OPTIMIZING PRODUCTION AND OVERALL EFFICIENCY WITH INTELLIGENT LONG STROKE HYDRAULIC PUMPING SYSTEM

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ABSTRACT

Many factors are involved when selecting the most cost effective artificial lift system.

This paper will discuss the advantages of The DynaPump Intelligent Long Stroke Hydraulic Pumping System (DPS) compared to other artificial lift systems.

DPS incorporates a stroke length up to 30 feet with a peak polish rod load capacity up to 80,000 pounds. These characteristics allow for operation at much slower strokes per minute greatly reducing tubing and sucker rod wear while retaining the ability to produce at greater volumes from deeper depths than conventional beam pumping units (CBU). DynaPump also uses a unique counterbalance system, variable frequency drive and computer logic which provides superior efficiency and flexibility compared to other artificial lift methods.

This study compares electrical infrastructure required, electrical efficiency, well intervention costs, production optimization, adaptability to changing well conditions, and overall environmental impact between DPS, CBU, electrical submersible pumps (ESP), progressive cavity pumps (PCP), and some other long stroke pumping units (LSU).

Included are actual operating parameters and runtime comparisons.

The conclusions highlight the total cost of ownership aiding in the selection of present and future artificial lift system requirements.

INTRODUCTION

About two thirds of the world’s oil wells are produced using Reciprocating Rod Lift (RRL). Due to the recently declining price of oil and gas, reducing operating expenditures (OPEX) is much more important than when commodity prices are much higher.

This has created a need for an artificial lift system that can operate extremely efficiently as well as one that will incur minimal downtime and well intervention.
By reducing the amount of energy required to operate and minimizing well intervention, OPEX as well as capital expenditures (CAPEX) will be decreased.

CHARACTERISTICS OF A DPS

Discussed below is an Intelligent Long Stroke Hydraulically Driven Pumping Unit manufactured by DynaPump, Incorporated.

A typical configuration consists of an electric motor that drives a hydraulic pump **(Fig. 1)** that transfers pressure to a “Triple Cylinder” and triggers the upstroke and down-stroke. An additional counterweight cylinder contains pressurized Nitrogen gas that compresses on the down-stroke and aids in lifting the hydraulic plunger on the upstroke **(Fig. 2)**. There is a pulley on top of the hydraulic plunger with wire rope secured on one side to the unit's base and the other end attached to a carrier bar that supports the weight of the rod string. As the plunger moves upwards, the carrier bar raises the rod string at twice the speed and distance as the plunger. The same effect occurs in the down-stroke.

The speed, distance and rate of acceleration and deceleration of the plunger are controlled by an Advanced Programmable Logic Controller (PLC) working in combination with a Variable Frequency Drive (VFD) **(Fig. 3)**. The upstroke speed and the down-stroke speed can be independently controlled. This is very advantageous in heavy-oil wells, gassy wells, and wells that have issues with rod floating/buckling.

TYPICAL APPLICATIONS FOR DPS

Heavy-Oil Wells and Wells with high GOR

The DPS can operate with a faster upstroke than down-stroke allowing more time for pump fillage while maintaining the strokes per minute (SPM) necessary to maximize production. For instance, with a conventional system, a down-hole pump operating at 6 SPM has 5 seconds to fill on the down-stroke and 3 seconds to fill on the down-stroke at 10 SPM. The DPS can independently adjust up and down-stroke speeds.

Deep Wells

The DPS can handle up to 80,000 pounds of peak polish rod loading which is more than twice the structural rating of many large conventional units. This allows for operation with longer, heavier rod strings, and larger diameter bottom-hole pumps.

High Volume Wells

The DPS has a maximum stroke length of 360". This combined with the ability to handle large rod loads allows for use with larger diameter and longer barrel bottom- hole sucker rod pumps increasing pump displacement. In addition to higher volumes, a long stroke length provides a high pump compression ratio, eliminating gas lock due to the traveling valve not being unseated on the down-stroke.

Deviated Wells and Abrasive Wells

Because of the DPS' long, slow stroke (typical operation is 3 SPM); the wear rate due to rods contacting the tubing is significantly decreased.

Economically Challenging Wells

Field testing has shown that DPS use significantly less energy compared to conventional beam units and ESPs. This results in lower lifting cost per barrel of fluid.

High Temperature Wells

Since DPS uses traditional bottom-hole sucker rod pumps, bottom-hole temperature is not an issue as long as a mechanical type seating assembly is used for hot well applications.

Wells with variable fluid production rates

DPS can adjust the SPM as well as the stroke length with the touch of a button. This allows for a wide range of fluid production without the need for equipment changes.

ARTIFICIAL LIFT METHOD COMPARISON

An operator in the Permian Basin of West Texas, USA performed a study on 15 wells concentrating on electrical consumption, production rates, well downtime, and well failure rate. The comparison consisted of 4 DPS, 5 ESP, and 6 Beam Units. All of the wells were producing from similar depths. The comparison was conducted over a 2 year period.

ELECTRICAL CONSUMPTION

A standard mechanical KWH revenue meter was used to measure the input power consumed over a 24 hour period. Data points collected are shown (**Fig. 5**). The power consumed in the 24 hour period is plotted versus total daily production. As expected, for a given artificial lift method, it requires more power to lift more fluid. The data was normalized by computing the average KWH/produced Barrel.

AVERAGE KWH/BARREL BY LIFT METHOD

ESP	4.15
Beam Pumping Unit	1.36
DPS	0.70

INCREMENTAL OIL PRODUCTION

The operator replaced a Model 912 Beam Unit that was producing 420 BFPD and operating at 7.9 strokes per minute using a 2.25" bottom-hole pump with a DPS Model 9. The DPS increased production to 505 BFPD running at 4.3 strokes per minute with the same 2.25" bottom-hole pump. This resulted in an increase of 25 BOPD.

The increase in production was due to 3 factors:

1 – The DPS Model 9 has an additional 48" of stroke length versus the Beam 912

2 – The DPS has a unique integrated pump- off control system. When the unit detects a pumped off condition, it automatically shortens the stroke length and reduces the SPM and continues to run in that condition until the pumped off condition clears and the unit returns to normal operation without ever shutting down. The Beam unit was shutting down for over 2 hours/day due to the pumped off condition.

3 – The DPS' slower strokes per minute and soft rod reversals reduce the amount of rod stretch providing more effective plunger usage.

WELL DOWNTIME

In the 2 year period the operator experienced less than 2% downtime with the DPS compared to 12% with the Beam Units and 14% with the ESPs.

REDUCTION IN WELL INTERVENTION

The operator had another Model 912 Beam Unit during the test period. It was producing 450 BFPD and operating at 8.1 strokes per minute using a 2.25" bottom-hole pump. The well encountered 6 failures during a 14 month period. All of the failures were attributed to excessive rod and tubing wear. They replaced the Beam Unit with a DPS Model 9. The DPS is running at 4.4 strokes per minute with the same 2.25" bottom-hole pump and had not required any well intervention for a period of 12 months as of the time of this report. The production also increased from 450 BFPD to 525 BFPD.

There are several factors involved with the elimination of the failures:

1 – Reducing the strokes per minute by almost 50% has reduced the rod and tubing wear by the same amount.

2 – The DPS unit incorporates a "Soft" transition between the up and down-strokes. The PLC automatically instructs the VFD to slightly reduce speed at the top and bottom of the stroke. This greatly reduces the amount of rod stress during this transition period.

3 – The integrated pump-off controller, as mentioned earlier, shortens the length of the stroke and slows down the speed of the stroke in a pumped off condition. Beam Units completely shut down the movement of the rod string for a set amount of time in a pumped off condition. By keeping the rod string in constant motion, the possibility of stuck rods is greatly reduced.

An additional well in the test group was being producing using an ESP. The unit failed 3 times during a 10 month period resulting in 30 days of lost production. Each of the failures was attributed to excessive solids production.

A DPS model 11 designed to produce 700 BFPD was installed and had been on production for 13 months with no failures.

Because the DPS model 11 has a stroke length of 336" it is able to operate at 2.9 strokes per minute greatly reducing the damage caused by erosive wear.

OPERATOR'S CONCLUSION

"Measurements have demonstrated that DynaPump units operate with lower energy costs versus either a conventional beam pump or a submersible pump when pumping the same equivalent flow from the same depth. Energy consumption is approximately ½ when compared to a beam pump and 1/6 when compared to a submersible pump. The DynaPumps, operating at much slower speeds because of its long stroke, have resulted in no rod parts and no tubing failures. The uptime and total production generally exceeds a conventional pumping unit due to the fact that the DynaPump can lift heavier loads and there is less downtime related to repairing down-hole failures. Based on these results and the fact that DynaPump thus far has been committed to supporting the pump and making improvements to address operational concerns, the Operations Team will continue the project next year. DynaPump is expected to be the lift choice for application in the production range of 500 to 1000 BFPD and may also replace selected conventional and submersible pumps on wells experiencing above average well maintenance and downtime such as those on deviated wells."

OPERATOR'S ACTIONS

Based on the success of this test, the operator has purchased and installed 41 DPS to date resulting in a significant reduction in OPEX and CAPEX.

REFERENCES

(1) The DynaPump Project Update by Saul Tovar, OXY Permian, Presented at the SWPSC, April 21-22, 2004, Lubbock Texas

Figure 1 – Electric Motor and Hydraulic Pump

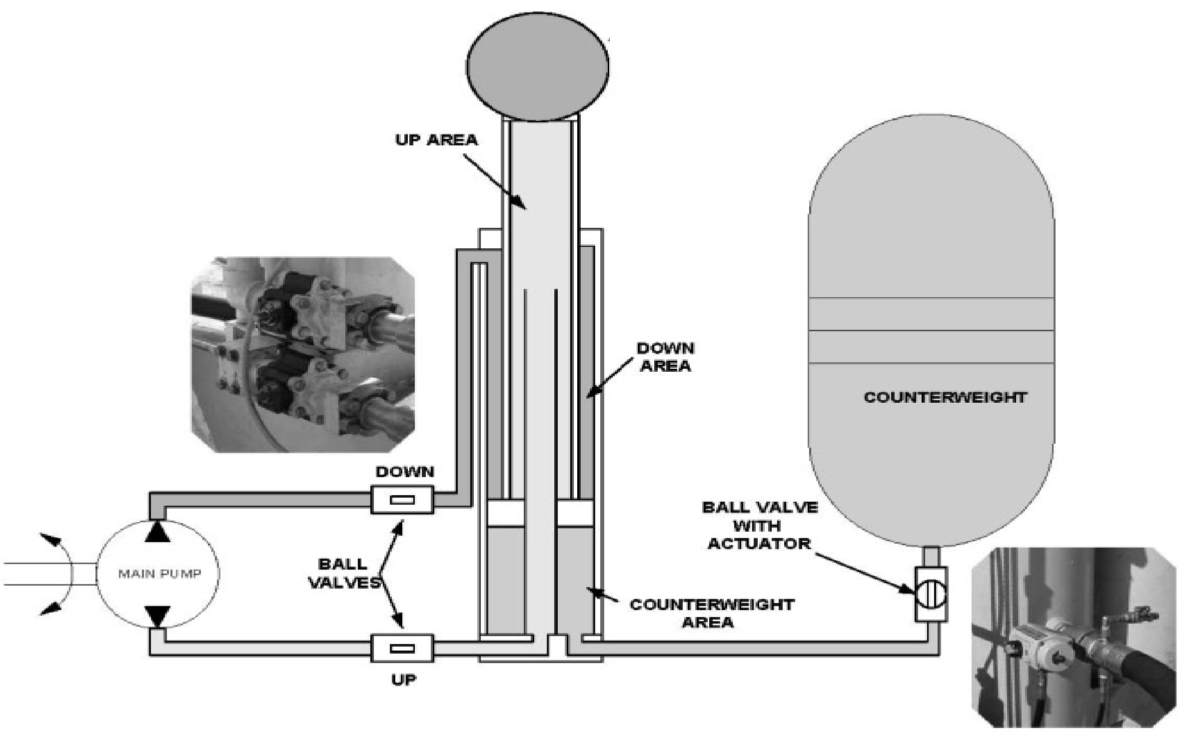

Figure 2 – Triple Cylinder and Counterweight

Figure 3 – Programmable Logic Controller and Variable Frequency Drive

Figure 4 – A typical DPS in Operation

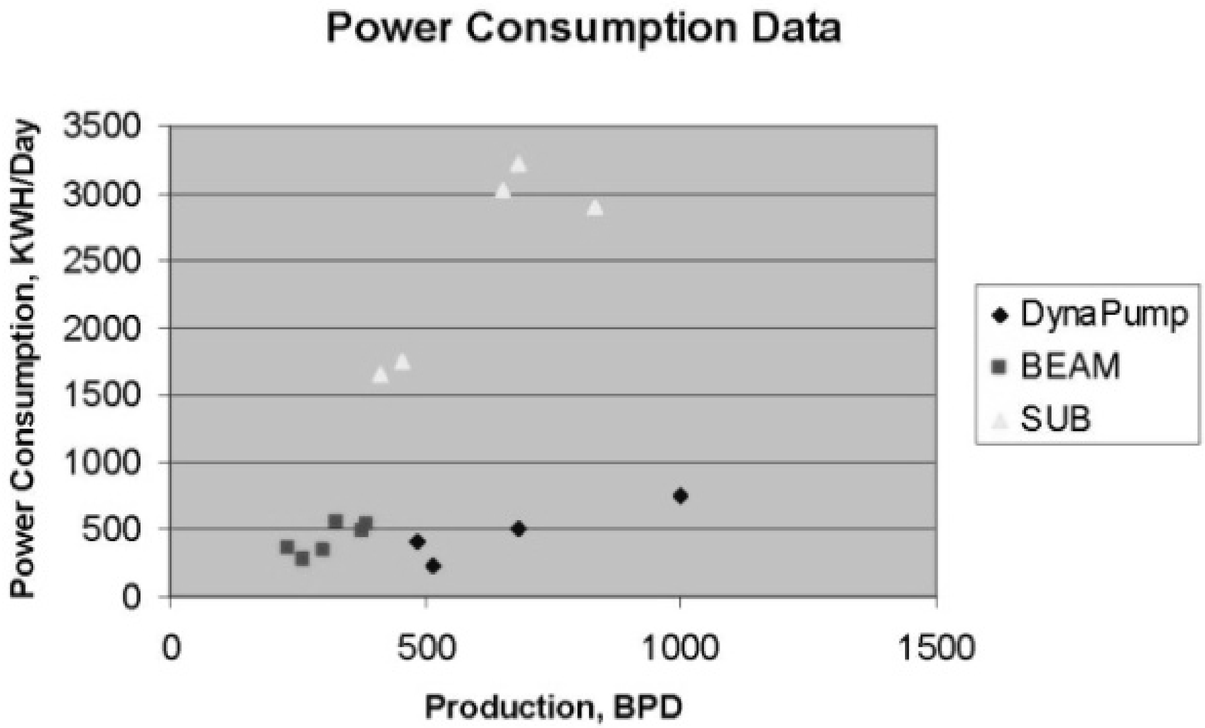

Figure 5 – Energy Consumption Comparison