

EVALUATION AND OPTIMIZATION OF SUCKER ROD PUMP IN WELL X AGAINST HYDROCARBON FLUID PRODUCTION INCREASE Y FIELD

Kristofol Waas¹, Berthy Pelasula², Melady Lokollo³

^{1,2,3}D4 Oil and Gas Production Engineering Study Program, Department of Mechanical Engineering, Ambon State Polytechnic

Email : kristwaas@gmail.com, bertxpelasula@gmail.com, meladylokollo0@gmail.com

ABSTRACT

To increase the productivity of a sucker rod pump, it is necessary to pay attention to the pump production capacity, stroke length, pumping speed. The decline in pump production can be caused by various factors. Well X experienced a decrease in production, this was due to not meeting the optimum target that could be achieved by the pump, where at the time the research was carried out, well X had already been produced using a Sucker Rod Pump (SRP). This is a method of artificial lifting (Artificial Lift) that is most commonly used, due to the combined motion between the equipment that is on the surface and the equipment that is below the surface. The Sucker Rod Pump (SRP) Artificial Lift method is used in several wells in the KLAMONO – PERTAMINA EP CEPU Papua Field.

To increase the production of well X, it is necessary to take optimization measures by increasing the initial SPM parameters. Before this optimization is carried out, the pump needs to be evaluated first to be able to find out the pump capacity by finding the PI and Qmax values to make the IPR curve. PI and Qmax in the X well studied by PI is 12.326 and Qmax is 1539.66 bfpd,

The results obtained using the Vogel method using the Pipesim application (PIP) for well X are only capable of producing 315 bfpd at 18 SPM with a Pwf of 187.279 psi and can still be optimized by increasing the Strokes Per Minute Parameter (SPM) to 24 SPM by production yield increased by 891 bfpd at a Pwf pressure of 129,847 psi.

Keywords: Sucker Rod Pump Evaluation and Optimization

INTRODUCTION

Oil wells can produce naturally (natural flow) if the reservoir pressure in the formation is greater than the well's hydrostatic pressure. In oil wells to lift the available formation fluid must have sufficient energy. The longer the pressure will continue to decrease so that the pressure is no longer able to lift the fluid to the surface. Production wells that are no longer able to drain reservoir fluid naturally due to the decrease in bottom water pressure from the well, therefore a plan for the installation of an artificial lift, namely the Sucker Rod Pump (SRP) is carried out.

Artificial lift is carried out to help produce oil in the field. Selection of the right artificial method is necessary to obtain optimum oil production. For its operation, the sucker rod pump is combined with the Pumping Unit (UP) on the surface facility. In the operation of pumping units in oil fields, there is often a problem of discrepancy between the desired production rate and the actual

production rate, so an evaluation of the sucker rod pump performance is needed to obtain optimum pump performance and production results.

In well X experienced a decrease in production. Because the longer it is produced, the reservoir pressure will decrease and will have an impact on decreasing the volumetric efficiency of the installed pump, so it is necessary to optimize the volumetric efficiency of the installed pump to increase the productivity of a sucker rod pump, it is necessary to pay attention to the stroke length (S) and pumping speed (N). . The rare length and pumping speed must be adjusted to the pump capability and also the IPR (Inflow Performance Relationship) curve. The expected result is to get an increase in production after taking into account the step length (S) and pump speed (N). By optimizing, it is hoped that the production rate will increase without an increase in WC (Water Cut).

1. Artificial Lift

Artificial lift is a mechanism for lifting fluid from the well to the surface using a pump because the pressure from the reservoir is unable to push oil to the surface or is the method most (> 90%) used to produce oil and natural gas. Generally these wells are in old fields, or are called brown fields. Artificial lift is applied when the Reservoir is unable to naturally push fluid to the surface, to produce oil and gas to the surface. In old wells, not only focusing on artificial lifts but also increasing reservoir pressure by adding injection wells around production wells (Richa Melysa, 2009). To determine the type of artificial lift to be used, the characteristics of the well must be known in advance and matched with the characteristics of the type of artificial lift.

2. Well Productivity

Well productivity is the ability of a well to produce the fluid it contains under certain pressure conditions. The ability of a well to produce fluid is highly dependent on the type of reservoir and driving force and reservoir conditions. Parameters that indicate well productivity are: Productivity Index (PI) and Inflow Performance Relationship (IPR).

Basically the Productivity Index (PI) is an index that shows the ability of a well to produce as much fluid volume as stated in barrels per day at a pressure difference between the reservoir pressure (P_r) and the flow pressure (P_{wf}) at the bottom of the well.

The productivity index (PI) obtained is only a rough description of the ability of a well to produce. In connection with the planning of a well or to see the behavior of a well to produce, the PI price can be expressed graphically, which is called the Inflow Performance Relationship (IPR) graph.

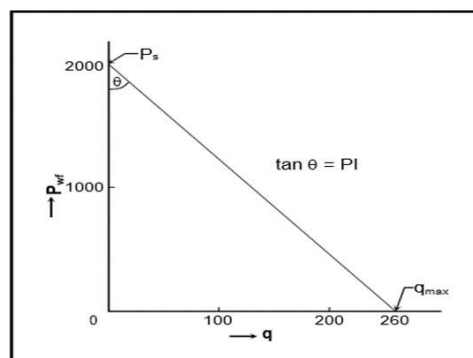


Figure 1. Single-phase flow IPR graph
(Source: Pamungkasjoko,2010)



Figure 2. Two-phase flow IPR graph
(Source: Pamungkasjoko,2010)

3. Vogel's method

The use of Vogel according to Irawan, 2007 to describe the production capability of a well in the Vogel reservoir develops the production behavior of the well with the following assumptions:

- The effect of gravity is neglected
- The compressibility of water and rock is neglected
- In conditions where the reservoir pressure is below the bubble point pressure
- There is no skin effect

Use of the Vogel method “The Vogel method is designed to predict the potential of oil wells with dissolved gas driving force. The Vogel method can still be used in oil wells with a water cut below 75%. The two-phase IPR curve was first developed by Weller, then simplified by Vogel to make calculations easier.

4. Sucker Rod Pump

Sucker rod pump (SRP) is an artificial lift technique that is used to help lift oil from the bottom of the well to the ground surface to the holding tank. This method is used because the natural energy reduction or the well's reservoir pressure is no longer able to lift oil to the surface. This equipment can provide Reciprocation Motion to the Rod String which is connected to a Positive Displacement pump in an oil well.

At a certain period of time, the Sucker Rod Pump installed in a well needs to be maintained. By definition, it is stated that well maintenance is all types of work related to pumping activities aimed at maintaining production according to its potential.

Before optimizing the Sucker Rod Pump, it is necessary to understand the production capability of a well's productive formation. Optimization of the Sucker Rod Pump is determined based on the working principle and calculations contained in the theoretical basis. The method of calculation is done by the method of analysis and from these calculations it can be seen the magnitude of the production rate of each well.

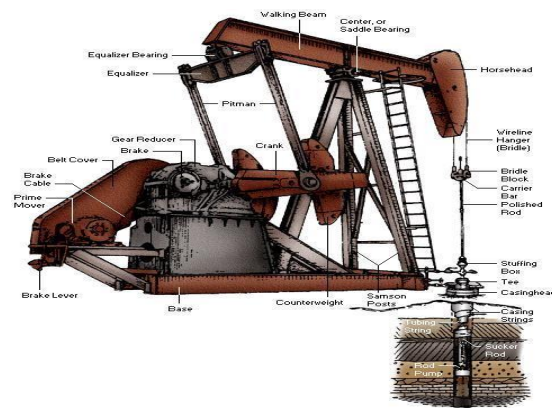


Figure 3. Surface Sucker Rod Pump
(Source: via industrimgas.com)

5. Subsurface Equipment

The main function of the sucker rod pump below the surface is to raise the hydrocarbon fluid from within the formation into the tubing and lift it to the surface. The sucker rod pump equipment below the surface can be seen in Figure 4.

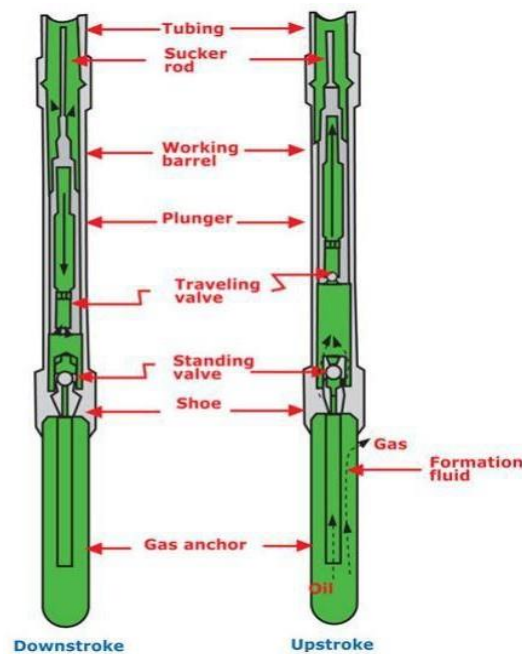


Figure 4. Subsurface Sucker Rod Pump Equipment
(Source: SriHaryono, 2018)

METHOD

The type of research used in research is analysis where research data is obtained from field observations and is used to evaluate pumps, and also uses the IPR curve. From the curve can see the rate of production. And also do optimization using the Pipesim application by changing the SPM load.

The data sources of this research are as follows:

- a. Literature review, research data obtained through literature that supports the discussion of the problem.
- b. Observation, the Sucker Rod Pump well data was obtained through direct observation of the X Klamono well.

The data is then analyzed to evaluate and optimize the Sucker Rod pump to increase well production using the Pipesim application

RESULTS AND DISCUSSION

Results

1. Evaluation of Sucker Rod Pump

Evaluation of the installed Sucker Rod Pump (SRP) is carried out to be able to find out the condition of the pump being used. Evaluation of the installed Sucker Rod Pump (SRP) pump can be used to find out several important parts and be an evaluation material to see how the pump is being used. In addition, it is necessary to calculate the potential of the well so that it can be known how much the production capacity of a well is and also the possibility of an increase in production. The small production rate and the large production capacity of a well will be a reason for optimizing the Sucker Rod Pump (SRP).

2. Data of Well X in Field Y

Well X uses a 2 ½" RWB pump with a maximum power of 115.50 HP and an assumption of a maximum DP of 30,000 psi is taken, the data for evaluation is taken in 2020 as follows:

-Sg Water	= 1	API
-API Oil	= 18	
-Bottom Perfo	= 498	ft
-Top Perfo	= 485,44	ft
-Middle Perfo	= 491,72	ft
-Gross	= 315	bfpd
-Net	= 2,3	bopd
-Water Cut	= 99,3	%
-Stroke Length	= 64	in
-Strokes/Minute	= 18	SPM
-SFL	= 0	Ft
-DFL	= 59,04	Ft
-Tubing Size	= 2,875	In
-Rod	= 0,75	In
-Plunger Diameter	= 2,25	In
-Temperature	= 140	°F

-Pressure Well Head	= 30	psi
- Pump depth	= 98,88	M
-Pwf	= 187,27	Psi
-Ps/Pr	= 212,83	Psi

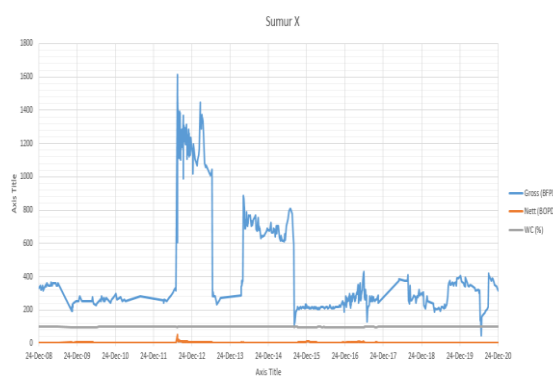


Figure 5. History Test Curve

3. Inflow Performance Relationship

To determine the production capacity is done by analyzing the Inflow Performance Relationship (IPR) with the Vogel equation. After obtaining the IPR curve, it is possible to select the desired optimum flow rate at a certain bottom well pressure. To get the IPR curve, it is necessary to do calculations to get the results by following the following equation:

a. SG_{mix} (Specifi gravity mixed fluid) and GF (Gradient Fluid) values

Obtained by using the following equation:

$$\begin{aligned}
 SG_{mix} &= ((1 - WC) \times SG_{oil}) + (WC \times SG_{water}) \\
 &= ((1 - 0.993) \times 0.946) + (0.993 \times 1) \\
 &= 0.9996
 \end{aligned}$$

$$\begin{aligned}
 Gf &= SG_{mix} \times 0.433 \\
 &= 0.9996 \times 0.433 \\
 &= 0.432
 \end{aligned}$$

b. The value of Static Pressure (P_s) and bottom well pressure (P_{wf}) is obtained by using the following equation:

$$\begin{aligned}
 P_s &= (\text{midperfo} - \text{SFL}) \times Gf \\
 &= (491.72 - 0) \times 0.432 \\
 &= 212.834 \text{ psi} \\
 P_{wf} &= (\text{midperfo} - \text{DFL}) \times Gf \\
 &= (491.72 - 59.04) \times 0.432 \\
 &= 187.279 \text{ psi}
 \end{aligned}$$

4. Production Capacity of Well X

From the calculation above, to get the IPR curve it is necessary to do calculations to find

out the PI and Qmax values by taking into account the data that has been obtained.
The following is the X well field data studied:

Static Pressure (Ps)	= 212,834	Psi
Well bottom pressure (Pwf)	= 187,279	Psi
Total production (Qt)	= 315	Bfpd
Oil production (Qo)	= 2,3	bopd

Then the calculation results for the IPR curve of the X well studied are as follows:

-Calculation of Productivity Index (PI):

PI is obtained by using the following equation:

$$\begin{aligned}
 PI &= \frac{q}{P_s - P_{wf}} \\
 &= \frac{315}{212,834 - 187,279} \\
 &= 12,326 \text{ bfpd/psi}
 \end{aligned}$$

-Q_{max} Calculation:

$$\begin{aligned}
 Q_{\max} &= \frac{q}{1 - 0,2 \left(\frac{P_{wf}}{P_s} \right) - 0,8 \left(\frac{P_{wf}^2}{P_s^2} \right)} \\
 &= \frac{315}{1 - 0,2 \left(\frac{187,279}{212,834} \right) - 0,8 \left(\frac{187,279^2}{212,834^2} \right)} \\
 &= 1539.66 \text{ bfpd}
 \end{aligned}$$

Plot the price of Q on the different P_{wf} prices to get the price of Q:

Table 1. Q values at various P_{wf}

P _{wf}	Q
0	1539.66
37.83	1446.00
62.83	1341.40
87.83	1202.80
112.83	1030.22
137.83	823.65
162.83	583.09
187.83	308.54
212.83	0.003

Inflow Performance Relationship (IPR) curve

From table 1 above a curve is made by connecting the well bottom flow pressure (P_{wf}) and fluid flow rate (q) as follows:

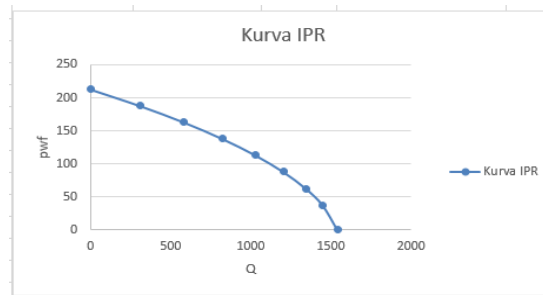


Figure 6. Well X's Inflow Performance Relationship (IPR) curve.

DISCUSSION

1. Performance Evaluation of the Sucker Rod Pump

From the performance evaluation of the pump installed on well X it can be concluded that well X can still be optimized even though it has a high Water Cut, this can be seen from the pump efficiency value which reaches 46% and the plot on the IPR curve which shows the price of Q_{max} obtained at 1539 bfpd where the results of the X well test were only 315 bfpd at a well bottom flow pressure (Pwf) of 187.279 psi with a Water Cut of 99.3%. By using the Pipesim software, optimization is carried out on the X well by increasing the value of the Strokes Per Minute (SPM) parameter from 18 SPM to 24 SPM at the same Pwf without changing other parameters.

2. Optimization of Sucker Rod Pump Performance

From optimizing the performance of the pump installed on well X it can be concluded that well X can still be optimized even though it has a high Water Cut, this can be seen from the pump efficiency value which reaches 98.3% and the plot on the IPR curve which shows the price of Q_{max} obtained is 1539 bfpd and 6,237 bopd where the results of the X well test were only 315 bfpd at a well bottom flow pressure (Pwf) of 187.279 psi with a Water Cut of 99.3%. By using the Pipesim software, optimization is carried out on the X well by increasing the value of the Strokes Per Minute (SPM) parameter from 18 SPM to 24 SPM at the same Pwf without changing other parameters.

3. Optimization of Sucker Rod Pump at Well X

Optimization of the Sucker Rod Pump (SRP) in well X is carried out by changing the Strokes Per Minute (SPM) to obtain an optimum production rate that is in accordance with the potential of the wells, so that better pump volumetric efficiency can be obtained without making changes to the pump unit. installed. This optimization also aims to be able to get a better production rate than before.

4. Nodal Optimization Sucker Rod Pump Analysis

In Nodal Analysis, input the data that needs to be entered for RUN. After that, the maximum production flow rate will appear on the stage and it will be efficient according to the target. Before RUN, enter the Outlet Pressure of 30 psi and in the Outflow Sensitivity section enter the name of the pump and also the pump parameters, where the parameter that will be changed in this optimization is to increase the production rate, namely the value of

Strokes Per Minute (SPM) from 18 SPM to 24 SPM.

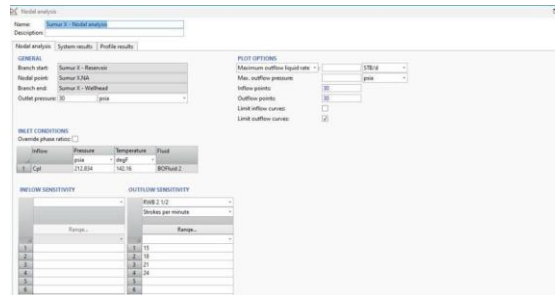


Figure 7. Nodal Analysis

After RUN, the production results and production curves for each specified SPM parameter are obtained.

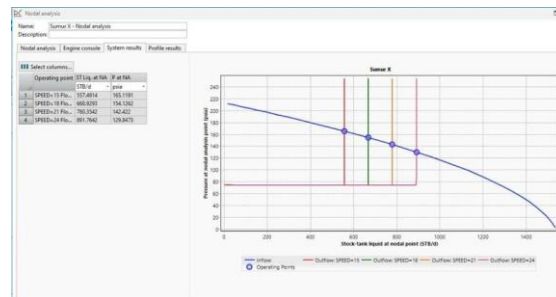


Figure 8. Yield and Production Curve for SPM

From the results obtained, it shows that the optimization carried out by increasing the SPM parameters without changing other parameters, can increase production from before optimization with the highest production results, namely 891,764 bfpd at 24 SPM with a Pwf pressure of 129,847 psi, much better than before it was carried out optimization is 315 bfpd at 18 SPM with a Pwf pressure of 187,279 psi. Based on the curve above, it can be seen that production has increased with the optimization method using the PIPESIM application, but it can still be optimized using methods other than increasing the SPM parameters used.

CLOSING

From the results of the discussion of the problem, several conclusions and suggestions can be drawn as follows:

1. Conclusion

From the research entitled Evaluation and Optimization of Sucker Rod Pump in X Well for Increasing Hydrocarbon Fluid Production in Y Field, namely from the evaluation carried out on the 2½" RWB sucker rod pump (SRP) in X well it was found that the pump has an efficiency of 46% with performance the well is only capable of producing 315 bfpd at 18 SPM with a Pwf of 187,279 psi. From the IPR curve, the maximum flow rate (AOFP) is 1539.644 stb/d. From the performance evaluation of the pumps and wells that have been carried out, production optimization can be carried out by changing the parameters of the

installed pumps in order to obtain an optimal production rate. By using Pipesim, the installed pump is optimized by changing the pump parameters. After several experiments, it was found that a significant parameter for increasing production was pump speed (SPM). After optimization, the production rate is 891.764 bfpd with 24 SPM at a Pwf of 166.212 psi.

2. Suggestion

From this study, it can be suggested to use other methods in order to obtain more optimal production results according to the target besides using the method of increasing the SPM parameters which may be more suitable for old well types in future research. In addition, it is advisable to look for efficiency comparisons or changes in increased production capacity based on several sensitivity variables so that the most optimal method is obtained for application to a pump in oil and gas wells.

In addition, for further research related to changes in SPM speed to gear box rotation or fully adjusted rotation with 24 SPM calculation results.

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