ENHANCING FAILURE ANALYSIS THROUGH THE USE OF ROD PUMP SERVICE DATA

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ABSTRACT

Rod pump service data provides valuable insight into wellbore conditions and the efficacy of the rod lift system. Trend analysis of metrics such as reason for well pull and pump component evaluation provides increased visibility about individual well performance issues and more broadly, about field performance. Comprehensive pump service data is an indispensable supplement to an operator's internal data in well review meetings for the purpose of improving optimization efforts. This paper will focus primarily on how this data may be used to benefit two key factors: performance and design.

METHOD

Trend analysis requires an accurate method for gathering rod pump service data. This begins with a standardized approach to the service process. Pumps are disassembled, examined, and serviced in accordance with API 11AR recommended practice (API, XXXX) and additional guidelines outlined in the pump technician's training program. During servicing, data on metrics such as the geometry of the pump, integrity of its components, and run life are collected using detailed tracking software (**Figure 1 and Figure 2**). This process ensures that the data collected is accurate, and therefore, ideal for analysis. Over time, the database will continue to track all service records for each well, building a well history (**Figure 3**). A lengthy well history enables the operator and failure analysis team (Poythress, 2012) to better identify trends in well behavior and equipment life. In addition, wells are grouped by lease and area to provide the operator with the added option to analyze the performance of a broad subset of wells.

The lifecycle of a well is dynamic. Over time the down-hole environment can change dramatically. Changes in production, fluid properties, or gas/solids saturation can wreak havoc on the rod lift design. Operators and their sucker rod, chemical, and pump providers collaborate to mitigate these issues and optimize the performance of the well. The pump service database is a valuable asset to this effort. A detailed well history can benefit the operator directly. However, it can also be used to benefit other members of the failure analysis team. For instance, any foreign material collected from the pump at the time of service is documented on the service record. A sample is then stored for use by the operator's chemical provider. Also, pump service data can help a sucker rod provider determine the root cause of a rod part. If we combine all available data, a much clearer view of well performance can be obtained.

ANALYSIS

Interpreting large subsets of data can be daunting. For a more intuitive experience, charts and graphs are used to condense large data sets into a more manageable form, as shown in **Figure 4**. The horizontal axis represents time and the vertical axis represents the average run time recorded for each pump and the pull count for each period in the timeline. This visual representation enables easy interpretation of the history of the well based on these metrics.

Analysis of well and field performance is aided by evaluating a variety of metrics found in the service history of each well. These include, for example,

- Run Time
- Pull Count
- Reason For Pull
- Pump Geometry
- Pump Component Materials
- Pump Component Failures
- Foreign Material Found in the Pump

Each of these factors contributes uniquely to the failure analysis process.

Well

Analysis of an individual well is most valuable when comparing rod lift design versus performance. For example, a comparison of pump geometry to run time over the life of the well may show that the current pump design is inadequate for existing well conditions or, alternatively, that a past pump design had a positive impact on well performance. Material strength and corrosion resistance are crucial characteristics that significantly affect well performance which can be evaluated by comparing pump component materials to the failure mode of each component. **Figure 5** depicts failure modes of different barrel materials. **Figure 6** illustrates some failure modes and the underlying issues that may cause them.

Field/Area

These metrics can also be used to analyze a field or area. However, because every well has unique characteristics, field performance is viewed with a wider scope. Rather than viewing performance with respect to an individual failure, the total pull count for a field is compared to the total number of wells, generating a failure rate (**Figure 7**). If run time for each pump installed in a field is evaluated, a distribution of run times can be determined, as shown in **Figure 8**. This gives a more realistic representation of field performance than alternative values such as an average runtime, which can be skewed. Likewise, the failure mode of pump components, evaluated across a field, can reveal trends relating to corrosion or solids that may result in changes to the pump design or chemical treatment across the field. This level of analysis helps the operator recognize and mitigate large-scale issues without the need to evaluate each well individually.

CONCLUSIONS

The evolution of the production industry has generated an appreciation for data collection and its contribution to the optimization process. By holding regular failure meetings, operators can expect to improve optimization efforts through the collaborative efforts of their service providers. This paper has demonstrated the impact that detailed rod pump service data can have on the failure analysis process, as a supplement to the operator's existing data.

REFERENCES

1) R.L.Soza, " Use of Rod Pump Database for Improving Artificial Lift Operations", Permian Basin Oil and Gas Recovery Conference, Midland, Texas, USA, 27-29 March 1996
2) API 11 AR – Recommended Practice
3) M. Poythress, "Depend On Something Other Than Luck To Reduce Your Rod Pumping Failure Rate", 2012

Pump Details	Installed Pump
Pump: 4058	**Pump Name:** 4421
API Description: 2-1.25-RHBC-20-4	**Description:** 2-1.25-RHBC-16-5-4
Description: sand div hvrc-200	**Installed:** 06/10/2016
Reason: Pump Failure	
Installed: 04/24/2014	
Pulled: 06/10/2016	
Days: 778	

Pre-Service Description	Post-Service Description	Service Details
Tubing Size: 2.00	**Tubing Size:** 2.00	**Stroke:** 174.00
Plunger Size: 1.25	**Plunger Size:** 1.25	**Clearance/Fit:** 0.003
Barrel Type: External Thread	**Barrel Type:** External Thread	**Barrel Mic:** 9999999999999999999
Holddown Type: Bottom Cup Hold-Down	**Holddown Type:** Bottom Cup Hold-Down	**Plunger Mic:** 9999
Barrel Length: 20.00	**Barrel Length:** 20.00	**Foreign Material:** None Found
Plunger Length: 4.00	**Plunger Length:** 4.00	
Upper Extension Length: 0.00	**Upper Extension Length:** 0.00	
Lower Extension Length:	**Lower Extension Length:**	

Figure 1 - Pump Service Report Header

Pump Component Status				
Pump Component	Material	Run Time	Quantity	Fail Status
Lift Sub	Steel, No Hardening	779	1	Worn
Top Valve Pull Tube Adaptor	Stainless Steel, 316 Or 316L	779	1	Worn
Top Pin Collet	Stainless Steel, 316 Or 316L	778	1	Worn
Pull Tube	Alloy - Stellite	779	1	Thread Damage
Pull Tube To Plunger Adaptor	Monel	778	1	Thread Damage
Plunger	Spraymetal, Monel/Nickel Pins	779	1	Thread Damage
Plunger Pin	Monel	779	1	Worn
TV Upper Cage	Stainless Steel, 303 Or 304	779	1	Worn
TV Lower Cage	Stainless Steel, 303 Or 304	779	1	Worn
TV Upper Ball	Titanium	779	1	External Pits
TV Lower Ball	Titanium	779	1	External Pits
TV Upper Seat	Tungsten-Carbide	779	1	External Pits
TV Lower Seat	Tungsten-Carbide	779	1	External Pits
Seat Plug	Stainless Steel, 316 Or 316L	779	1	Thread Damage
Rod Guide	Steel, Hardened	779	1	Worn
Accessory Mandrel	Stainless Steel, 303 Or 304	779	1	Worn
Sand Shield	Rubber	778	1	Worn
Barrel Connector	Stainless Steel, 303 Or 304	779	1	Worn
Upper Extension	501 Stainless	779	1	Worn
Barrel	Stainless, Chrome Plated	779	1	Internal Pits
SV Upper Cage	Stainless Steel, 316 Or 316L	779	1	Beat Out / Pounded
SV Lower Cage	Stainless Steel, 316 Or 316L	779	1	Beat Out / Pounded
SV Upper Ball	Titanium	779	1	External Pits
SV Lower Ball	Titanium	779	1	External Pits
SV Upper Seat	Tungsten-Carbide	779	1	External Pits
SV Lower Seat	Tungsten-Carbide	779	1	External Pits
Holddown	Stainless Steel, 303 Or 304	779	1	Worn
Holddown Spacer	Stainless Steel, 303 Or 304	779	2	Worn
Holddown LockNut	Stainless Steel, 303 Or 304	779	1	Worn
GAC	Stainless Steel, 316 Or 316L	779	1	Worn

Figure 2 – Pump Component Status

Operator Lease Well Results 50 From 02/18/2015 To 02/17/2017 Search Download

Pump	Size	Installed	Pulled	Days	Reason	Serviced	Foreign Material	Service Type	Ticket Cost	Comments
3691	2-1.25-RHBC-20-4	2/12/2014	11/2/2015	628	Tubing Leak / Tubing Failure	11/3/2015	None Found	Junked	$0.00	Barrel was split 1' ....more
4950	2-1.25-RHBC-16-5-4	11/2/2015	11/28/2016	392	Tubing Leak / Tubing Failure	12/14/2016	None Found	Junked	$0.00	** Area Pump** ....more
4840	2-1.25-RHBC-20-5	11/28/2016		81						

Figure 3 – History of a Well

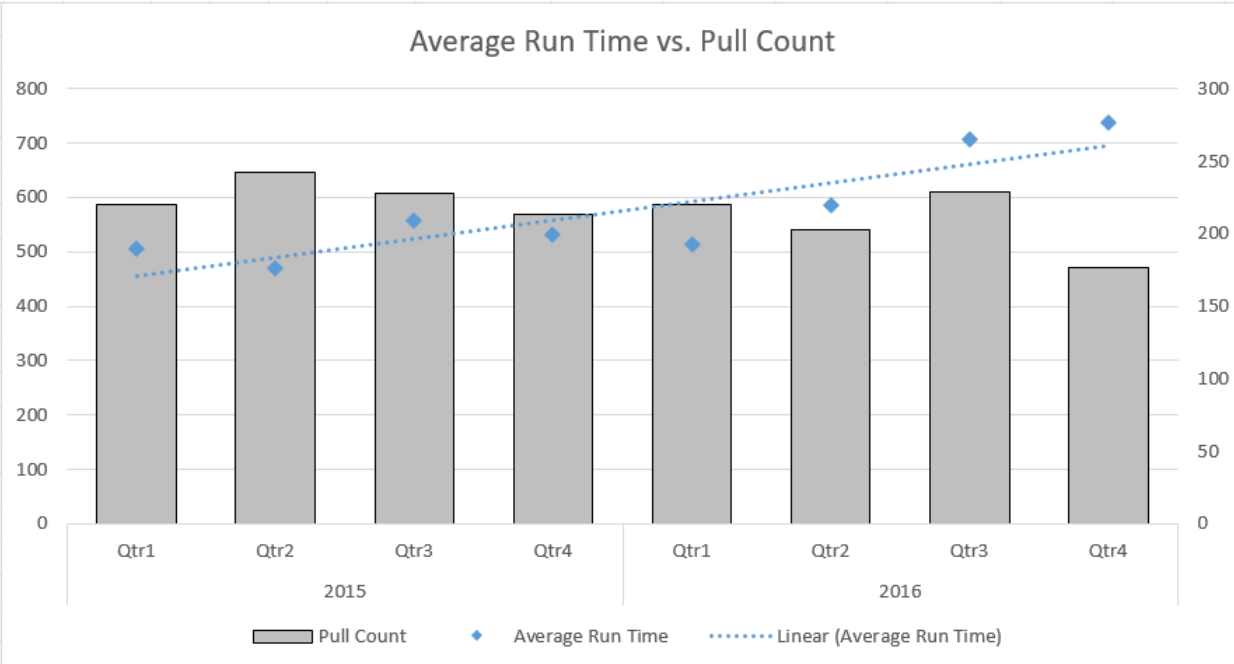

Figure 4 – Graph of Average Run Time and Pull Count

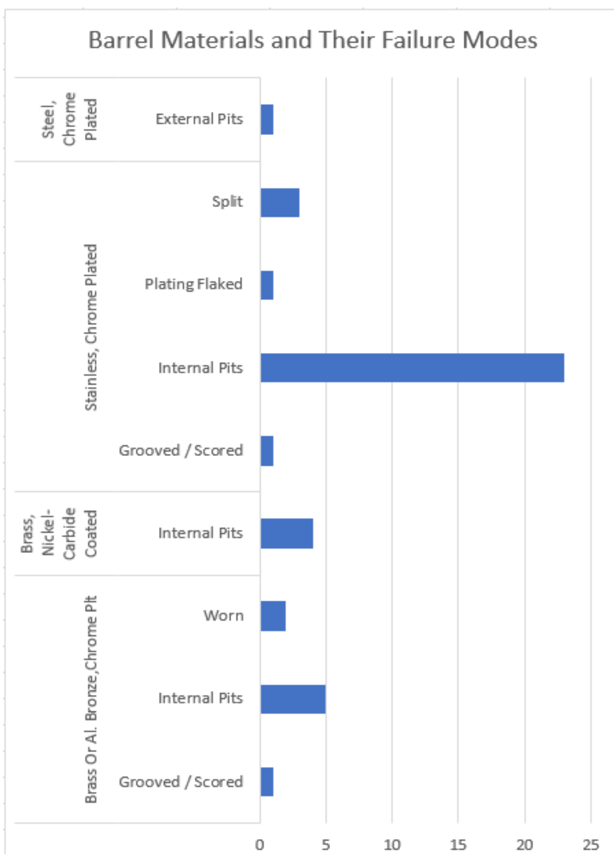

Figure 5 – Material Failure Modes

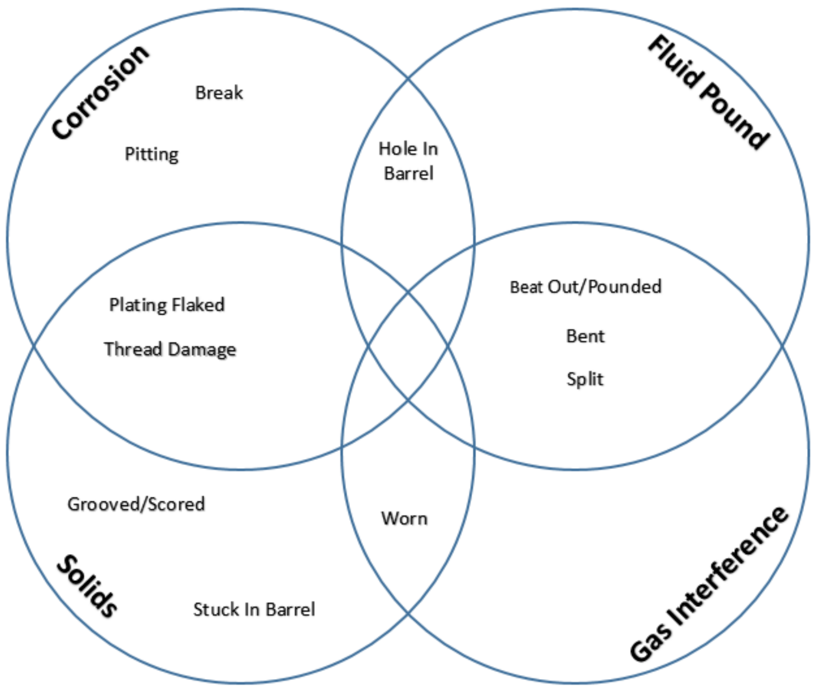

Figure 6 – Failure Modes of Pump Components and Their Relationship to Downhole Issues

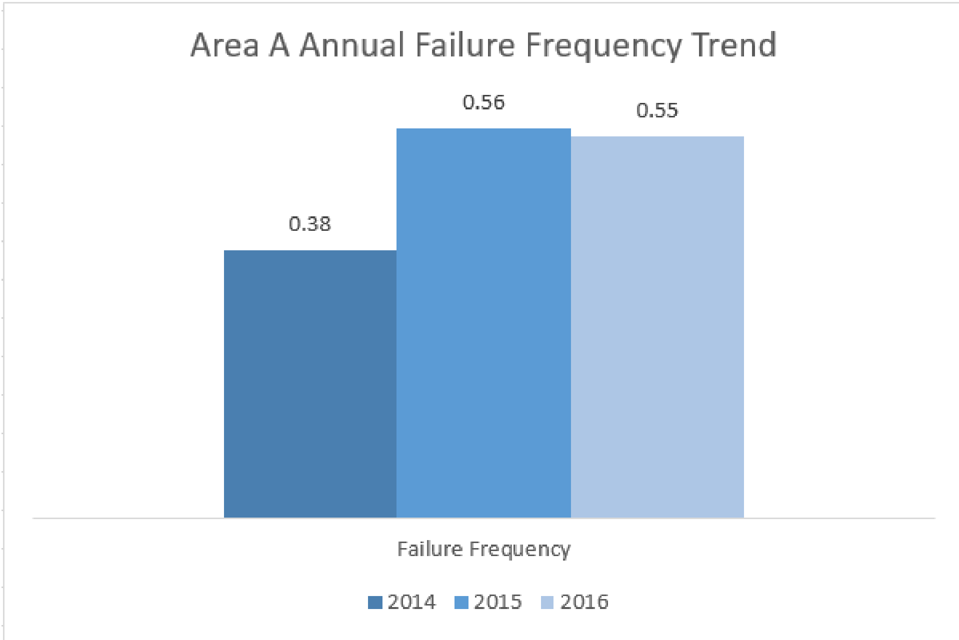

Figure 7 – Failure Rate

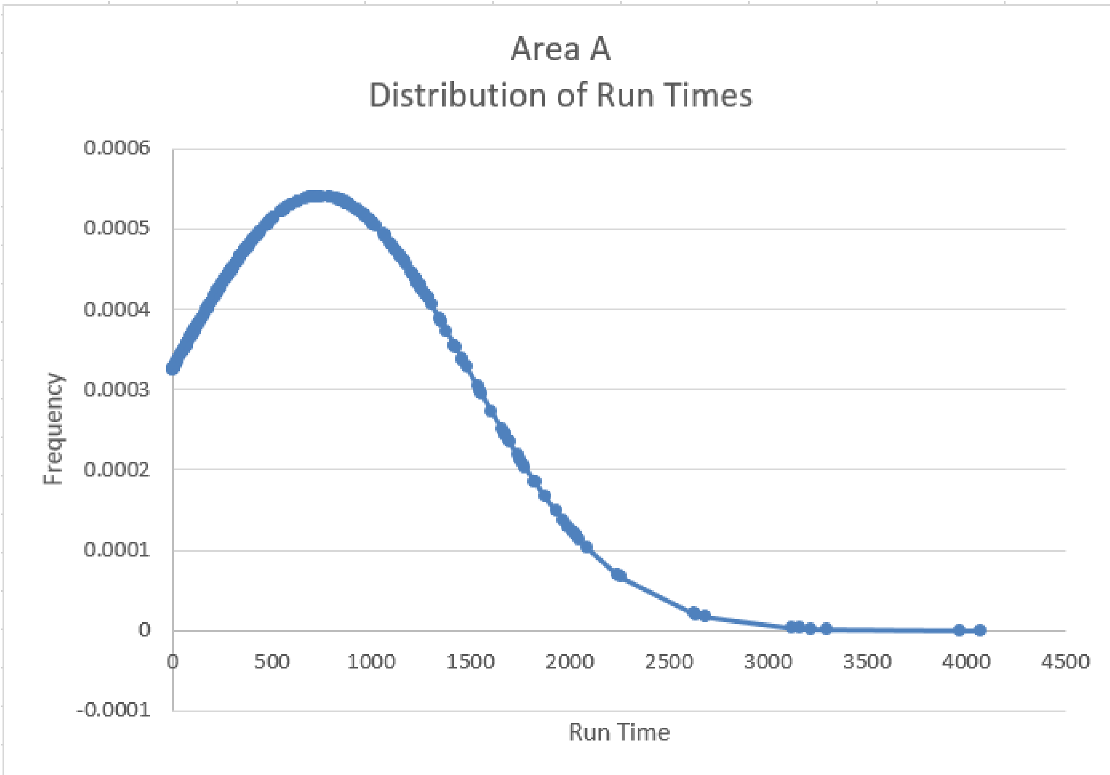

Figure 8 – Run Time Distribution