HIGH VOLUME TECHNOLOGY FOR LOW VOLUME APPLICATIONS

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ABSTRACT

Historically, Electric Submersible Pumps were designed and manufactured for large volume applications producing from moderate depths. Low volume production (less than 400 bpd) was considered rod pump territory. Unfortunately, due to depth limitations inherent to sucker rods, rod pumping low production wells at deeper depths often becomes uneconomic due to high failure rates. Utilizing new control technology, the advent of wider vane designs, and high pressure housings, low volume ESP's have proven successful in replacing conventional and non-conventional pumping units in today's oil industry.

INTRODUCTION

Oil and Gas producers now have a choice when selecting artificial lift for deep, hot bottom hole temp and low volume wells. This is primarily due to the technological innovations and improvements in the electric submersible pump industry.

Historically, low volume submersible pump designs consisted of production ranges higher than 400bpd. These submersible pumps had narrow vane clearances which plugged up easily, limited gas handling capabilities, small thrust washer areas which limited run times, and low-pressure housings which created an unsafe and limited application ranges.

This paper will present cases where low volume, deep applications presented a problem for a Rod Pump design therefore an ESP was utilized.

In addition, we will show the changes in the Electric Submersible Pump industry that were necessary to achieve longer run times.

ROD PUMP CHALLENGES

Typical Design:

The Wells in the SELF Unit utilized an assortment of Pumping Units that were inherited when the lease was acquired. Lufkin 912 Mark II's & American 640 Conventional's being the most prevalent. Downhole Pumps were sized from 1.5 to 2 inches depending on volume requirements. Average pump setting depth was 9,830 ft. Standard practice called for a Perforated Sub and Mud Anchor. TAC's were set between 500 and 1000 ft above the SN. The typical rod string employed Norris 97's with an 87 design along with 200 to 300 feet of 1.5" K-bars above the pump. Pumping speeds averaged 7 SPM. And all of the Units were equipped with Lufkin System 60 Pump Off Controllers.

Challenges

Beam Pump systems are the oldest and most widely used type of artificial lift for an oil well. Sucker rod pumping systems are limited by the size of the casing, the strength of the rods and the speed with which they can be reciprocated. Under the most favorable of conditions approximately 150 BPD of fluid can be lifted from 12,500 ft. In contrast, over 2,000 BPD of fluid can be lifted from less than 2,000 ft. The SELF Unit incurred several non-ideal conditions that makes beam pumping difficult. Some of these challenges are Depth, Paraffin, Low Fluid Volumes and variations in gas production. These combined conditions, result in sudden load variations (pumped off condition or gas interference), which eventually result in downhole failures.

SELF Unit Failures

The majority of the rod parts occurred on the lower producing wells, less than 350 bbls/day. The typical failure was body breaks in the 7/8" string, usually at the neck just above or below the coupling. Three wells had failure rates greater than 2.5, or one failure every 4 to 5 months per well. Average cost for a rod repair and pump change averaged $18,500. In addition, due to rig availability problems, the wells were typically down for 7 to 10 days before the repair could be performed. This downtime resulted in lost or deferred revenue of $12,000 to $20,000 depending on the well. Combined, these three wells resulted in costs and lost revenue of nearly $300,000 per year.

ELECTRIC SUBMERSIBLE PUMP DESIGNS

The Electric Submersible Pumps in the SELFU field were designed with the following specifications:

100 # pump intake pressure
5 ½ casing
2 7/8 tubing
50 # tubing pressure
50 # casing pressure
1.05 specific gravity of fluid
10 to 20 % oil cuts
5 to 150 GLR

KEYS TO SUCCESSES UTILIZING ESP'S

Downhole Monitoring And Controls

An integrated control system was used to supply accurate bottom hole pressures, temperatures and vibration information. This information was collected and used to make better decisions in equipment sizing and equipment selection for future applications.

The integrated control system's temperature shut down capabilities were also used to prevent failures in wells SELFU 10-1 and 13-2. The electric submersible pumps in these wells were shut down on several occasions due to high temperatures that were associated with pump off conditions. Considering the static bottom hole temperature of + or - 200-degree F., excessive cycling would have been detrimental to the life of the equipment. These wells were pulled and well work was performed.

Lift Per Stage Improvements

The improved impeller designs aid in reducing the number of pieces that must be installed in the well. Deep applications require multiple motor, seal and pump sections, so being able to reduce the number of components lessons the opportunity for failure.

Figure #1 is an example of the total stage requirements in the 300 bpd pump range compared to previous technology.

Wider Impeller Designs

Some of the characteristics of high volume pumps can now be seen in the low volume pump designs. The gas handling capabilities along with the ability to produce small amount of solids in low volume pumps have greatly increased by the wider vane designs. The vane clearances of the old and new 300 bpd designs can be seen in Figure #2.

Increased Thrust Washer Area

The engineering of the new stage designs have included increased upthrust and downthrust pad area. This improvement aids in increasing run life in typical and non-typical designs. The thrust washer area of both designs can be compared in figure #3.

Power Cost Comparisons

There is a myth that electrical operating costs of ESP's are grossly higher than the electrical costs of rod pumps. The improvements made to today's low volume pump stages reflect higher efficiencies and comparable operating costs. The monthly electrical costs are depicted in Figure #4.

SUMMARY

Run times in the Oil and Gas Industry can be improved by utilizing new technology. The Electric Submersible Industry is only one example that has made a noticeable difference in Low Volume and Deep applications.

CURRENT 9000ft + LOW VOLUME INSTALLATIONS

WELL NAME	INSTALL DATE	CSG SZ	SETTING DEPTH	HP	STAGES	PUMP SIZE	TTL PROD	MTR TEMP	TOTAL DAYS RUN	FAILURES
SELF 5-1	5/23/2005	5 1/2"	9728	60	344	TD 650	793	205	254	NO
SELF 6-3	5/24/2005	5 1/2"	9876	80	382	TD 650	1023	221	253	NO
SELF 9-2	10/6/2005	5 1/2"	9882	54	344	TD 650	582	219	236	NO
SELF 10-2	12/10/2005	5 1/2"	9818	37	533	TD 150	233	212	53	NO
SELF 13-2	11/1/2005	5 1/2"	9878	57	388	TD 460	291	197	92	NO
SELF 26-3	11/12/2005	5 1/2"	9798	52	502	TD 300	332	229	81	NO
ALMA 1	7/18/2005	5 1/2"	9086	71	334	TD 460	674	171	198	NO
SM HALLEY B-42	10/26/2005	5 1/2"	11213	105	407	TD 650	210	175	98	NO

Run time as of January 1, 2006

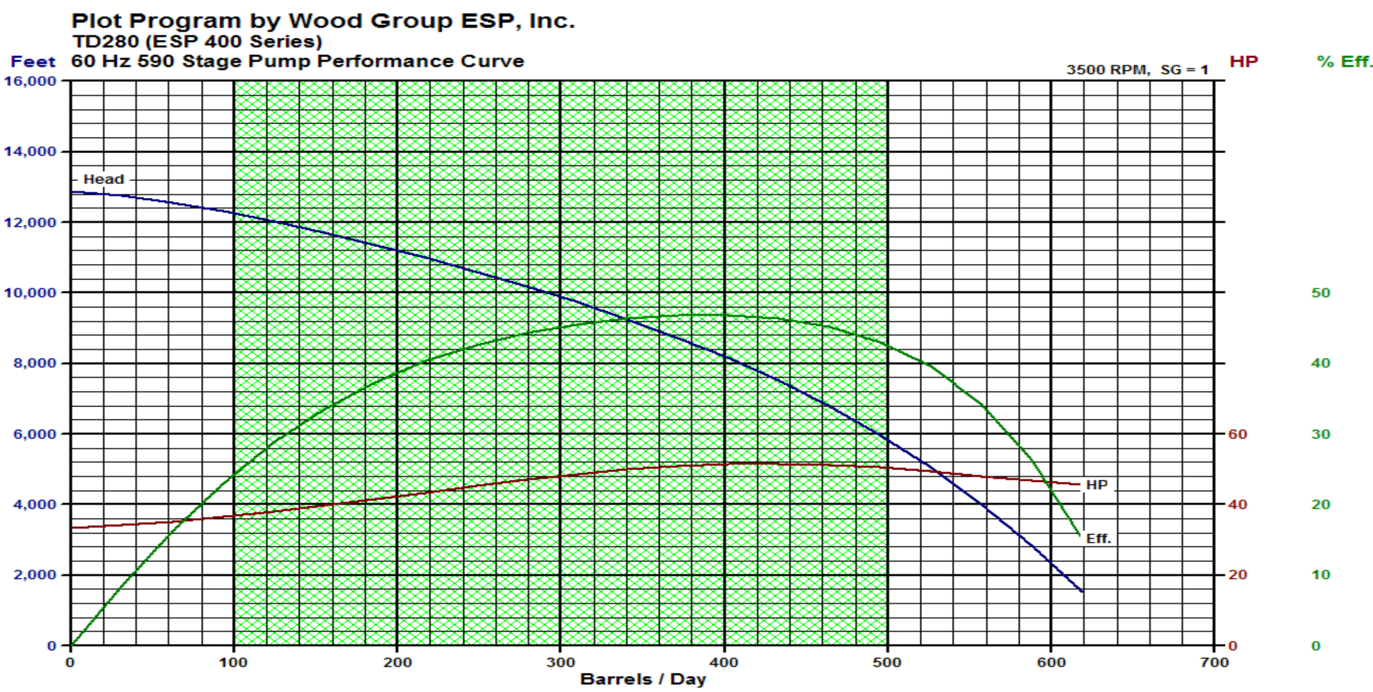

Figure 1A

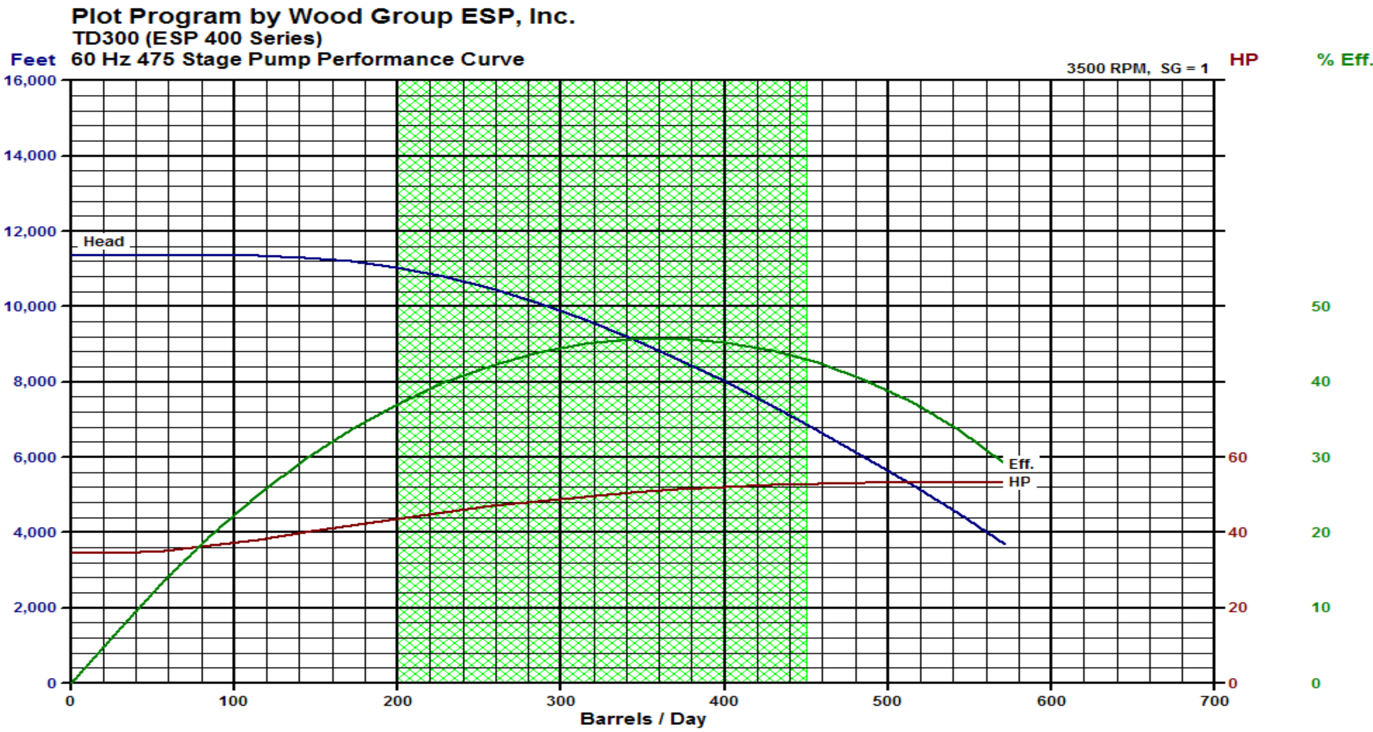

Figure 1B

Figure 2

Figure 3

System Type	Depth	Rate (bpd)	Motor HP	Monthly Power Cost	
Rod Pump	10,000	150	40	$1,489	8.9 strokes per minute
Sub Pump	10,000	150	34.5	$2,688	
Rod Pump	10,000	300	80	$2,457	13.9 strokes per minute
Sub Pump	10,000	300	45	$3,676	
Rod Pump	10,000	460	100	$4,063	14.1 strokes an minute
Sub Pump	10,000	460	61	$4,603	

Figure 4