MITIGATING PARAFFIN BUILDUP IN UPTON COUNTY, TEXAS – HARNESSING INNOVATIVE TECHNOLOGY TO PREVENT PARAFFIN BUILDUP FROM CAUSING AND CONTRIBUTING TO WELL FAILURES.

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ABSTRACT

At the start of their resurgence as technology industry leader, Apple rolled out an ad campaign in 1997 featuring various individuals renowned for their contribution in modern society. The photos featured individuals such as Albert Einstein, Thomas Edison, Pablo Picasso, among others with the slogan “Think Different”. The phrase encapsulated the notion that Apple’s approach to computers and technology was singularly different than the competition.

In a similar manner, when issues are addressed at Diamondback, we consider the industry standard but we’re always seeking how to do things better. Recently, an opportunity presented itself with the possibility to work on the age old paraffin dilemma on a legacy producing field. The framework for the study was already in place and the options were wide open towards any method for achieving the goal.

As Apple’s tag line in the late 1990’s stated, this goal required us to ‘think differently’ towards the issue of paraffin and enabled us to find a solution that works in the focus area. This study encompassed a systematic approach towards finding a solution to the costly nuisance of paraffin formation. This particular solution utilizes technology that mitigates paraffin formation, prolongs well run time, and ultimately reduces operating expenses for Diamondback wells.

INTRODUCTION

Paraffin problems have existed since the beginning of the oil industry. They are Commonly addressed as long chain alkanes due to dehydrated oil, often caused by temperature drops, pressure changes and increased gas production. Common treatment methods include varying degrees of wax crystal modifiers, Solvents such as xylene or toluene, treated hotwater or hot oil applications and tools such as paraffin knives during workovers.

The focus field was called the Bloxom field in Southeastern Upton county, 45 miles south of Midland, and contains the worst paraffin among fields in Diamondback’s portfolio. Initially a multipay stacked vertical play, known as the Wolfberry, later turned into the company’s first horizontal unconventional field targeting the Wolfcamp B and Lower Spraberry shales. All wells during the period of study were in their exponential decline.

Map 1 showing Upton County and the focus area within the circle can be found below in the Appendix section.

Any well work or repair is first met by dealing with paraffin on these wells. The cloud points typically occur from surface to 3000’ below surface. Rig time lost due to dealing with paraffin averaged 1-2 days. Worst case scenarios were up to 5-7 days ***prior*** to focusing on specific cause for workover. Hot watering, pumping solvent, pulling incrementally over string weights, rod stripping and hacksawing were all common use methods for freeing the rodstring and clearing the tubing.

Photos 1-2 in the appendix are example well pulls that show the level of paraffin we deal with on wells that were being treated with conventional paraffin chemical on either weekly or biweekly scheduled treatments. The last photo is the most significant as it illustrates very thick paraffin engulfing the rod and occupying every void space between it's outer diameter and the inner diameter of the tubing.

Initiating what would become our version 1.0 test, we set up parameters for our study. We issued opportunities to 3 companies with unconventional methods of treatment including nano-particles and aromatic blends. We also retained our conventional chemical company for baseline comparison. The test would be a 3 month duration with a well pull at the conclusion for physical examination of the results. By design, we yielded to the chemical provider for treatment frequency and methodology. Our pumpers implemented regular backpressure and check valve monitoring for surface physical samples. We also utilized flowline recording devices to monitor live pressure/flowrate trends to help observe effects of treatments.

After the 3 month period concluded, we began to pull the test wells unannounced to keep all contenders on an equal field. Evaluation proceeded. Rods were pulled without help of any external factors, such as hot watering or rod stripping. We found that in some instances paraffin formation began regenerating within 2 weeks of initial circulation. One of the companies had varying pressure and flowrate trend changes after the application of each subsequent treatment. Another of the contenders showed clean surface samples throughout the test period yet had to work fairly aggressively for several hours to unseat the pump due to the paraffin accumulation on the rods. All results contained light to moderate hydrated paraffin with some examples involving moderate chunks of paraffin. None of these options were any more beneficial than our existing methodology.

Photos 4-6 illustrate a sample of results after the three month trial with the 4 chemical companies. So there we were, unsatisfied with the results. None of the options worked any better than what our existing treatment could yield. It was time to think differently. The credit going forward goes to one of our geologist, who happened to see Revelant at a conference. He mentioned the encounter and that's when Diamondback was introduced to Revelant's Enercat tool.

DISCUSSION

The Enercat is a passive resonance filter made from aluminum alloy. The tool works similarly to a transducer. Using the ambient temperature from reservoir fluid, a one way reaction occurs enhancing the fluid's natural amplitude preventing colloidal solids from coagulating to each other and other solid surfaces. This reaction doesn't reverse as temperature decreases or as fluid flows up through the tubing and into production facilities. This tool is about four foot long tubing short joint. It should not to be confused with magnets or tools using radio frequencies as were utilized in the past. The Enercat is a completely passive tool without a need for external power.

After learning of the Enercat's trial runs in other producing regions and visiting with Dr. Amber Krummel - Revelant's Chief Technology Officer, we elected to try tools out on several of our worst example wells and trial the wells for a separate 3 month period.

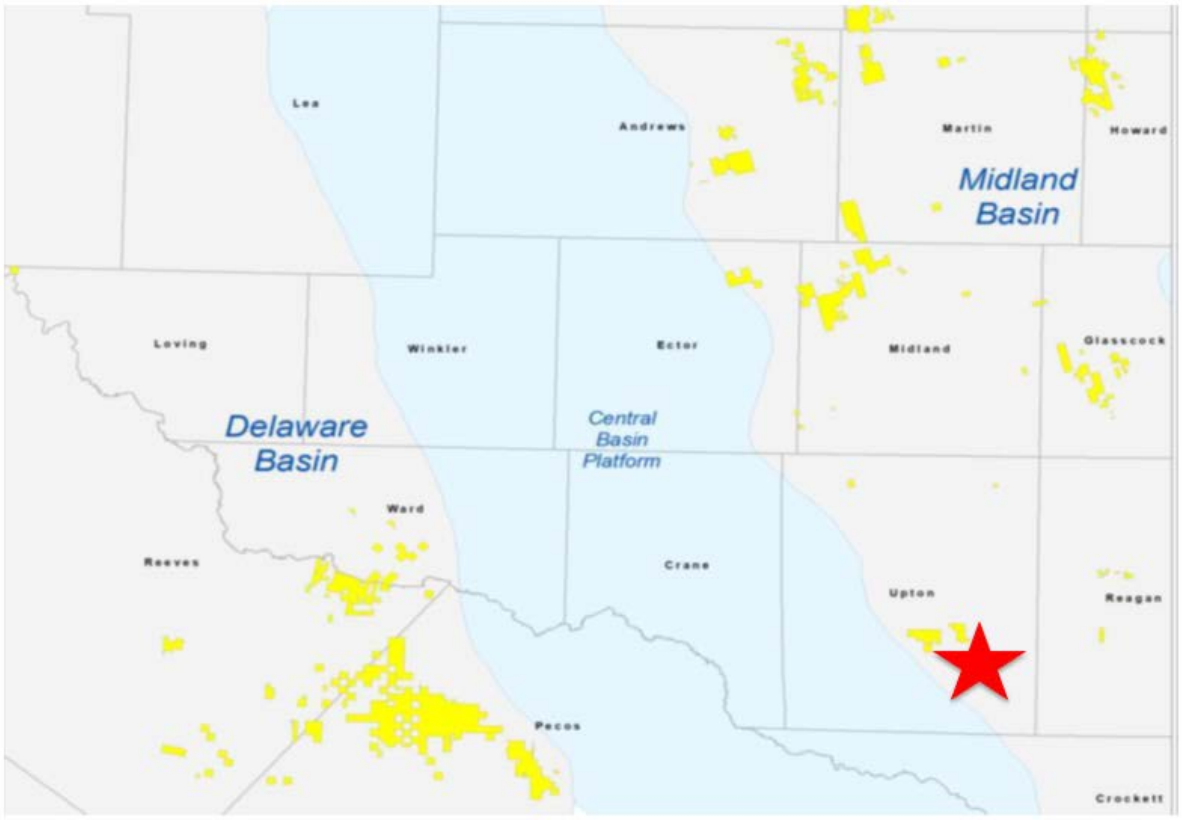
This Test involved 7 candidate wells, 2 of which were horizontals and the remaining 5 were verticals and similar to test 1.0, the following parameters. The test wells were pulled to install tubing variant in each well, above the intake, below the seat nipple. The wells were allowed No paraffin chemical treatment while the tool was in the ground. Only corrosion chemical would be pumped in test wells through the period. The Pre-test and post-test fluid samples from the wellhead analyzed for trend changes. As before, our pumpers monitored the check and backpressure valves and regularly checked for paraffin accumulation. At the conclusion of the 3 month test period the wells were to be pulled to determine physical evidence of results, supported by detailed notes in report and photos. Results are indicated by a description below but the evidence is well represented by the photos below.

The first install was in the Betty Ruth #3. The communication was a little unclear during this first installation. We ended up installing the tool beneath the intake. But ultimately it didn't appear to make any clear difference. We had to zoom in on the photos on to find traces of paraffin (see Appendix, **photos 7-9**). The tools were placed above the pump intake and below the seat nipple in the remainder of the examples. Slight nodules were present on the Neal 8 #7, but hardly any build up occured on the rod upsets. The Janey 16H, Diamondback's first horizontal well, had to be pulled early at 2 months into the test due to a failing pump. However virtually no paraffin was present on the rods. We had to pull the tubing on this well but had no presence of paraffin during that trip out either (see Appendix, **photos 10-11**). When pulling the Janey #3, all rods were hydrated with slight traces of non uniform paraffin on the bodies. The Janey 4H, another horizontal well, also yielded no paraffin. At the later point of this timeframe, our rig was able to conduct a roundtrip with the rods in addition to rigging down and moving on to the next well in about 8 hours. The savings in time and rig associated costs became blatantly obvious. Our last well was the Crystal #1. This well was down, not pumping for a week prior to the workover, and **that's important** because it's possible that paraffin also forms when a well is not moving fluid, but here we see it wasn't an issue. We later found an electrical issue in the drive box preventing the well from pumping. Interestingly though, with no fluid moving for a week, this well had only miniscule non-uniform sheath of paraffin on a few rods at it's worst – none of which were problematic (See Appendix, **photos 12-13**)

Moving on toward the most important thing, cost. The cost of the Enercat tool is a onetime purchase represented by the blue curve on **Plot 1** in the Appendix, Whereas our aggregate expense dealing with paraffin conventionally is ongoing. Diamondback's conventional method cost is comprised of 3 things: annualized batch treatment costs, annualized costs dealing with paraffin during workovers, and annualized cost of equipment replaced during workovers due to paraffin. As can be observed in the plot, Diamondback's conventional method costs, in the orange curve, accumulate over time whereas the Enercat method involves a one-time expense. Payout time is slightly more than 1.5 years when compared to the conventional method, but the cost savings averages about 2-3 times over a 5 year period.

CONCLUSION

In conclusion, these numbers were based on a 3 month test, We are continuing the observations in those wells as time progresses. But we're optimistic by what we continue to see so far. Diamondback Energy will be continue to utilize Enercat technology on wells where severe paraffin is known to exist, in an effort to mitigate paraffin formation, prolong time between failures, and ultimately reduce operating expenses.



Map 1 Illustrates the entire Permian Basin, with the star notating Diamondback Energy's Bloxom field.

Photo 2 Illustrates paraffin stripping while pulling out with rods on a typical workover in Bloxom.

Photo 3 Illustrates paraffin occupying every void space between the rod and tubing during a recent workover.

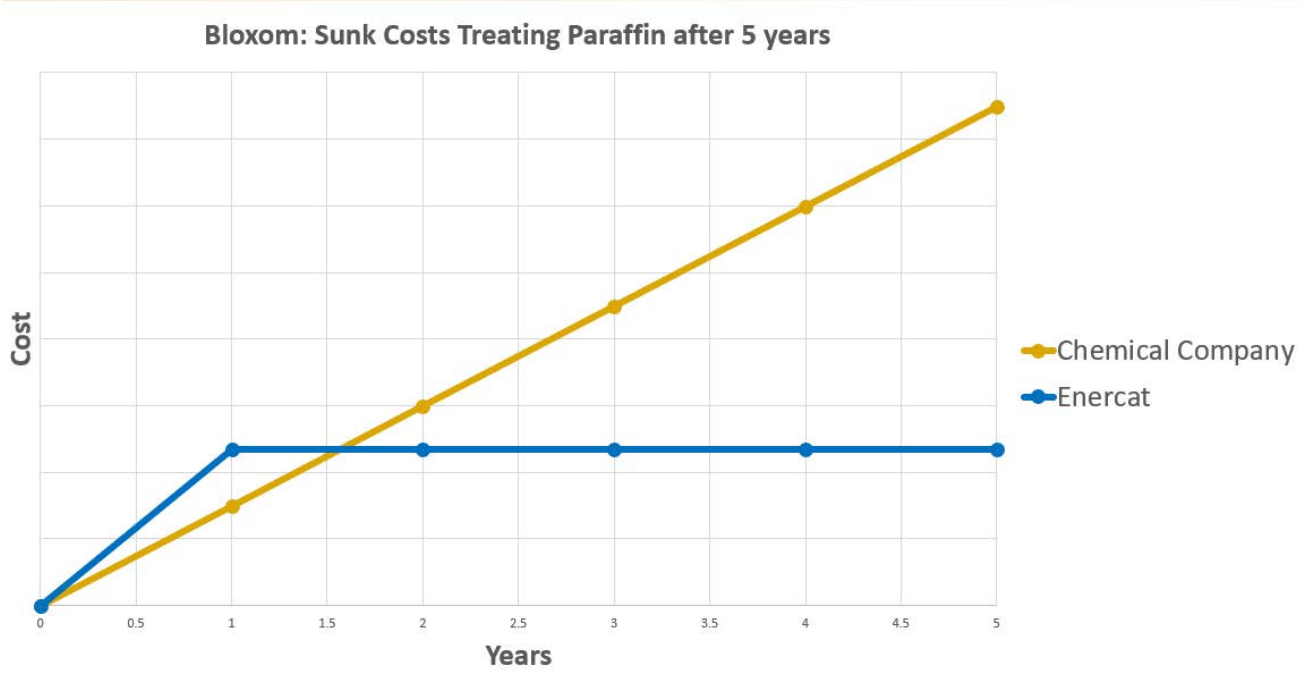
Photos 4-6 illustrate results of three unconventional chemical methods during a paraffin treatment trial test that took place during a three month duration.

Photos 7-9 Show the post test rod pull on the Betty Ruth #3.

Photos 10-11 Demonstrate the Enercat's work on the Janey 16H, clean rods and clean tubing.

Photo 12 Shows the paraffin level in the Crystal #1 prior to the Enercat installation.

Photo 13 Shows the results of the three month test on the Crystal 1 rods.



Plot 1 Illustrates the cost savings over time comparing the Enercat vs. an aggregate of conventional methods for treating paraffin.