SAND FLUSH PLUNGER PERFORMANCE IN THE HWY 80 FIELD

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ABSTRACT

Field case studies for the patented Sand Flush Plunger™ (patent #8,535,024) have been performed at the Hwy 80 field operated by Pioneer Natural Resources (PNR). Pump repair and well conditions data was collected from the pump and well tracker systems used by the service providers of the field. Standard pump repair information dated since 1989, while the Sand Flush Pump begun usage on 2009. Interestingly, the results show that the average run time for the Sand Flush Plunger Pump is 840 days out of 560 well workovers that used it, while for a Standard Pump (Metal and Grooved Plunger) is 561 days out of 5313 workovers. Within the 560 wells that have tested the Sand Flush Plunger, 161 used both types of plungers providing a more detail correlation. From these, the Sand Flush averaged 1333 run days compared to the 604 days of a Standard Pump.

INTRODUCTION

In 2012 at this same conference, it was presented a new pump configuration called the Sand Flush Plunger pump that consisted of a modified short plunger and a long barrel that together provided an alternative to improve the way standard pumps handle solids on sucker rod pump systems.

Traditional stationary barrel sucker rod pumps use a short plunger and a long barrel (Figure 1). The length of this metal plunger and diameter is generally defined based on fluid slippage calculations and clearance for particulates, while the barrel length is chosen based on plunger length and stroke length[1]. During the upstroke, fluid is lifted toward the surface above the plunger (high pressure side) while fluid enters the pump from the formation below the plunger (low pressure side). This translates into a pressure differential across the plunger of several hundreds or even thousands of PSI's. As the plunger is moving up the pressure of the fluid column is pushing fluid as slippage of fluid between the plunger and barrel interface which is necessary for lubrication. If abrasive particulates are being produced then they also are being forced between the plunger and barrel by the pressure and as the plunger moves up it runs over the particulates (Figure 2).

As shown in figure 2, the discharge point of traditional plungers is located a few inches above the plunger/barrel clearance which creates a relatively stagnant volume between the bottom of the fluid discharge passages and the beginning of the plunger/barrel interface. In this volume particulates can accumulate before being forced to enter between the plunger and barrel. To try to extend the life of the plunger and barrel, the patented Sand Flush Plunger™ uses a different fluid dynamic concept. This design has an internal valve rod connector with fluid discharge ports and sharp edge right at the beginning of the plunger/barrel interface (Figure 3). During the down-stroke of the pump, the fluid flowing through the plunger flushes any sand or particulates keeping them suspended in the fluid away from the critical plunger/barrel clearance.

The intention of this paper is to evaluate the performance of the Sand Flush Plunger at the Hwy 80 field operated by Pioneer Natural Resources (PNR) through the use of large amounts of data collected by the pump and well tracker systems since 1989.

DATA ANALYSIS

Harbison-Fischer (HF) received a data dump from Tommy White Supply (TWS) that contained pump repair information since 1989. This data consisted of fields such as Lease Name/Well Number, Pull Date, Failure, Key Fail, Pump Size, Run Days and several other fields that would describe the pump features (Table 1). As an example, see record on table 2.

In order to be able to study the data and find correlations, additional fields were added to capture key information from the existing fields. Please see below the explanation of the changes.

1) Addition of a **Pump Type** column to identify records where the Sand Flush Pump was used. Non Sand Flush pumps were identified as a Standard Pump. Several terms and phrases were used in more than one field to identify the type of pump used.

   - "Nsiw" in Failure column – Standard Pump.
   - "Siw" in Failure column – Sand Flush.
   - "Flush" in Failure column – Sand Flush.
   - "SF" in Failure column – Sand Flush.
   - "–SF" in Pumpsize columns – Sand Flush.
   - Any other record that didn't have the information above was flag as Standard Pump.

2) A **Pull Reason** column was added to the records to categorize the records into PUMP, TUBING, or ROD related failures. The data will be filtered to focus on PUMP related pulls instead of TUBING/ROD related failure. Out of the 850+ Key Fail descriptions, the top 20 make up 90% of the record data. The top 20 Key Fail descriptions were categorized as PUMP, ROD, or TUBING failures. Key Fail descriptions that were not clear enough were flagged as UNKNOWN. See table 3 for the conversion list of Key Fail used for this analysis.

RESULTS

The first analysis performed was a general understanding of the average run days of the Sand Flush Pump versus a Standard Pump. Creation of a pivot table that focused on one single Pull Reason (PUMP) took place. The filter for the pull reason was to exclusively concentrate the analysis on PUMP type of failures and avoid TUBING or ROD failures which would not provide a good understanding of the pump status. This filter is shown on the top section on table 4.

The bottom section of table 4 contains on the first column the 2 different types of pumps that PNR/HF are interested in analyzing, called for this study the Sand Flush and Standard Pump. The second column contains the average run days for each of the pumps and the last column shows the number of leases that have used both pumps with the PUMP being the reason for the repair. As you would expect the number of repairs that have seen a Standard Pump is significantly higher (about 9.5 times) than the repairs that have seen the Sand Flush. This is due to having records dated since 1989 up to the present year while the Sand Flush started being used just 7 year ago. This analysis shows an overall 50% increase in the average run days when using the Sand Flush.

Even though this result gives a general idea of the performance of both pumps, this may not provide a good comparison as the Sand Flush would be used in wells that have issues with solids and a Standard Pump would be used in wells were solids are not as critical. This prompted finding out wells that had data for both Standard Pump and the Sand Flush. There were 161 wells that matched these criteria. The Sand Flush had an average of 1333 run days compared to the 604 days of a Standard Pump. Also, for 71% of the wells that had used both, a Sand Flush and Standard pump, the Sand Flush increased the run days. Further analysis shows that excluding pump failures non-related to the plunger, maybe caused by the barrel or traveling/standing valve assemblies, increases the number of wells with larger run days due to the Sand Flush to 77%. Going even further, when selecting pump failures related only to plunger/barrel clearance, it was found that 80% of the wells had an improved run time by using the Sand Flush.

When looking through the failure description field, the need to create a new field was identified to try to better describe the Plunger/Pump Status. The goal to provide clear insights on how the plunger or pump was at the moment of the repair was achieved with this new field. As the title of the category states, the focus was given to the plunger and pump, so statuses related to the barrel, balls and seats, cages, valve rod and other parts of the pump were

excluded. Table 5 exhibits the average run days for both types of pumps (Sand Flush and Standard) for different Plunger/Pump status and the number of repairs that saw that specific status. Interestingly, 6 out of the 9 statuses (Plunger Good, Grooved, Pin Broken, Pump Good, Sandcut and Plunger Stuck) showed a better average run time when using a Sand Flush compared to a Standard Pump. Improved average run days from 1.07 to 6.50 times the run days achieved with a Standard Pump were observed. It is important to mention that Sandcut refers to fine cuts on the plunger commonly done by fine particulates such as sand, while Grooved relates to surface damage by larger elements like metal pieces or large portions of foreign material. Lastly, Worn pertain to plunger fit being out of tolerance. The numbers of repairs with the Sand Flush Plunger flagged as Worn or Sandcut-Galled were only 3 and 1, respectively, compared to the 25 and 1 instances that saw the Standard Pump Worn or Sandcut-Galled. Due to this, it's expected the data may not reflect an accurate comparison from these low amounts of records. Repairs that had the plunger threads Galled, showed that 5 out of the 7 consisted of the valve rod galling to the top plunger bushing, while 2 were related to the traveling valve cage.

Table 6 presents the average run days for both types of pumps but in this case correlates the information to the barrel metallurgy. The Sand Flush using it with a 501 CR CHROME barrel had an average of 1372 run days compared to the 641 days of a Standard Pump. Similar to the previous analysis, the number of repairs that have seen a BRASS CHROME barrel with any of the 2 types of pumps is too low to be considered. It is important to mention that the goal when using a BRASS CHROME barrel was to extend the life of the barrel due to corrosion issues and at the same time be able to use the Sand Flush plunger. Even though other barrel metallurgies have been used on various wells, a combination with the Sand Flush hasn't taken place due to limitations of the plunger or well conditions. It is important to remember that these detailed analyses were performed on wells that have used both pump types, and the pull reason and Plunger/Pump Status was PUMP related.

Table 7 displays similar information to table 6 but this time correlates the average run days with the pump size. One of the commonly used pump sizes (1¼) had an average of 1562 run days versus the standard pump which had 736. This is an improvement of more than 200%. The 1½ pump shows similar results with a 225% increase in run days. Based on the importance of plunger fit for the pump solid management performance, it was also observed -.005 fit on a Sand Flush Plunger Pump to be able to outperform the average run days of a Standard Pump by more than double.

SUMMARY

The Sand Flush Plunger Pump analyzed in this paper it is designed for wells with any kind of particulates. This was the way Harbison-Fischer and Tommy White Supply used to extend the pump life at Hwy 80 field. As shown by large amounts of records from the Hwy 80 field operated by Pioneer Natural Resources, the Sand Flush Plunger will most of the time increase the average run time compared to a Standard Pump with Metal or Grooved Plunger. Within the 560 wells that have tested the Sand Flush Plunger, 161 used both types of plungers providing an average run time comparison of 1333 when using the Sand Flush versus 604 days when using a Standard Pump.

In addition to the pump performance benefits, the Sand Flush Plunger is a very competitive plunger price wise. If compared to a standard Monel pin plunger with a Monel top plunger adapter (TPA), the Sand Flush Plunger can provide ≈8% savings in initial acquisition cost.

ACKNOWLEDGMENTS

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REFERENCES

1- Williams, B. J., Harbison-Fischer, "New Sand Flush Plunger™ for Particulate Producing Wells Using Reciprocating Lift Pumps", Proceedings of the 59th Annual Meeting of the SWPSC, 2012, pp 175-179.

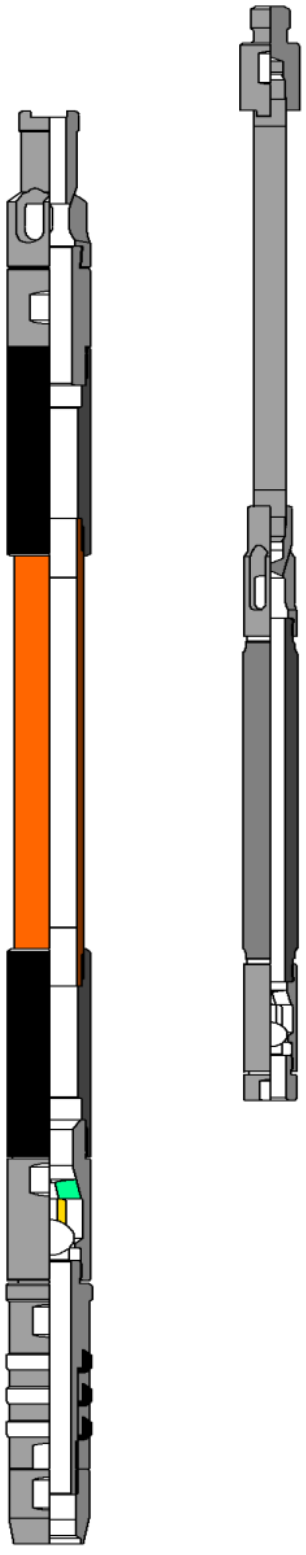

Figure 1

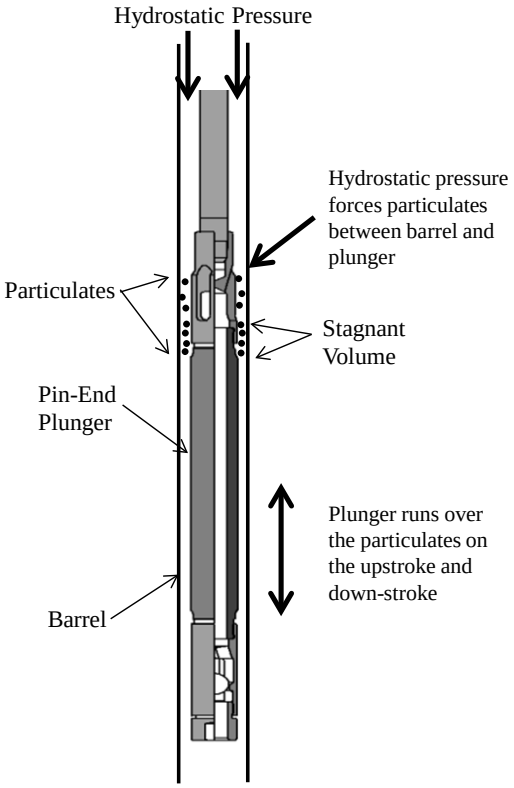

Figure 2

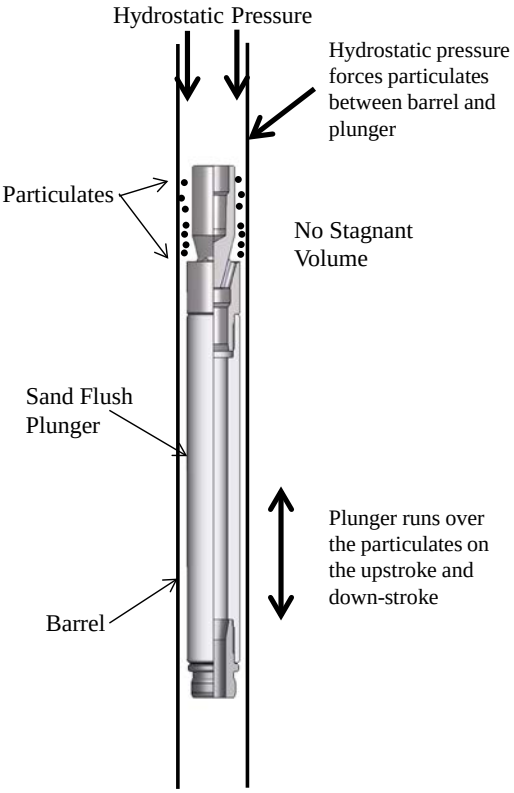

Figure 3

Pump Tracker Fields		
Lease Name/Well Number	Fit	Type B&S
Pull Date	Pump Type	Type Barrel
Failure	Stroke	Trim
Key Fail	Pin Size	Run Days
Pumpsize	Gas Anchor	

Table 1

Lease Name/Well No.	XXXXX #8
Pull Date	01/26/2015
Failure	Tubing Leak - Barrel Pitted - Plunger Sandcut (pic) - No Tagging Or Solids - New Pump
Key Fail	TUBING LEAK
Pumpsize	20-150-RHBC-24-6-ALT
Fit	.005
Pump Type	RHBC
Stroke	210”
Pin Size	¾”
Gas Anchor	1”
Type B&S	SV-TC/C TV-TC/C
Type Barrel	CORRESIST
Trim	SS - HARDLINED
Run Days	360

Table 2

Key Fail	Pull Reason
PULLING TUBING	TUBING
ROD PART	ROD
TUBING LEAK	TUBING
PUMP CHANGE	PUMP
NEW PUMP	PUMP
TA WELL	UNKNOWN
NEW CLEANUP	TUBING
WO WORKOVER PLUNGER	PUMP
ROD CHANGE	ROD
CHANGED TO	PUMP
WO WORKOVER PUMP	PUMP
BALL SEAT	PUMP
WO WORKOVER SEVERE	TUBING
BARREL PITTED	PUMP
WO WORKOVER BARREL	PUMP
PA WELL	UNKNOWN
CASING LEAK	TUBING
NEW PRODUCTION	UNKNOWN
TUBING JOB	TUBING
CHANGED PUMP	PUMP
PUMP CHANGESEVERE	PUMP
PUMP CHANGEBARREL	PUMP
PUMP FULL	PUMP
PUMP STUCK	PUMP
PUMP CHANGEPUMP	PUMP
PUMP CUT	PUMP
PUMP IN	PUMP
PUMP POUNDED	PUMP
PUMPING SOLIDS	PUMP
OTHERS	UNKNOWN

Table 3

Days	**(Multiple Items)**
Pull Reason	**PUMP**
Month/Year	**(All)**

Pump Type	Avg. Run Days	No. of Repairs
Sand Flush	845	555
Standard Pump	561	5318

Table 4

Increase/Decrease	(All)
Pull Reason 2	(Multiple Items)

Pump Type	Plunger/Pump Status							
	Galled		Plunger Good		Grooved		Pin Broken	
	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs
Sand Flush	137	7	1732	18	2213	33	400	6
Standard Pump	474	17	266	49	796	100	121	13

Pump Type	Plunger/Pump Status							
	Pump Good		Sandcut		Sandcut-Galled		Plunger Stuck	
	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs
Sand Flush	125	8	1476	38	518	1	808	29
Standard Pump	116	3	656	55	71	1	250	44

Pump Type	Plunger/Pump Status	
	Worn	
	Avg. Run Days	No. of Repairs
Sand Flush	562	3
Standard Pump	889	25

Table 5

Increase/Decrease	**(All)**
Pull Reason 2	**(Multiple Items)**
Plunger/Pump Status	**(Multiple Items)**

Pump Type	Barrel Metallurgy							
	501 CR CHROME		BRASS CHROME		BRASS NI-CARB		STEEL	
	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs
Sand Flush	1372	115	147	2				
Standard Pump	641	188	141	4	461	39	197	20

Pump Type	Barrel Metallurgy			
	STEEL CHROME		STEEL NI-CARB	
	Avg. Run Days	No. of Repairs	Avg. Run Days	No. of Repairs
Sand Flush				
Standard Pump	1433	11	1382	1

Table 6

Increase/Decrease	**(All)**
Pull Reason 2	**(Multiple Items)**
Plunger/Pump Status	**(Multiple Items)**

Pump Type	Pump Size									
	1.063		1.25		1.5		1.75		2	
	Avg. Run Days	No. of Repair	Avg. Run Days	No. of Repair	Avg. Run Days	No. of Repair	Avg. Run Days	No. of Repair	Avg. Run Days	No. of Repair
Sand Flush			1562	93	575	22	71	2		
Std. Pump	280	3	736	193	254	61	81	3	416	2

Table 7