in corrosive environments

- Reduced porosity vs. conventional rod guide plastics

- Proven Sidewinder design (higher erodible wear volume with minimal fluid turbulence)

- Injection molded–maximum adhesion to the rod body

- Separate hoppers for increased melt temperature, for zero contamination