A MULTI-LAYERED FILTERING SYSTEM ENGINEERED TO PREVENT 100-MESH FRAC SAND, THE MOST PREVALENT TYPE IN THE PERMIAN, THEREBY ENHANCING ROD PUMP LONGEVITY. PROVEN SUCCESSFUL IN FIELD APPLICATIONS ACROSS THE PERMIAN BASIN

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ABSTRACT

This paper presents a novel technology designed to address the challenges posed by 100-mesh frac sand (149 microns) in rod pumps, particularly in the Permian Basin. This sand often causes premature pump failures by clogging and damaging key components like the plunger and barrel. The solution extends pump run life and prevents pump sticking.

The multilayer filtering system leverages the concept of completion screens, a long-established technology in the industry, but with a redesigned approach to be integrated in the production cycle where it is compatible for rod pumps and is made to filter sand sizes ranging from 60 to 300 microns, effectively removing particles traditional vortex separators miss. Its innovative design includes eccentric layers with dimples, maximizing open area to nearly 40% across its 288-inch length. The modular setup allows multiple units to be combined, enhancing filtration capacity while minimizing pressure drop.

Field installations in the Permian Basin have demonstrated significant operational benefits. In one case study, pump run time tripled following the system's implementation, reducing well interventions and equipment replacement. This improvement also lowers the carbon footprint of operations.

Uniquely, this system integrates with vortex and gas separators for added protection against solids and gas. Constructed with premium materials and a robust assembly process, it offers durability and long-lasting performance for rod pump applications.

INTRODUCTION

Sand Problems:
Sand production generally occurs due to two primary factors: the strength of the rock and the prevailing production conditions, including workover operations. Given that over 70% of oil fields are developed in sandstone formations, many of which are unconsolidated, sand production becomes an inevitable aspect of hydrocarbon extraction. This issue can significantly reduce, or even eliminate, the profitability of projects with high failure rates.

Managing sand production is a major challenge in the oil and gas industry, as it compromises well integrity and disrupts production due to frequent, unplanned interventions. Addressing these challenges requires proactive risk management strategies, particularly in developing new and increasingly complex reservoirs. A key decision in this process is determining where to implement a sand control system—either at the surface facilities or downhole. Ideally, an integrated sand management approach (as shown in Figure 1) would be the most effective solution. However, the high capital costs associated with such an approach make it challenging. Additionally, most facilities are not originally designed to fully mitigate sand-related issues. From an economic perspective, the decision to control sand production can have a substantial impact, influencing net present value by more than 40%.

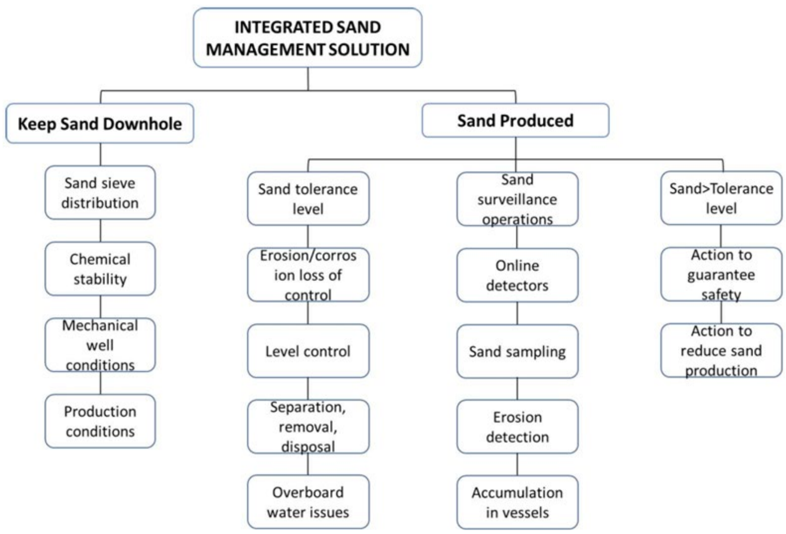

Figure 1- Comprehensive sand management

Sand Management Techniques:

In the oil industry, the term "sand control" is the most widely recognized concept related to sand management. It primarily refers to preventing sand from entering the production system (such as pumps and tubing), while the concept of sand management is less commonly considered. Even less known is the idea of homogenizing sand production at the well's bottom.

The most common approach to sand control is the installation of production screens. However, the typical design of these systems focuses on excluding as many solids as possible without accounting for other critical properties and phenomena that significantly impact their effectiveness. Additionally, the wire used in manufacturing these screens is usually rounded, which, compared to type V wire, provides a smaller open area for fluid flow (Figure 2), potentially reducing efficiency. This design often results in premature plugging, leading to well intervention and loss of fluid production.

Another frequently used sand control method is the installation of centrifugal separators. While effective, these systems require a significant number of tail joints beneath the tool to prevent premature filling (Figure 3). Without this precaution, unexpected well interventions become necessary, impacting project profitability. Furthermore, conventional sand control solutions are often rigid and do not integrate combined systems to mitigate sand production effectively. As a result, the success rate of sand control projects remains low, leading many companies to prioritize corrective maintenance over preventive strategies.

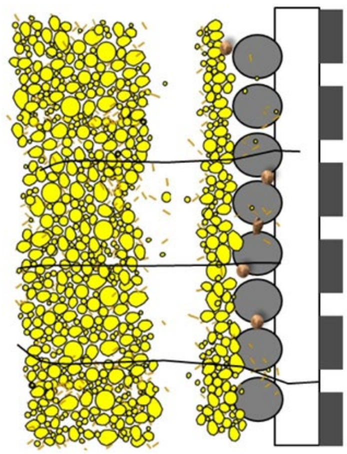

Figure 2- Bridges are created on the screen by large particles

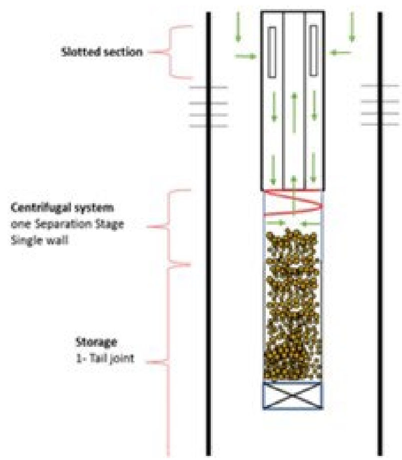

Figure 3- Centrifugal separator - One stage of separation

MULTI-LAYERED FILTERING SYSTEM

Overview:

The multi-layer filtering system (Figure 4) is an innovative sand control solution designed to enhance well performance in challenging conditions. It incorporates the idea of production screens as mentioned above, but enhances the design by using multiple layers which, when combined effectively, regulates and separates the most prevalent sand size that is the 100 mesh. This system also incorporates the second most frequently used sand control method which is the centrifugal separator that works in conjunction with the multi-layered filtering system. This results in maximizing sand control before it gets to the artificial lift system.

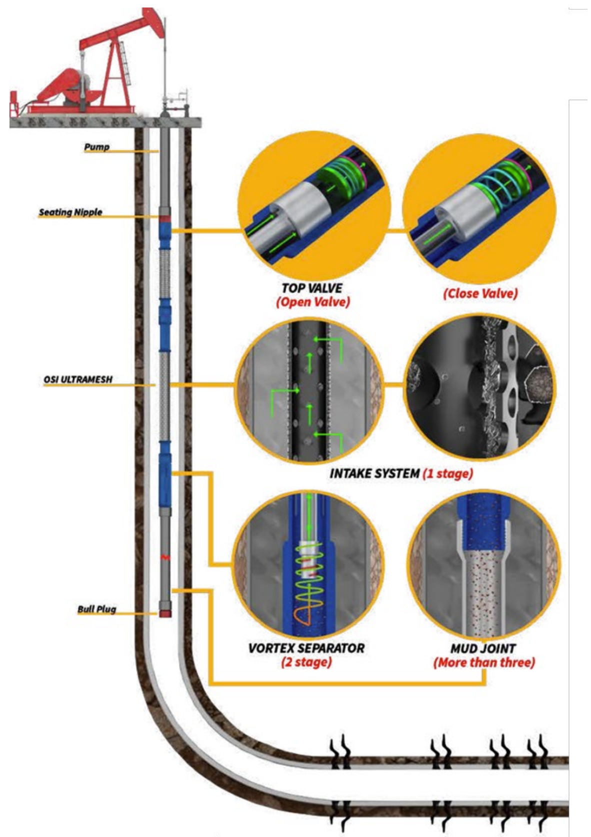

Figure 4- multi-layer filtering system

System Design and Components:
The system comprises of 2 key sections:

Multi-Layered Filtering System- The Filtering system is made of 4 Mesh Filters, as shown in figure 5, that are engineered in a way that ensures a separation range of 60-300 microns when it comes to the sand size being filtered out.

Figure 5- multi-layer filtering system

Centrifugal Separator – The Centrifugal separator is designed with engineered vanes that induce centrifugal force to the fluid to separate different phases like solids and liquid. The Centrifugal Separator itself is made of 4 key sections: the Sleeve, Body, Helix and inner pipe (Figure 6) that connects to the helix and communicates with the pump.

Figure 6- Centrifugal Separator and components

Auxiliary component

Bypass System

An additional component can be added on top of the multi-layered filtering system for severe sand conditions or if scale or other solids disallow flow through the filter. This component will bypass the filter preventing the pump from starving. Flow paths are shown below in Figure 7

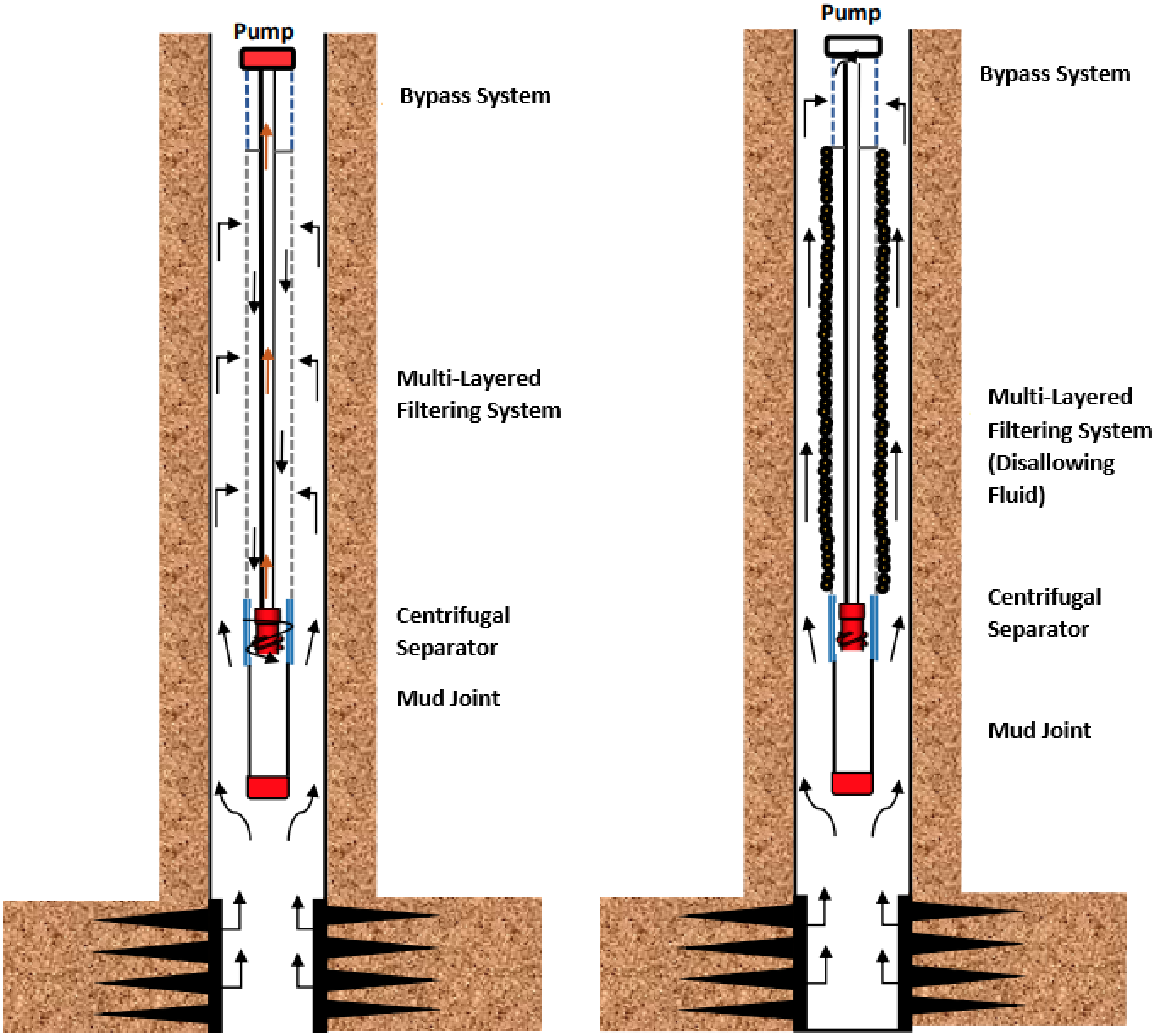

Figure 7- Bypass system in case of severe solids issues to assist the multilayered system

CASE STUDY

The performance of the Multi-Layered filtering system device is depicted through one case selected from unconventional applications on a hydraulically fractured well.

This well was in a Wolfcamp A formation and had issues related to stuck pump and had 3 short runs. The problem was determined to be fine foreign material, which is why a multi-layered filtering system combined with a centrifugal separator that is designed to filter out 60-300 microns sand sizes was selected to increase run time. After the installation, an overall improvement in run time was achieved.

The series of events will demonstrate the before and after results of the use of the multi-layered filtering System.

Historical summary:
April 2024: Rod and Tubing Issues, Pressure Testing Problems
In April, the subject well went down with a suspected hole in the tubing. Upon pulling the rods, severe coupling and rod wear were found. When the tubing was pulled, a bent joint was found along with 3 red joints and 25 green joints. These problems indicated early signs of equipment degradation and set the stage for continued mechanical challenges.

May 2024: Pumping and Pressure Holding Failures
During May, the primary challenges revolved around pumping inefficiencies and pressure retention failures. On May 11, the tubing failed to hold pressure during hot water treatment and was condemned for failure. This issue persisted until May 19, when a pulling unit pulled and replaced the downhole pump. After spacing out the pump, the tubing pressure held, indicating the tubing integrity was adequate. This also indicated that the pump had solids in it, causing fluid to leak by the pump when the pressure test was performed. The well was returned to production on May 20.

August 2024: Equipment Breakdowns, Rod Failures, and Pump Sticking
August saw another rod part and hole in tubing. On August 29 a pulling unit moved in and found the rods parted at 4718'. After failed attempts to unseat the pump, tubing had to be pulled to retrieve the parted rod. On August 31, after pulling all the rods and tubing, the bottom tail pipe was found packed with sand (Figure 8) along with several bad joints of tubing.

Figure 8- Sand found in the bottom mud joint.

September 2024: Rod and Pump Adjustments, Testing Challenges
On September 1, minor adjustments to the rod design and polish rod clamps were required to stabilize the well. Additionally, pressure testing showed inconsistencies,

requiring multiple long strokes to achieve the desired pressure. These setbacks, while less severe than previous months, indicated lingering issues with maintaining performance and equipment reliability.

October 2024: Severe Rod Wear, Stuck Pump, and Tubing Failures
October presented some of the most critical failures. On October 2, extensive wear was observed on guided rods, and a rod part occurred 4779’ down just below the rod box. The following day, on October 3, unsuccessful attempts were made to fish and unseat the pump. Eventually, the rods and tubing were stripped out of the hole. On October 4, tubing failures were identified, requiring hydro testing and tubing replacements. The repeated rod and tubing failures throughout October suggested that long-term wear and mechanical stress were severely impacting well performance, along with the repeated unsalvageable pumps due to solids in the pump.
In October, the operator decided to install the multi-layered filtering system (Figure 9) to combat solids issues and increase overall run time. This proved successful and the well has been running for 175 Days and counting.

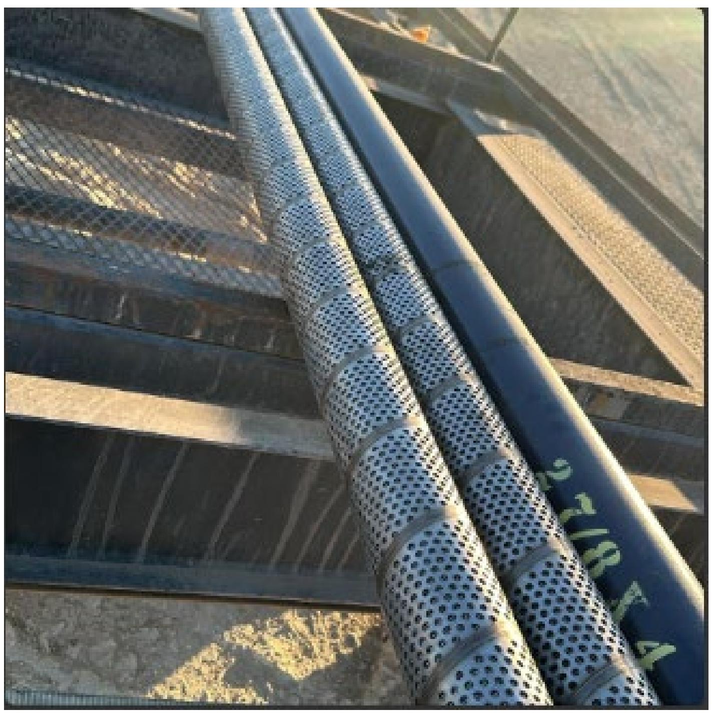

Figure 9- Multi-Layered Filtering System

The number of shutdowns causing downtime is shown below in Table 1, along with overall run time before and after the installation of multi-layered filtering system.

# Shutdowns	Start Date	Failure Date	Down Time (Hours)	Total Run Time (Days)
1st	4/12/2024	5/19/2024	314	37
2nd	5/20/2024	8/29/2024	120	101
3rd	8/31/2024	10/2/2024	226	32
Multi-Layer Installation				
	10/5/2024	Still Running	0	175 Days so far

Table 1- Historical summary of run time

The graph below (Figure 10) illustrates the pump SPM (Strokes Per Minute) trend over time. The black arrow shows before and after operational conditions where average speed was about 3.44 SPM compared to the 2.67SPM before, thus highlighting the fact that operational conditions were not affected after the installation of the multi-layered filtering system. In fact, the operator was able to keep the pump running smoother.

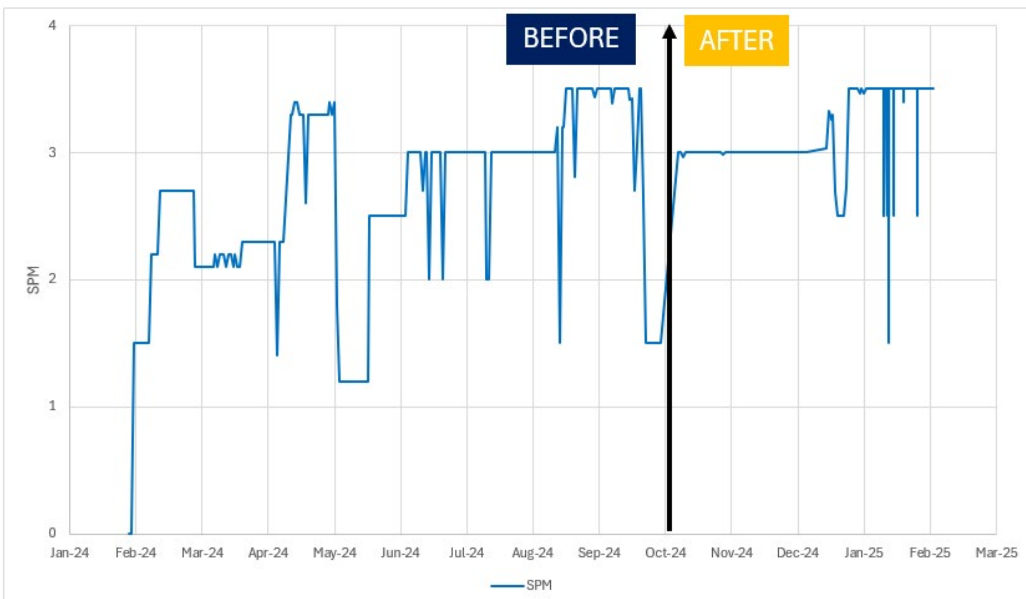

Figure 10- Pump Speed

Figure 11 illustrates the pump fillage before and after installation. As seen, the pump fillage after installation of the multi-layered filtering system has ups and downs but still running. One key observation to note when using multi-layered screen, the pump is not starving or showing signs of fluid pound. This means it is effectively separating 100 mesh that this well has previously shown issues with, while still having ample open area. Also shown is the latest pump card (figure 12) with about 80% pump fillage.

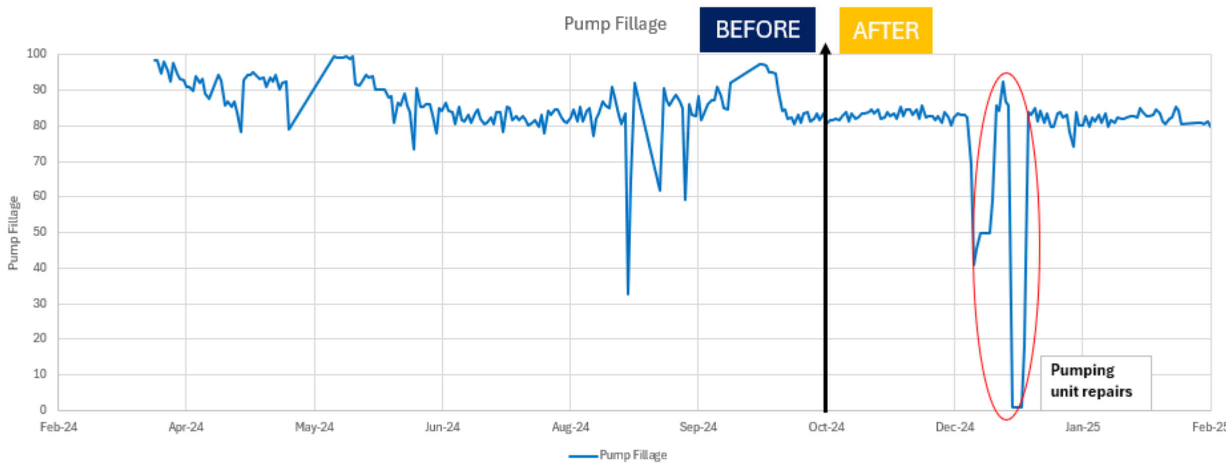

Figure 11- Pump Fillage before and after installation

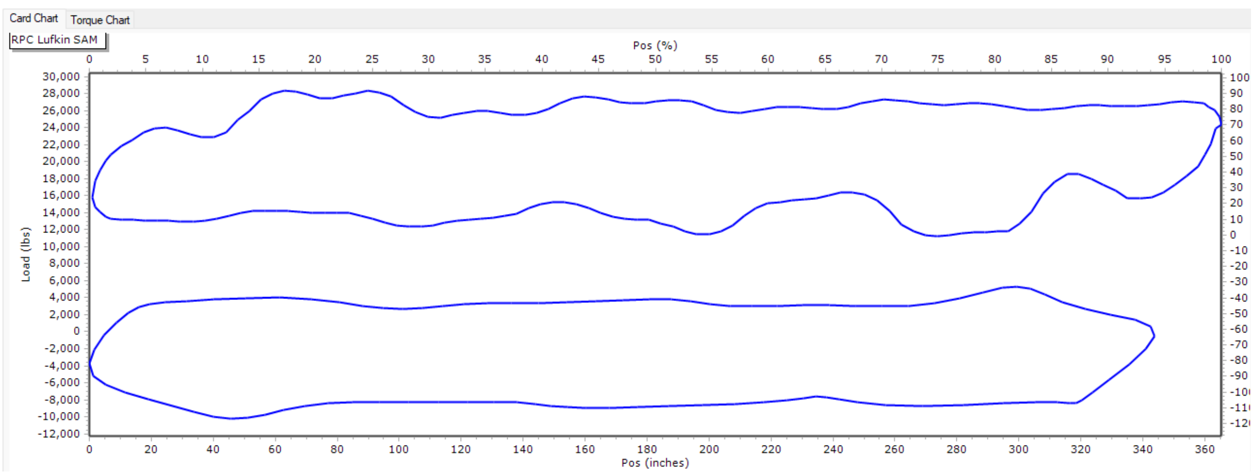

Figure 12- Latest pump card showing no solids interference

Figure 13 shows the graphics of production and pressure data over time, highlighting key metrics such as Gas Production (MCF), Oil Production, and Water Production. As shown below and as previously mentioned, after installing the multi-layered filtration system, production values maintained as before but without producing the erosive sand this time.

Figure 13- Production Data

CONCLUSIONS

- A Multi-Layered Filtering System is designed to tackle one of the most prevalent issues when it comes to sand related failures which is the 100 Mesh.
- A combination of a Filtering system and a centrifugal separator can regulate and separate sand production including slugs by filtering majority of the erosive sand, later relying on the centrifugal separator to handle the rest of it to maximize rod pump run times and minimize pump wear.
- Case study illustrates history of solids related failures in the past causing downtime and operational expenses.
- After the installation of the Multi-layered filtering system, a considerable improvement in run time has already been achieved.
- A common notion about filtering systems is that they get plugged quickly, which could be the case if the well conditions are not taken into consideration. Since this multi-layered screen was deemed to be the right application for this well, even with severe sand production history, the pump fillage reflects its nature of regulating the sand that is allowed to be caught in between the layers while allowing clean production fluid through.

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