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REDESIGN OF CONTINOUS LIFT TYPE GAS LIFT WELL EC-6

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Abstrak

Sumur "EC-6" lapangan Sumatera Selatan merupakan sumur yang telah dipasang sistem produksi gas lift tipe kontinyu sebelumnya. Namun dalam upaya meningkatkan volume produksi, maka rencana untuk mendesain ulang lift buatan yang dipasang sedang dipertimbangkan. Metode yang dipilih adalah gas lift tipe kontinyu. Penelitian ini dalam upaya redesain manual selain materi edukasi redesain manual untuk gas lift tipe kontinyu. Lift gas yang dipasang sebelumnya di sumur "EC-6" memiliki laju produksi sebesar 1020 BFPD dengan laju maksimum sebesar 3022 BFPD. Berdasarkan rencana redesain continuous gas lift, nilai PI ditetapkan sebesar 2,79 BPD/psi dan berdasarkan perhitungan IPR ditetapkan nilai maksimum sebesar 2178 BFPD. Berdasarkan rencana redesain sumur "EC-6", jumlah katup yang dibutuhkan adalah 10 katup dengan kedalaman titik injeksi 1570 ft dan jumlah gas injeksi yang dibutuhkan setiap hari adalah 15168.74 scf/d. Menurut evaluasi target tingkat produksi 1500, produksi telah meningkat sebesar 47%.

Kata Kunci : *Sucker Rod Pump*, Optimasi, Laju Produksi

Abstract
The "RK-23" well is a production well using the sucker rod pumping method with an initial production rate of 195 BOPD. Based on the potential analysis, this well has a maximum capacity (Qmax) of 642 BOPD which indicates an opportunity to increase production. To optimize pump performance, an evaluation was conducted using six plunger size variations: 1¼ in, 1½ in, 1¾ in, 2 in, 2¾ in, and 3½ in. The optimization results showed that using a 1¼ in plunger produced a flow rate of 190 BPD (stroke length 117 in, 9.2 SPM), while a 1½ in plunger increased production to 230 BPD (stroke length 120 in, 9.5 SPM). A 1¾ in plunger produces 250 BPD, but is less efficient than a 1½ in plunger as it requires adjustments to the operating parameters. The 2 in plunger size produced 240 BPD, while the 2¾ in and 3½ in plungers did not provide optimal results due to the mismatch of the performance curves. Of all the scenarios, the 1½ in plunger (Scenario 2) was the best option with an increase in production of 35 BPD (from 195 BPD to 230 BPD), operating efficiency, and technical considerations related to the optimal plunger size. Thus, the optimization recommendation for Well "RK-23" is the use of a 1½ in plunger to effectively increase production.

Keywords : *Sucker Rod Pump, Optimization, Production Rate*

PENDAHULUAN

Artificial lift methods are used to produce fluids from a dead well or to increase the production rate of a flowing well(Bishop, 2001). There are a variety of artificial lift mechanisms available to choose from. One commonly used type of artificial lift method uses a pump installed below the fluid level in the well to increase the pressure to overcome the flow pressure losses that occur along the flow path to the surface(Bourgoyne, 1991). Another artificial lift method uses compressed gas, injected periodically below the fluid in the well tubing and using the energy of the gas expansion to move the slug fluid to the surface. A third mechanism works on a completely different principle: instead of increasing the pressure in the well, the flow pressure losses are reduced by the continuous injection of high-pressure gas into the well flow(Brown,1980). This allows the actual bottom hole pressure to move the well fluid to the surface(Yanti et al., n.d.).

In the case of the "EC-6" well in South Sumatra Province, it is an example of a well that has previously been installed with artificial lift(Lesmana,2019). This well has been installed with gas lift which functions to maintain or keep the production flow rate stable(Craft,1991). However, the "EC-6" well, in an effort to increase the production rate, will be reinstalled with artificial lift. The reinstallation activity will of course also be accompanied by a redesign of the gas lift(Megawati et al., 2025)).

The gas lift procedure involves injecting gas at higher pressure into a fluid column(De,1974). This serves to relieve and reduce the fluid pressure gradient, allowing it to rise to the surface through gas expansion(Michael,2016). In general, the method in which reservoir fluid is lifted to the surface is achieved through gas injection into the well(Ariyanto et al., 2025).

METODE PENELITIAN

The method used in this final project is the design method for the Continuous Gas Lift system. The process begins with collecting reservoir and well data, including pressure, temperature, oil production, and fluid characteristics. This data is essential to understanding operational conditions before designing an optimal system. Once the data is gathered, the Continuous Gas Lift system is designed by calculating the necessary technical parameters. The gas injection point is carefully selected to ensure maximum oil production, along with determining the gas injection rate, injection pressure, and the number of gas lift valves required in the system. After the initial design is completed, an evaluation is conducted through simulations or technical calculations to assess its effectiveness. If deficiencies or mismatches with field conditions are found, the design is revised and adjusted to achieve better optimization. The results of the evaluation are then analyzed to ensure that the designed system functions effectively and efficiently in enhancing oil production. In the final stage, if the design proves to be effective, the Continuous Gas Lift system is ready for field implementation. This method is iterative, meaning that evaluation results may lead to design modifications to produce a more efficient system that aligns with the reservoir and well conditions. Through this approach, oil production can be optimized using a systematically designed Continuous Gas Lift technique.

RESULTS AND DISCUSSION

In Continuous Gas lift planning, analysis and calculation of existing data are required. In the calculation, there are stages to obtain the value. Here is the flowchart

1. EC-6 Well Data

"EC-6" Well data is data that the author obtained from a scientific journal that has been validated by the journal owner. The data aims to conduct a calculation analysis of Continuous Gas lift design planning. The data required is as follows :

Table 1 Data reservoir EC-6 Well

Data reservoir EC-6 Well		
Parameter	Value	
Bottom Hole Pressure	1039	psia
Bubble Point Pressure	620	psia
Bottom Hole Temperature	180	°F
API *Oil*	35.8	°API
SG *Oil*	0.85	
SG *Gas*	0.86	
SG *Water*	1.07	
Gradien air	0.433	psi/ft

Table 2 Pysical Data EC-6 Well

Physical data EC-6 Well		
Parameter	Value	
OD *Tubing*	2 7/8	in
ID *Tubing*	2.441	in
OD Casing	9 5/8	in
ID Casing	8.6	in
Mid Perforation Depth	2470	ft TVD
Orifice Depth	2314	ft TVD
Wellhead Pressure	100	Psia
Casing Head Pressure	1031	Psia

Table 3 Deviation Data Well

Deviation Data Well	
MD	TVD
0	0
332	332
1213	1181.4
2791	2314
2829	2340

2. Design calculation *Continuous Gas lift*

a) Determination of fluid column height in tubing

1) Using the weight of gas column chart, based on the operational pressure and specific gravity of gas the gas pressure gradient (GD) was determined to be GD = 12.8 psi/1000 feet.

2) Assuming Pso = 500 psi, calculate the gas injection pressure at the bottom of the well:

$$P_D = P_{so} + D(G_D)$$

$$P_D = 500 + 2340\,\frac{12.8}{1000}$$

$$P_D = 429.95\ Psi$$

3) Calculate the pressure at the bottom of the tubing, assuming ΔP = 100 psi

$$P_t = P_D - \Delta P$$

$$P_t = 429.95 - 100$$

$$P_t = 329.95\ Psi$$

4) Using the weight of gas column chart, with well head pressure and gas specific gravity, the gas pressure gradient (G_{gt}) = 2.3 psi/1000 feet was determined.

5) Calculate the height of the fluid column in the tubing with the equation:

$$H_{TL} = \frac{P_t - P_{wh} - G_{gt}D}{G_S - G_{gt}}$$

$$H_{TL} = \frac{395.95 - 100 - 2340\,\frac{2.3}{1000}}{0.6 - \frac{2.3}{1000}}$$

$$H_{TL} = 375.72\ \text{Ft}$$

b) Determination of Injection Point

1) Calculate GLRf with the following equation:

$$GLR_f = (1 - water\ cut)\ GOR$$
$$GLR_f = (1 - 0.76)\ 500$$
$$GLR_f = 120\ scf/bbl$$

2) Plot the point (1084.15, 2340) on a Cartesian graph with pressure (psi) as the and depth (feet) as the Y

3) Calculate the drawdown pressure with the equation:

$$\Delta P = \frac{q_t}{PI}$$
$$\Delta P = \frac{1500}{2.79}$$
$$\Delta P = 538.13\ Psi$$

4) Calculate the drawdown pressure with the equation:

$$P_{wf} = P_r - \Delta P$$
$$P_{wf} = 1084.15 - 538.13$$
$$P_{wf} = 546.02\ Psi$$

5) Plot (546.02, 2340) on a Cartesian graph.

6) Based on the flow rate (ql), water cut, and ID of the tubing used, select the appropriate flow pressure gradient graph. Select the appropriate GLRf line that has been calculated, then determine the equivalent depth Pwf. Adjust the Pwf equivalent point to the point (546.02, 2340). Then copy the corresponding GLR line to the cartesian paper.

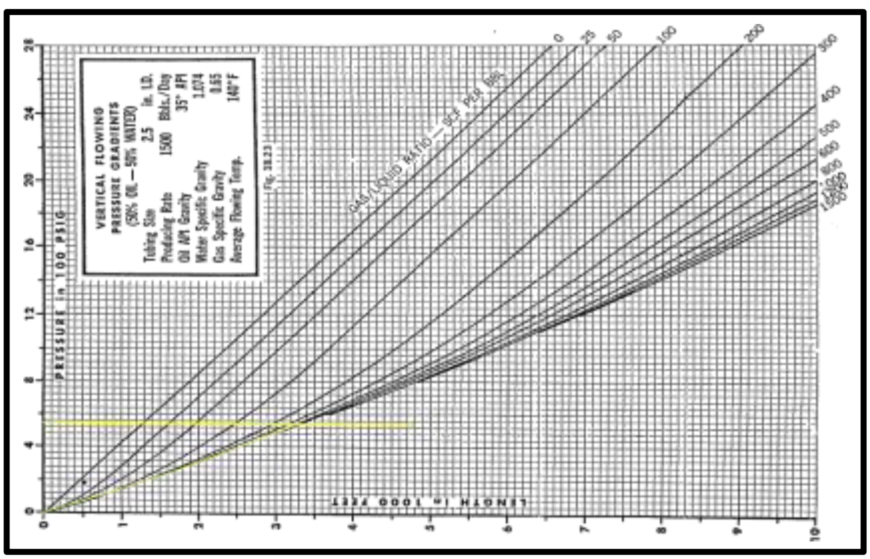

Figure 1 *Pressure Traverse Chart*
(Source : Brown, 1980)

7) Plot the points Pko = 550 - 50 and Pso = 500 - 100 at depth D.

8) Using the weight of gas column graph, obtain the gas pressure gradient for Pko and Pso. Calculate Pko and Pso at the bottom of the well with the following equations:

$$P_{koD} = P_{ko} + D\ (G_o)$$

In this Final Project writing discusses the analysis of the design of artificial lift gas lift type Continuous method. To make a gas lift design for the EC-6 well, it is necessary to analyze data, such as production data, well data and other completions data so that the design for the EC-6 well can run effectively and oil can be lifted to the surface. To complete the lack of data, the assumption data based on other literature is used.

The first step in gas lift design is the calculation of PI and IPR. Based on the calculation results, a PI value of 2.79 BPD/psi is obtained, which in gas lift planning, the PI value obtained is included in the large category. Based on the IPR calculation, the maximum production rate of 2128.06 BPD and the optimum production rate of 1702.45 BPD were obtained. Due to the limitation of supporting graphs, the target production rate is determined to be 1500 BPD, which is 70% of the maximum production rate. Based on the IPR graph, the target production rate is in the semi-steady state phase of depletion.

The next step is to determine the fluid column height at the bottom of the well, followed by determining the depth of the injection point. Based on the calculation, the fluid column height at the bottom of the well is 375.74 ft, less than 40% of the total well depth. Based on the qt, SGgas, and pressure determined, the pressure traverse graph used ish which is 1500 BPD and 50% water - oil.

With a drawdown pressure of 538.13 psi, it is determined that the well pressure when producing with gas lift is 546.02 psi. With the results of the assumptions and calculations of Pso Pko which have been drawn on a cartesian graph with pressure traverse, POB and POI are obtained at 1915 ft and 1570 psi. These two points are used to determine the depth of the standing valve, which is a valve that functions to control the fluid entering the tubing.

The next step in gas lift planning is determining the amount of gas injection and determining the depth and spacing of each valve. With Pwh and the graph of the previous step, it is determined that the GLR of the well after gas lift redesign is 200 scf/stb, and the amount of injection gas that has been corrected for injection temperature is 151765.74 scf/d.

Determination of valve depth is done by completing the Cartesian graph with the intersection line between the line that is inclined according to the kill fluid gradient, the Pko and Pso lines, and the pressure traverse line. Based on the graph that has been made (Figure 4.4), the number of valves required is 10 valves.

The next step in the design of continuous gas lift is to determine the opening pressure at the surface. This pressure is required in the gas lift startup stage until the gas column reaches the injection valve depth. Valve sizing and adjustments and corrections for 60°F conditions (NIST standard conditions) are required.

The results of the calculation of each valve are as follows:

1) Valve 1: Valve 1 is at a depth of 250 ft, csing injection pressure (Pvo) 510 psi, tubing pressure (PT) 300 psi, valve temperature 145, port size 5/16, dome pressure (Pd) at 60°F of 556.19 psi, and pressure at the workshop 731.54 psi.
2) Valve 2: Valve 2 is at a depth of 435 ft, Pvo 510 psi, Pt 303 psi, Tv 145°F, port size 3/8, Pd@60°F of 453.30 psi, and Ptro 692.06 psi.
3) Valve 3: Valve 3 is at a depth of 603 ft, Pvo 410 psi, Pt 306 psi, Tv 145°F, port size 3/8,

Pd@60°F of 457.23 psi, and Ptro 698.05 psi.

4) Valve 4: Valve 4 is at a depth of 760 ft, Pvo 411 psi, Pt 309 psi, Tv 145°F, port size 3/8, Pd@60°F 461.17 psi, and Ptro 704.08 psi.
5) Valve 5: Valve 5 is at a depth of 905 ft, Pvo 412 psi, Pt 312 psi, Tv 145°F, port size 3/8, Pd@60°F of 462.02 psi, and Ptro 713.01 psi.
6) Valve 6: Valve 6 is at a depth of 1031 ft, Pvo 413 psi, Pt 315 psi, Tv 145°F, port size 3/8, Pd@60°F of 471.01 psi, and Ptro 719.10 psi.
7) Valve 7: Valve 7 is at a depth of 1150 ft, Pvo 414 psi, Pt 317 psi, Tv 145°F, port size 3/8, Pd@60°F of 475.40 psi, and Ptro 725.80 psi.
8) Valve 8: Valve 8 is at a depth of 1250 ft, Pvo 416 psi, Pt 319 psi, Tv 145°F, port size 3/8, Pd@60°F of 479.81 psi, and Ptro 732.53 psi.
9) Valve 9: Valve 9 is at a depth of 1345 ft, Pvo 418 psi, Pt 320 psi, Tv 145°F, port size 3/8, Pd@60°F of 482.16 psi, and Ptro of 736.12 psi.
10) Valve 10: Valve 10 is at a depth of 1425 ft, Pvo 420 psi, Pt 320 psi, Tv 145°F, port size 3/8, Pd@60°F of 484.08 psi, and Ptro 739.05 psi.

CONCLUSION

The results of the data analysis and manual calculations for the EC-6 well, so that the EC-6 well can run effectively. The conclusion of the EC-6 well is:

1) Based on the calculation with Vogel's formula, the PI value is 2.79 BPD/psi. By calculating the IPR of the "EC-6" well, it is determined that the maximum flow rate of the well is 2128.06 BPD, with an optimum production rate of 1702.45.
2) The result of the gas lift redesign planning on the “EC-6” well is the installation of 10 operating valves in the well. Based on the calculation, the height of the fluid column in the well is 375.72 ft. The depth for the injection valve is 1570 ft. The amount of gas injection required is 151765.74 scf/d, with a total GLR of 200 scf/b.
3) Based on the performance evaluation of the redesign with a target production rate of 1500 BPD, which is 70% of the maximum flow rate, the increase in production was 47% from the previous production rate of 1020 BPD.

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