SOLVING COMPRESSION RELATED TUBING PUMP FAILURES

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INTRODUCTION & HISTORY

Since becoming a Lift Specialist in November of 2019, it was very clear we had significantly higher failure frequencies on wells with 4.5” liner, 2 3/8” tubing, and 1.75” tubing pumps vs other configurations. My knowledge is solely based on South Plains and the problems we faced.

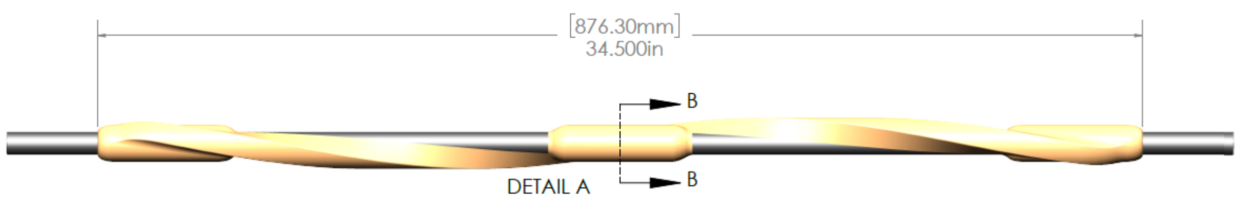
One of my counterparts had reached out to the pump shops to understand how we could beef up pull rods inside of tubing pumps. It was discovered that a 1-1/16” pull rod could be ran in 1.75” and 2.00” insert pumps. Oxy began taking this route immediately, but stimulated other thoughts; what could be ran in a tubing pump to help beef up the pull rod/stabilize it better?

Oxy had a few different options which had been tried in the past.

1) Land the pump barrel in tension above the TAC to create better stabilization vs. leaving the pump at the bottom of the hole allowing for movement.

2) Change our pull rod and increase the diameter from 7/8” to a 1.25” sinker or polished rod for more durability (common practice).

Several weeks later, Oxy went on a field trip to one of our trusted pump shops. While there, we noticed a Black Mamba guided rod on top of one of their racks. This particular rod was a 3/4” rod with guides fitted for 2 3/8” tubing.



Tubing Pump Stabilizer Guide for Strickland.

Traditional guided sucker rods cannot scope in and out of tubing pump barrels – dimensionally, they do not fit properly. With Complete Rod Control™ already achieved and realized on sucker rods throughout production tubing, can we develop a guide with a manufacturer which is specially designed to fit inside of tubing pump barrels, and clear the collars and other components which are the restriction?

THE PUPOSE

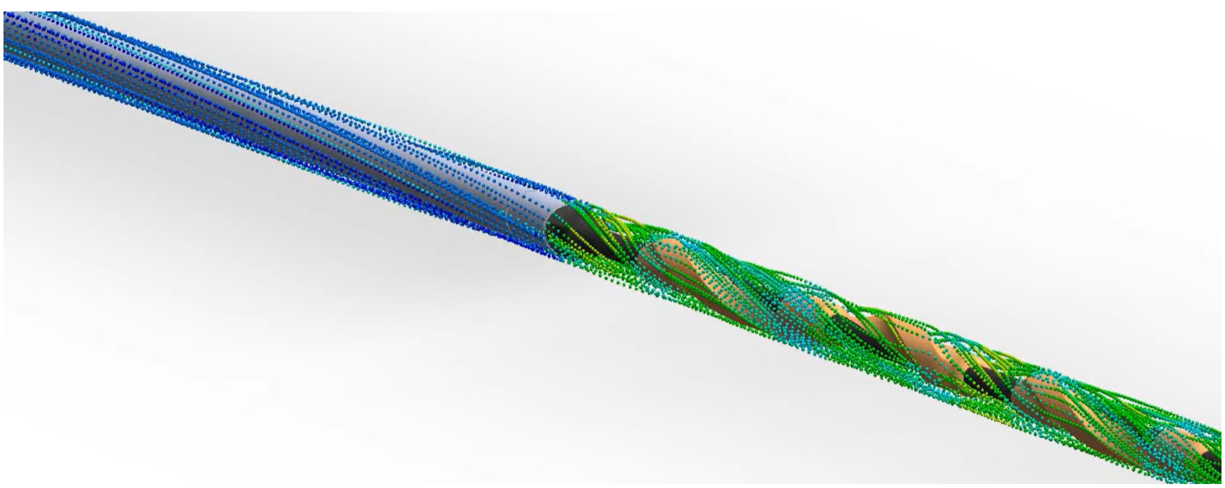
Oxy had already begun collecting data as it relates to split tubing pump barrels or pull rod failures, prior to this idea. Data had been compiled on 88 wells with tubing pumps, and was used to determine the best design of landing the pump barrel in tension above the TAC or at the bottom of the tail pipe.

Failure mechanisms were primarily split barrels and broken pull rods due to wear or coupling breaks.

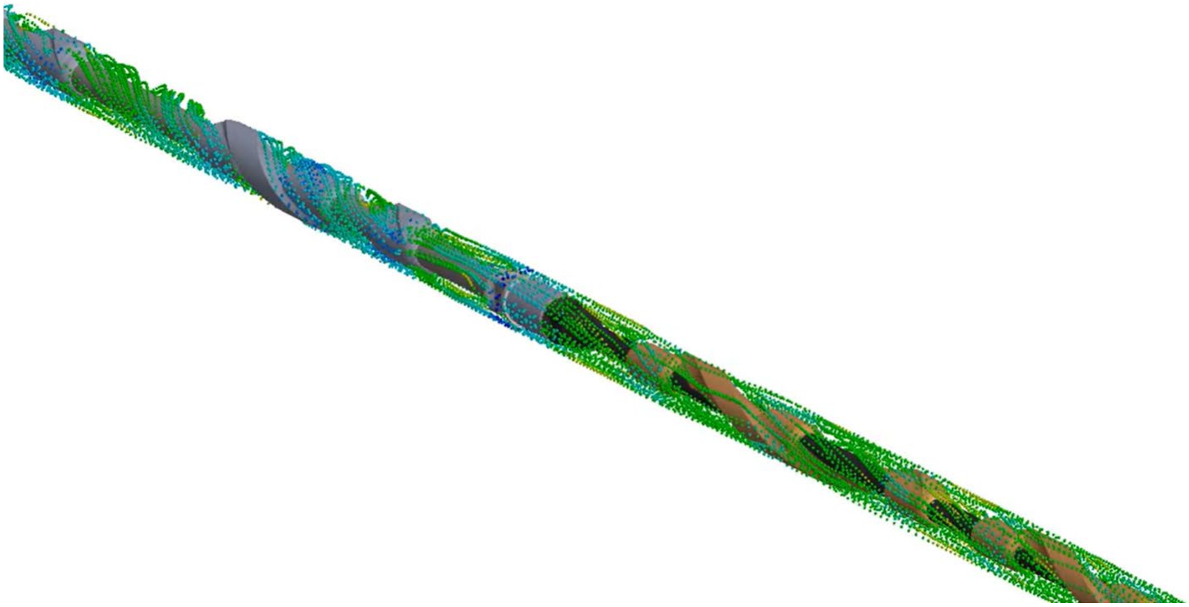
Preliminary results showed that the barrel in tension had significantly longer RT than the barrel landed below the TAC (> 2 years on average). Understanding there could be some production loss associated with raising the pump above the TAC, how do we balance production and longevity? Was there a way to get the best of both? Either way, the answer was the pump should be stabilized to gain the best results.

PRODUCT DESIGN

Courtney Richardson and Jonathan Strickland of Occidental worked directly with Jonathan Martin and Blake Cobb of Black Mamba Rod Lift to design and run computational fluid dynamics (CFD) analysis for flow-area and pressure/restriction analysis. The goal was to compare 1.25” sinker bar/polished rod as a rigid pull rod versus and fully centralized and protected 3/4” sucker rod feature Complete Pull Rod Control.



Tubing Pump Pull Rod to Sinker Bar Transition.



Tubing Pump Pull Rod to Sinker Rod Transition.

After review, Oxy elected to pursue a pilot testing program of the guided tubing pump pull rod. This required special mold tooling specific to our needs in our pumps.

In addition to the guided pull rod, it was agreed to run 1” CRC sinker rods above the pump, and to use CRC guided rods at every taper break (4 mambas each side of the taper break in every taper) in conjunction with the plunger stabilizer rod, a unique dimension Black Mamba guided 3/4” Norris N90 (DS/KD) sucker rod.

TRIAL DATA

Over 10 wells feature an End-to-End Rod Control Pull Rod from Black Mamba.

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Well Name	Install Date	Previous Run Days	Current Run Days with Stabilizer
CLU-181	10/20/22	637	154
CMU-225	9/9/22	425	195
LLU-591	11/9/22	1476	134
SEU-2-28	11/11/22	189	132
SEU-2-75	11/21/22	164	122
SEU-4-28	10/1/22	358	173[1]
SEU-4-7	10/3/22	202	147 Days[2]
SEU-7-2	10/7/22	277	167
WRKM-52	11/18/22	1133	125
WSDU-37	9/28/22	364	176[3]
CL-500	1/10/23	1370	72
SEU-2-112	1/6/23	208	76
SEU 4-21	2/1/23	175	50

[1]Failed 12/27/22 for pump fail; 1/23 pulled and had all rods and plunger minus SV assembly. Did not find tubing leak when hydrotesting. Waiting for pump report. Reran Mamba Stabilizer Rod.

[2]Failed 02/27/23, parted in 68 RFS between 2 guides. Similar failure mechanism to FU 0120. Will submit rod sample to Norris via Black Mamba. Converted to flowing to explore other MOP's. This is the only well in the subset that run time stopped accumulating.

[3]Failed 1/4/23 for tubing leak. Previous redesign with Mamba Stabilizer already had caused sustained damage to tubing leading to the short run. Reran Mamba Stabilizer Rod. Failure Sample to be shown at SWPSC.

CONCLUSION

In the wells which we have had well interventions, unrelated to the Black Mamba Stabilizer application, we observed little to no wear in the guides. We have observed no visible signs of erosion/corrosion in the steel rod sections throughout the Black Mamba Stabilizer Rod design and the Black Mamba sinker rod configurations above suggesting that the flow path through the single vein design is not creating a disruption in flow leading to turbulence.

Of the 88 wells examined in this study, 90% operate in a 4.5” liner and 2-3/8” tubing configuration. These wells are particularly challenging for Occidental as these are located in CO2 or water floods moving total fluids between 250-500 bbls with high GLR and low oil cut.

The challenge for us continues to be the balance of the operation of the wells (conforming to best practices) while not leaving any production behind. Naturally, these well configurations have the highest failure frequencies in Occidental's sucker rod pumped assets, but produce these particular wells have low oil cuts prohibiting us from making economic cases to convert to sub.

Much of lift design is a balance of trade-offs. Historically, the addition of a sinker bar or polished rod above the pump assembly was the only way to provide a more robust linkage which would be resistant to the buckling and wear related issues seen in tubing pump barrels and extensions. Large diameter sinker bar or polished rods restrict the flow path of fluid and force a decreased annulus space. A polished rod or sinker bar does provide protection against rod buckling, however, in significantly deviated wells very little could be done to centralize the large diameter rod. We still continue to see failures observed from wear with this approach. The polished rod or sinker bar solution in some instances also leads to:

1. Inhibitor wipe corrosion failures, or
2. Erosion failures due to the decreased annulus space between the rod and ID of the tubing. Many of our wells move heavy solid entrained fluid.

The Black Mamba Stabilizer was an alternative approach that provides the least amount of disruption to flow in the transition from the plunger assembly into the rod taper while also providing a more stable and wear resistant environment. In addition to increased runtime, we also believe that keeping our failure mechanisms withing the rod strings are *huge* OPEX savings, as tubing pull interventions are roughly 2.5x the cost of a typical rod part or rod pump failure.