BASIC METHODS FOR IMPROVING ROD PUMP OPERATIONS

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ABSTRACT
Mainly due to its long history, sucker rod pumping is a very popular means of artificial lift. Nearly two thirds of the worlds producing oil wells are on this lift. This paper reviews concerns that producers are faced with today when using inadequately designed sucker rod pumping designs, and suggest basic methods to assist with those concerns. In general, sucker rod pumping applications can be very effective when properly designed.

INTRODUCTION
Sucker rod pumping applications are the oldest and most widely used forms of artificial lift for oil wells. There are about 2 million oil wells in the world, with just over half of those using artificial lift. About 80 percent of U.S. oil wells are stripper wells, making less than 10 bpd and these primarily use sucker rod pumps. Taking a look at the advantages/disadvantages, and suggesting basic methods for improving rod pump operations will give those new and old to the industry and fresh approach. There are many types of pumps and basic practices to suit the varying well and well fluid conditions seen today.

THE HEART OF THE SYSTEM
Five Basic Parts of the Pump

See Figure 1

1. Barrel
2. Plunger
3. Traveling Valve
4. Standing Valve
5. Hold Down Assembly

ADVANTAGES
Sucker rod pumps are the favorite consideration for lower volume stripper wells. Entry level field personnel with little experience in the operations can often operate rod pumps because they are very rugged and simple. Sucker rod pumps can operate efficiently over a very wide range of production rates and depths. The majority of the sucker rod pump components are manufactured to meet existing American Petroleum Institute (API) standards. An additional wide variety of sucker rod pump parts are available that do not meet API requirements. Some of the best diagnostic technology exists today for these applications.

DISADVANTAGES
A (SRP) has a limited ability to produce sandy fluids, although available in the industry today are special pumps that are designed to limit the sand allowing the pump to operate while it moves through the clearance of the barrel and plunger. Veterans in the industry will suggest tighter clearance plungers for large size sand, and loose fit plungers for small fines. In certain producing areas paraffin and scale will severely impact the operation of a (SRP.) Special techniques are used to limit failures such as wipers on the rod string. Hot water treatments are also very effective to control paraffin. Sucker rod pumps are also known to pound gas, and gas lock in certain pumping environments. Gassy situations are very present in today's producing efforts requiring special attention. Free gas entering the pump reduces production and causes a variety of other problems.

METHODS FOR SRP IMPROVEMENT
GAS POUND
In cases where gas is present in the production fluid and entering the SRP this will highly reduce the production rate and create a number of other mechanical problems, most typical problem is gas pound. Gas pound is very similar to

fluid pound but instead of a free fall and then a collision, gas in the fluid starts compressing slowing the downward acceleration causing a cushioning affect. One of the most costly problems is misunderstanding the problem and replacing the pump. The best initial method is to have a dynamometer test and a pressure test. Closing the flow line for a few strokes to see if the pump builds pressure can do the pressure test. If the fluid is mostly gas it will build pressure with each stroke. Once gas pound is detected, consul with the proper manufacturer's sales representative to get you headed into the right direction by discussing and practicing proper down hole gas separation techniques to restrict gas from entering the SRP such as a good down hole gas separator. Set the pump intake below all gas and fluid entry zones. The pump is going to pump what is available to it and one of the most common problems is incomplete fillage causing low producing efficiencies. Several specialty pump designs are available in the industry today to help produce with gas interference such as the (Variable Slippage Pump®.) The VSP allows the traveling valve to equalize at the top of the stroke and eliminate rod compression. Sucker rod pump's should be designed and built where the traveling valve is within 1" of the standing valve when the pump bottoms out when clutched at the top end.

Longer Stroke = Higher Compression Ratio
Gas Separation Before The Pump Is Always The Best & Most Economical Solution
Set Pump Below The Perforations For Best Gas Separation

Compression Ratio

$$C\ R = \frac{\text{Swept Vol.} + \text{Unswept Vol.}}{\text{Unswept Vol.}}$$

Fluid Pound

Fluid pound is a phenomenon that occurs when the down hole pump exceeds the production rate of the formation. It can also be due to low-pressure gas between the valves causing deflection of the sucker rods, valve rods, and pull tubes. This typically will cause fatigue type breaks, and friction wear. On the down stroke of the pump, the gas is compressed, but the pressure inside the barrel does not open the traveling valve until the traveling valve strikes the liquid. When the traveling valve opens, the weight on the rod string can suddenly drop thousands of pounds in a fraction of a second. Several steps can be taken to help avoid this situation. The first method involves slowing down the pumping unit and changing your stroke length, this will dramatically reduce the stress on the pump. The second and one of the most basic tools available today to help fluid pound situations is the use of a pump off controller. When the fluid level is drawn down to the pump intake, a POC will detect incomplete pump fillage and shut down the beam pumping system for a pre-determined set of time. This allows the fluid to re enter the annulus before starting back up. The absolute main goal is to operate the SRP with each stroke full of liquid for trouble free operation.

Sand

In certain well applications sand is an ongoing problem for all SRP's. The veterans in the oil and gas industry will refer to this problem as "sticking" or "packing off." Sticking of the plunger is when sand is trapped between the barrel and plunger. Packing off is defined as when your cages have become packed off or full of sand causing your valves to stay open. Sand will also cause your bottom hole pump to become stuck in a joint of tubing. Sand size ranges in the thousands of an inch. Below .003" is classified as silt and clay ranging up to most extreme at .040" and above as very course sand. The general rule is as follows for plunger/barrel clearance for pumping sand. Large grain size .020" clearance and higher. Small to medium grain size .015" and smaller. The term "tight fit" plunger means excluding sand from barrel/plunger interface. The term "loose fit" means your allowing sand to pass through the barrel/plunger interface. Several specialty pumps and pump accessories are available in the industry today to help produce when sand is present. Your technical salesman will be your best asset to assist with this information.

Pump Operation and Cyclic Fluid Load

See Figure 2

The plunger has a close fit to the inside of the barrel, which along with the length of the plunger creates a seal between the upper and lower chambers. At the beginning of the upstroke, the traveling valve closes and the standing valve opens due to pressure differences. The fluid above the traveling valve is lifted in the upper chamber while fluid enters the lower chamber. On the upstroke the rod string supports the fluid. After reaching the top of the stroke and starting downward, the fluid in the lower chamber is trapped between the closed standing valve and the traveling valve. The plunger does not move if the pump barrel is full of incompressible fluid. The pressure quickly builds up to the hydraulic pressure of the tubing and the traveling valve opens allowing the plunger to move through the fluid in the lower chamber to start the next stroke cycle. During the down stroke the fluid load is supported by the tubing string, without a tubing anchor the tubing string would move under this changing load causing loss of relative pump stroke.

1. When the traveling valve is closed on the up stroke; the fluid load is on the rods.
2. When the traveling valve opens on the down stroke; the fluid load shifts to the tubing.

SIMPLE PUMP GUIDELINES

Match pumping requirements with well bore inflow, eliminate gas interference, use full pump capacity by controlling run times with a POC or Timer, when efficiency is low always use your resources to find and fix the problem. Keep it simple, more complex pump designs fail and end up costing more. Keep your traveling valve within 1" of the standing valve when designing and building a SRP, and use proper gas separation techniques. Know what you are running and always consult with your technical sales team and existing field support.

CONCLUSION

Sucker Rod Pump's are the most widely used form of artificial lift today. SRP's should be periodically monitored and evaluated to ensure that the pump is operating efficiently, and has no mechanical problems. Timers and POC's operate the pump when the pump is full of fluid. A full pump prevents low efficiencies and mechanical damages that usually result from gas interference and fluid pound. Applying these methods discussed in this paper will help result in lower operating cost and longer pump life. Keep in mind that some practices may not be a cure all for some fields. Anytime a change is made a follow up analysis should be conducted to make sure your new practice is working properly.

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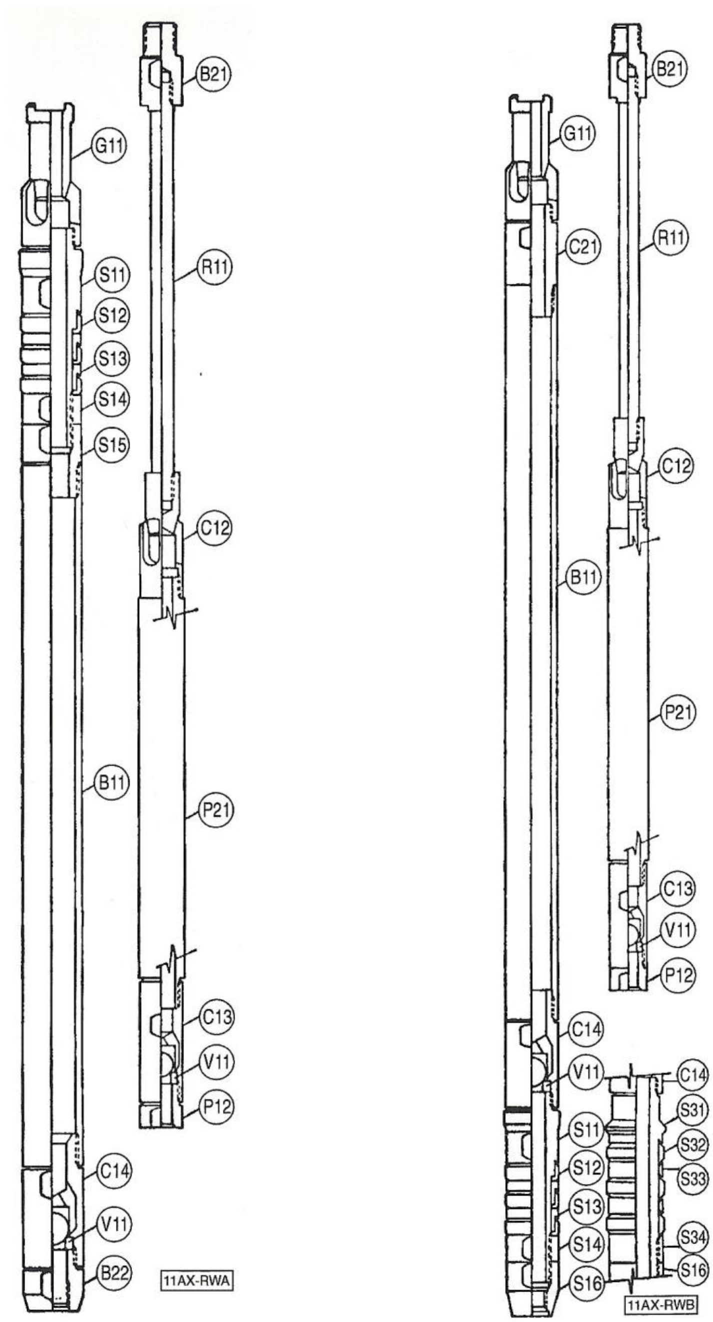


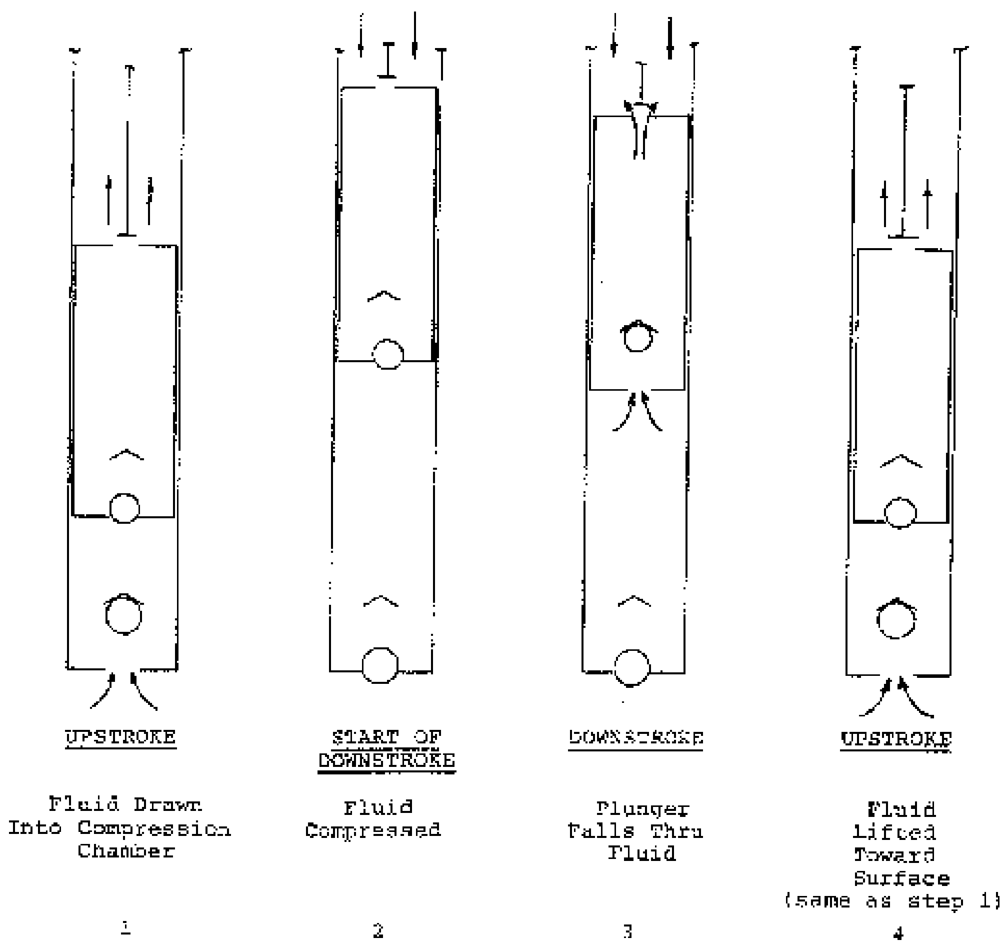
Figure 1

Top Hold Down Illustrated

Bottom Hold Down Illustrated

From API 11AX

1-0



UPSTROKE
Fluid Drawn Into Compression Chamber
1
START OF DOWNSTROKE
Fluid Compressed
2
Plunger Falls Thru Fluid
3
UPSTROKE
Fluid Lifted Toward Surface (same as step 1)
4

Figure 2