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Effectiveness of Using 80 cm Cyclone Profile at The End of Suction Pipe After Sand Screen for Sand Separation at The Accessories of Tubing Pump

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Abstract. The Oil and Gas Industry is facing huge challenges, especially for mature field. Enhanced Oil Recovery (EOR) already used to maintain the reservoir pressure, so the crude oil still produced in accordance with its reserves, although artificial lift is needed. The other problems of mature field are sand and scale, mechanical accessories chosen to solve that because it is cheapest way. The data said the 73% of well services problem contributed from sand problem which cause pump stuck, leakage of ball and seat, and pump intake clog since the mud anchor is full of sand on sucker rod pump wells.

The first mechanical accessories to solve the sand problem is using sand screen at the intake as the pump accessories. Based on the evaluation, sand screen in not effective to cure the problem. The sand still breaks through the pump. Additional accessories behind the sand screen are needed for sand separation. A cyclone profile with 80 cm length and 60^o angle is pinned at the end of eight-meter suction pipe to separate the sand form production fluid, then the sand collected at three joints of mud anchor located at the end of tubing pump string. To prevent pump stuck, extension plunger and tungsten ball & seat are used.

The installation of these accessories produces good result for overcoming sand problem. The two wells that uses these accessories had longer run life more than six months from before. The other good advantage is when the surface pumping unit at the surface is accidently shut down, the plunger of the pump did not stuck inside the barrel, so the production could continue. With this result, the accessories could prevent the sand from produced into the pump, and it is an effective tool to resolve the sand problem in mature field with less cost.

The installation of 80 cm cyclone profile at the end of the suction pipe on tubing pump string is a practical solution with less cost for mature oil field that encounter sand problem as a common challenge in producing oil.

Keyword(s): mature field, sand problem, suction pipe, cyclone profile, extension plunger.

1 Introduction

Sucker Rod Pump provides mechanical energy to lift oil from subsurface to surface. It is efficient, simple, easy to operate, low-cost investment than other artificial lift and suitable for marginal field. The mechanical system at the start of the upstroke of the plunger, the traveling valve is forced to close and standing valve is drawn to open, then fluid flow from the wellbore to the pump barrel chamber during the upstroke. The standing valve will close and trap that fluid in the barrel chamber when the plunger reaches the top of the stroke and start the beginning of the down stroke. The travelling valve opens during the down stroke of the plunger. This process is continuously repeated, eventually bringing the well fluids to the surface as Figure 1.

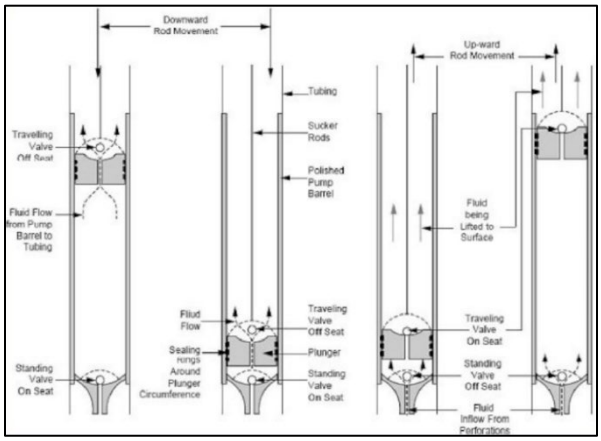

Figure 1 Subsurface / Downhole Sucker Rod Pump Mechanical Principle of Operation

However, the mechanical system of Sucker Rod Pump is not designed or able to handle sand problem especially the very fine of sand like mud. Figure 2 is a pareto chart from the last study. It shows very fine sand/sand problem represent the highest percentage ±73% of the sucker rod pump failures.

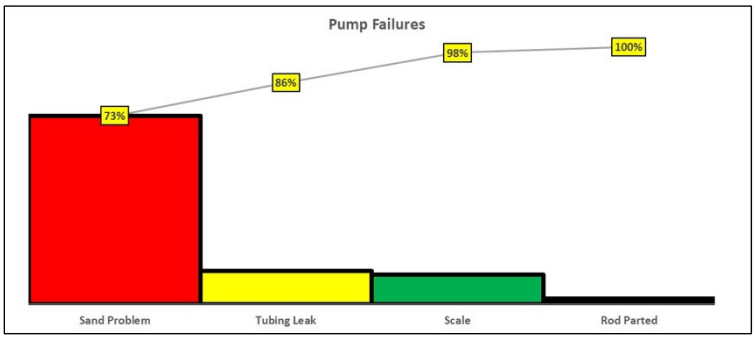

Figure 2 Pareto Chart of Pump Failures

The major problems caused by sand are stuck, erosion of material subsurface pump, rod parted or tubing leak cause of buckling effect due to presence of sand around plunger that increases the friction so this will restrict plunger movement downward freely.
Generally, to avoid sand into downhole pump by applying sand handling design such as raise up pump intake or utilizing downhole sand trap like desander or sand screen. But it doesn't effectively to handling very fine of sand due to the limitation of each downhole sand trap: desander (limitation: flowrate) or sand screen (limitation: mesh size could not be adjustable).

2 Methodology

To solve the sand problem in mature field could be done by stimulation or acidizing, but it had a big cost. For mature field, mechanical method by using accessories after the downhole pumps was the most efficient way to overcome sand problem. On the first trial, sand screen was used as its accessories. Unfortunately, using sand screen without additional accessories was not enough, the sand still produced through the tubing pump which could cause leakage on standing valve and stuck of the plunger.
From the data that was driven by production test results and pump setting parameters, we defined the design requirement of the accessories that installed with sand screen after the tubing pump. The design should make the accessories separate the sand and the liquid. The idea was making the flow become like a vortex. Then 3D design was with a strip plat which was shaped into a spiral as Figure 3. The spiral design, then called as cyclone profile, attached to the outside of the suction pipe.

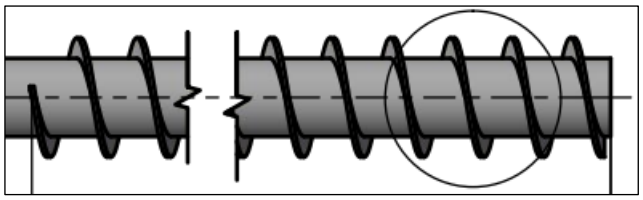

Figure 3 Spiral profile which welded outside the suction pipe

Next step, the length of spiral must be determined since we need to effectively shape the vortex. The authors calculated using *Reynold Number* equation (1).

$$L = \frac{N_{Re}\mu}{\rho v} \tag{1}$$

The flow in a round pipe is turbulent if the Reynolds number is greater than approximately 4000 (Munson, 2009). Then the author got the result of the length was 79 cm, next rounded up into 80 cm. After that, a simulation was conducted by comparing its flow profile through the length of the spiral which was less than 80 cm and equal to 80 cm. The result said that the profile of velocity was better with the 80 cm length of the spiral. The comparison of the simulation result between the difference of spiral length as Figure 4 the cyclone didn't shape well and Figure 5 the cyclone had better of shape.

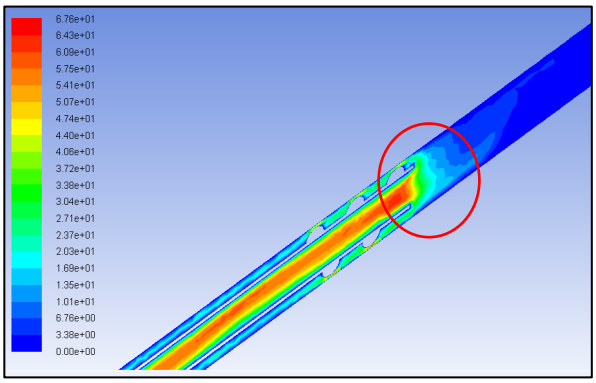

Figure 4 Simulation result for 12 cm of spiral length

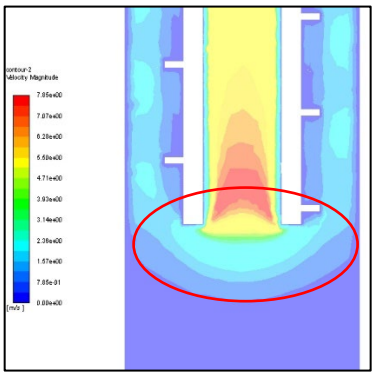

Figure 5 Simulation result for 80 cm of spiral length

The length of the spiral had been defined, then the author needed to determine the angle of the spiral with the axis of the suction pipe. The literature said with an angle between 45° - 60° the sands will not settle in the plate (Tchobanoglus, 2002). Next, the author conducted the simulation for comparing the flow profile again. The comparison of simulation result between the difference of angle as Figure 6 and Figure 7.

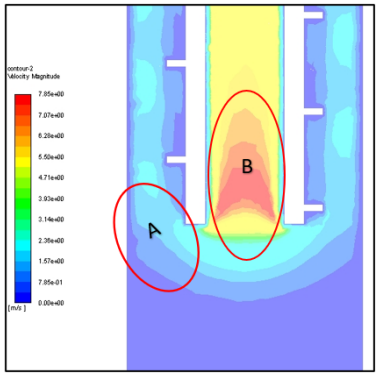

Figure 6 Simulation result for 60° to the axis

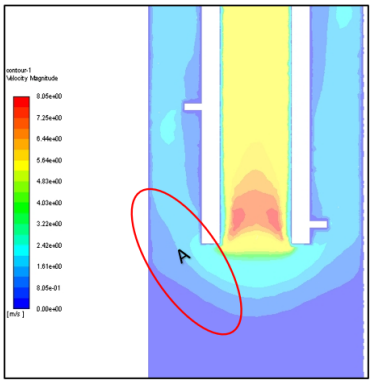

Figure 7 Simulation result for 45° to the axis

In the Figure 6 with "A" circle, the velocity profile more perfect than "A" circle in the Figure 7. Also, in Figure 6 in "B" circle had a fully developed velocity profile which the flow to get the laminar flow was easier. With the laminar flow entered the suction pipe causing decrease the difference of kinetic energy and the benefit that we could get was minimizing the pressure drop (Munson, 2009) through the downhole pump.

After the design of additional accessories was completed, the tool was fabricated in the pump shop and installed into the sand screen. The spiral plat welded on the outside of the suction pipe and conducted the NDT test to ensure its quality. The additional improvement for the mitigation of pump stuck, the authors used an extension plunger (Farr Plunger homemade) and changed the material into tungsten for abrasion resistant.

3 Result and Discussion

Cyclone profile accessories installed in two wells. The first well, Well A-1, underwent well service within one month after the previous well service. The tubing pump string installed with gas anchor and the plunger went stuck when it will be pulled of tubing pump string during well service. Cyclone profile then installed on the tubing pump string. In Figure 8 it shows that the well could produce normally and had longer run life than using other downhole accessories without cyclone profile. The run life increased to 661 days from the previous 46 days.

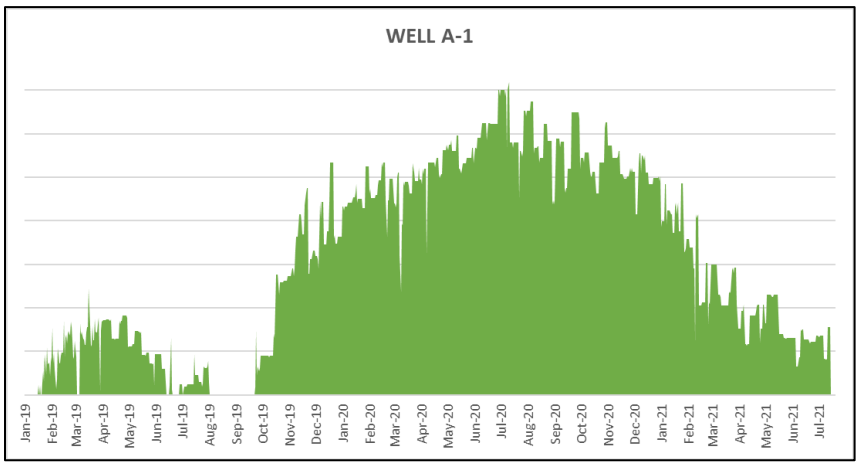

Figure 8 Well A-1 Production Profile Graph

The second well, Well A-2, underwent well service two times within one month before the installation of cyclone profile accessories. Sand screen accessories installed on the first well service, it has 13 days of run life, then modified gas anchor with dip tube installed on the second well service, it has 13 days of run life. The short run life makes this well could not produce to its potential, so cyclone accessories was installed on the third well service and the run life increased from 13 days to 244 days as of December 31st, 2021. The production profile and run life period of Well A-2 can be seen in Figure 9.

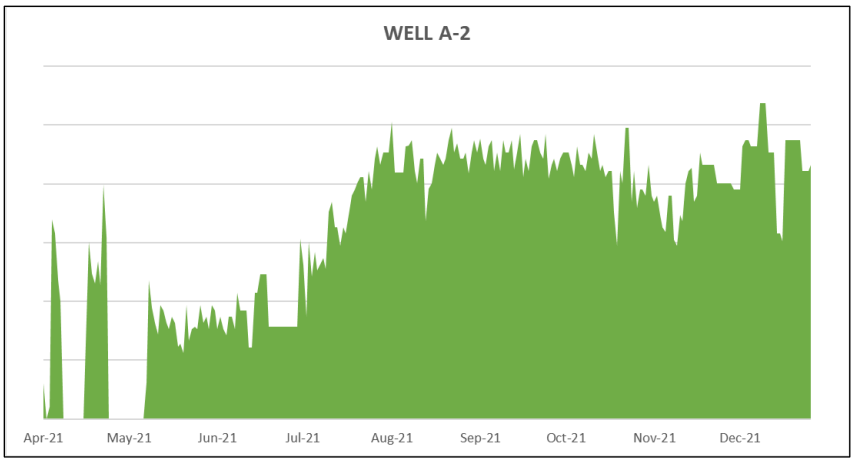

Figure 9 Well A-2 Production Profile Graph

The effectivity of sand separation on cyclone profile accessories could prevent the sand that can still break through the tubing pump accessories, such as sand screen and desander, to enter the plunger. Production optimization by changing the stroke length or stroke per minute becomes possible since the tubing pump is not compromised by the sand form the reservoir.

4 Conclusion

The installation of 80 cm cyclone profile at the end of the suction pipe on tubing pump string is a practical solution with less cost for mature oil field that encounter sand problem as a common challenge in producing oil. In detail with cyclone profile the authors get:

a. The cyclone profile with a certain length and angle effectively separates the sand before entering the tubing pump.
b. The lifetime Well A-1 and A-2 have longer of lifetime than before.
c. Production optimization by applying the pump parameters becomes possible since the tubing pipe can be operated with sand in fluid.

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