RESPONSE TO REQUEST FOR LOW COST SYSTEM FOR PUMPING GAS WELLS

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ABSTRACT

This paper describes a new pumping system for low-volume/marginal oil wells and deliquification of gas wells to extend well life by reducing the economic limit. The economic limit is reduced by decreasing capital, installation, and operating costs of low-volume artificial lift. Many low liquid volume gas wells cannot justify the current cost of artificial lift.

Although beam pumping is typically the lowest cost lift method, its inefficiency at low rates requires a much higher lift capacity than the well actually produces and requires a minimum +/- 25 horsepower. This new pumping system can operate on as low as +/- 0.5 horsepower, significantly reducing capital, installation, and operational costs.

This new pumping system reduces costs by using the following equipment:

1. A high efficiency down-hole pump that can also handle solids production (sand and fines) that reduces required surface horsepower and counterbalance.
2. A coiled, light-weight, thermoplastic hollow actuating string that lowers required surface horsepower, does not require a rig, and eliminates corrosion. It also maximizes liquid velocity, keeping solids suspended. A service truck will be readily available for installation and servicing.
3. A speed controlled linear motor, at the surface, to actuate the rod string. Eliminates fluid-pound without intermittently shutting the well down—automatically slows strokes per minute or shortens stroke length. Is small enough to be installed by hand (2 man crew).

Other benefits of this new pumping system include:

1. Simple and efficient design results in reliable operation and minimal power/pulling costs
2. High efficiency pump maximizes production and allows large plunger/barrel clearance to minimize sticking and increase lubrication to reduce wear
3. Pump change does not require a workover rig
4. High temperature thermoplastic conduit applicable to steamflood operations (rated +/- 400°F)
5. Hollow actuating string provide an additional conduit for liquids in slimhole completions and chemical treating in tubing-casing completions
6. Enables minimal pumping speed to match pump capacity with liquid inflow (as low as +/- 0.5 spm)
7. Minimal rod-on-tubing wear
8. Environmentally friendly: rigless operation, minimal footprint, reduced visibility, relatively quiet, can use renewable energy, and safe for livestock and populated locations (small without rotating mass)
9. The reduction in required surface horsepower makes the use of alternative power sources (wind, solar, and/or gas engines) feasible for remote locations without commercial power.

KEY: EFFICIENT SUCKER ROD PUMP

Longer Sealing Surface

"Following successful downhole pump trials, system development will package not only the pump but also the liquid/ power conduits, surface power supply and sales/service." In their extensive presentation of the gas well dilemma known as "liquid loading" the authors of the December 1, 2006 ***E&P*** article titled "Wanted: low cost system for pumping gas wells" clearly understood that the key for solving this predicament would be the downhole

pump. The rest of the system would be built around this efficient pump. Extensive testing has validated that the Samson Pump increases efficiency more than 300% in some cases.

A typical or API or “conventional” sucker rod pump normally consists of a short plunger wholly reciprocating within a longer pump barrel. The ability for this device to produce sub-surface fluids depends upon the seal within the pump to lift, or push, this liquid up the tubing string. The “seal” of the rod pump is the interface between the plunger and barrel. This interface, or surface area, is a constant—length of the plunger times the outside diameter of the plunger.

All of the independent claims in the two US patents covering the disclosed device states that the “plunger is longer than, and always projects out one end of, the barrel, **thereby forming a variable length seal**”. Rather than a “constant” seal as described above, the Samson Pump’s efficiency is increased with its “variable” seal. In an apples-to-apples comparison of 16’ pumps the plunger length in a Samson Pump is exponentially longer than that of the conventional pump. And testing results indicate that with the same clearance, or fit, the seal is therefore exponentially better. Therefore, better sealing capability means more efficient pump.

Even low liquid volumes still produced

“In most cases, a very small liquid volume needs to be lifted in order to deliquify the well bore.” Since most typical or commonly used pumping methods are designed for much larger volumes, they are not an efficient means for producing less than 10 b/d. The Samson Pump enables minimal pumping speed to match pump capacity with liquid inflow. Even at speeds as slow as 1/2 stroke per minute the longer plunger—resulting in a more efficient seal—is still able to produce the fluid to the surface. Comparatively, the API pump with the same 0.009” fit would “leak”, or slip past the plunger (slippage), all available liquid resulting in zero production at these slow speeds. The calculated displacement—or what the pumps should have produced—for a 1-3/4” rod pump is 30.70 BFPD at 1 SPM. Both pumps were 1-3/4” bore, with 88” stroke length, and 0.009” tolerance, or fit, between the plunger and barrel. The leakage rate was 37.49 BFPD and 12.32 BFPD for the conventional pump and Samson Pump respectively.

Further testing data confirmed that if the fit, or clearance, of the Samson Pump was increased by 50% over the conventional pump the leakage rate was almost equal. Smaller bore pumps were used with differing fit. Both pumps were 1-1/4” bore and the stroke length remained 88”. However, the clearance on the Samson Pump was increased 50% over the comparative API pump—0.012” versus 0.008” respectively. The calculated displacement for the 1-1/4” rod pump at 1 SPM is 15.65 BFPD. Now the leakage rate for the Samson Pump with a 0.012” fit was 6.35 BFPD and the leakage rate for the conventional pump with 0.008” fit was 7.64 BFPD.

The table at the conclusion of this paper highlight the data collected from testing performed at the Rocky Mountain Oilfield Testing Center (ROMTC) in Casper, Wyoming and at Texas Tech University’s Red Raider #1 in Lubbock, Texas.

Larger clearance should mean better handling of solids

The Samson Pump should greatly reduce the amount of solids wedging between the clearance of the plunger and pump barrel, and should minimize pump-sticking problems in wells operated with time clocks or POC's. However, with extremely high concentrations of solids the Samson Pump may not keep the well from “sanding up”. The produced fluid velocity has to exceed the settling velocity of the solids in the tubing to prevent the solids from accumulating in the tubing string and eventually “sanding up” the well. A better approach should be to reduce the speed of the pumping unit to eliminate the need to stop the pump. However, solids would accumulate if displacement (fluid velocity) is too low to carry solids out of well.

Producers are now able to prove the above assertions by installing the Samson Pump in production wells with solids and/or scale to validate the assumed longer run times. This would verify endurance of the pump as well as increased life of entire pumping system.

LIQUID CONDUIT

A coiled, light-weight, multi-layer thermoplastic hollow actuating string will be used to connect and power this ultra-high efficiency rod pump with the motorized reciprocating unit source at the surface. The lighter weight reduces the required horsepower of the prime mover at the surface. This is especially important where alternative energy sources are to be implemented. Additionally, the deployment time and effort is significantly decreased with

this conduit stored and conveyed on a vehicle (truck or trailer) that does not require a pulling unit or workover rig for either installation or servicing. The small ID with nearly no friction maximizes liquid velocity, keeping solids in suspension. Both the inner and outer layers are resistant to corrosive and/or abrasive deterioration. Two temperature specifications will be available for applications of up to 250° F or 400° F. By eliminating the need for additional tubing this conduit conveys the produced fluid along with actuating the pump in slimhole completions.

SPEED CONTROLLED LINEAR SURFACE UNIT

The linear action of a reciprocating surface unit allows for comprehensive control of both speed and stroke length automatically without changing equipment/parts. Again, the added efficiency of the variable length seal in the Samson Pump enables pumping speeds much slower than most typical or conventional pumping units. Even with variable frequency drive the linear rod pumping unit can be powered by alternative energy sources such as photovoltaic (solar) panels, wind turbines/generators, etc. Additionally, this LRP can be installed directly on casing flange or tubing production tee. The minimal footprint reduces visibility and can be decorated or camouflaged to blend in with surrounding terrain. Safely operated for livestock and/or populated locations without rotating mass.

PACKAGED SYSTEM

"Ultimately, the amount of gas resource that is recovered, and not left in the ground, will depend on the development of new, low-power technology that will reliably and economically remove small liquid volumes from marginal gas wells." The convergence of technologies presented in this paper can change the game. And the implementation of the combined components may be the answer to significantly increase the sub-surface fluid production for many operators. Exploitation of this reliable, low cost system must now be leveraged by both large and small producers to take advantage of the solids handling of the pump, corrosion resistance of the conduit, and flexibility of the surface equipment.

CONCLUSIONS AND RECOMMENDATIONS

1. The SAMSON pump appears to have an application in the sand producing oil fields in the Permian Basin.

2. Additional run time data will be required to fully evaluate the SAMSON pump, and to accurately compare the advantages over conventional suck rod pumps.

3. The SAMSON pump should be evaluated in heavy oil applications.

4. The SAMSON pump should be evaluated for cleaning up recently frac'd wells and for de-watering of gas wells.

REFERENCES

Dotson, Bryan, Del Mundo, Fulbert, and Cadwallader, Stephen; BP America Production Company. "Wanted: low cost pumping for gas wells." *E&P* Dec. 1, 2006. < http://www.epmag.com/archives/features/165.htm >.

Table 1
Production comparison of 1-3/4” bore with 0.009” fit

1-3/4" Production Comparison with 88" Stoke			
SPM	API/conventional	Samson Pump	Ratio
0.5	(22.14)	3.03	∞
1	(6.79)	18.38	∞
2	23.91	49.08	105%
3	54.62	79.79	46%
4	85.32	110.49	30%
5	116.02	141.19	22%
6	146.72	171.89	17%
7	177.42	202.59	14%
8	208.13	233.30	12%
9	238.83	264.00	11%
10	269.53	294.70	9%