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Reservoir Performance Forecasting in Term of Recoverable and Production Life Time in Y Field

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ABSTRACT

Firstly, the production of oil is up to 1.827 MMstb by the Natural flowing in 2018 to 2023 or seing in recovery factor is 1.5%. considered as a small recover. Because, the pressure was decreasing to 3749 psi in the saturated conditons owing to the countinuing production by time. So that, the oil production of the well had reduced. As consequently, the wells equiped with Electrical Submersible Pump to improve the oil rate in term of predictions the recoverable and production life time in Y field, which the limit is by pump constraint approach where not a real, it proposed as the hypothesis with assuming FBHP is 500 psia. This work present the recovery factor will have obtained from the tank as big 8.14% by using the ESP system which working at normal speed (60 hz). It could be higher by increasing the pump speed (Nguyen, 2020). However, the pressure will have be declining to 3156.25 psia along with the wells produce at 620.71 bbl/d by the time, 2050. In conclusion, the production will have been continuing because no have a intersection between the production rate and the limitation rate which at the given of 294.16 stb/d (Fig 6), in term of technically evaluation. There is ESP'pump constraint method using to find out the production limitation which proposed by Kermiz E. Brown's statement that production in pumping system should not be produced at lower than 40% of Absolotu Open Flow Potential owing to prevent the pump thrust occurring. This approach is applicable to demonstrate the production limitations using lifting system which means not seem by ecomical limit.

Keywords: flooding, flood discharge, synthetic unit hydrograph, Nakayasu, watershed

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1. Introduction

The Y Field produced by Natural Flow (NF) in five years and technically situated on onshore. Along the production by NF, were obtained the cumulative productions approximately 1.827 MMstb from Original Oil In Place (OOIP) 120.271 MMstb or 1.5% seeing in Recovery factor (RF). The maximum of recovery for an oil field is 40% by OOIP (Craft & Hawkins, 1991). In this case, the Natural flowing are not allowing to be produced at high rate or below 30% from AOFP. Basically, a new conventional field is going to produce the hydrocarbons naturally, it means take advantage of natural force. And then, The pressure decreases owing to the continuing prodution by a time. So, the liquid production of the had reduced by time. Therefore, to improving the economical rate in this particularly field is by using the Artificial Lift (AL) method (Guo et al., 2007). Where, the AL method is a cheaper method of Improved Oil Recovery (IOR) which the main focus has been put on the wells, instead of a pressure maintanence technique (e.a. secondary gas injection) (Darvish Sarvestani & Hadipour, 2019). In addition, AL methods are divide into two categorized are pump-lift methods and gas-lift methods. However, the prosess of selecting the AL based on objective analysis of economic and technical criteria (Patron et al., 2018). But a pumping system had proposed from many industries by its reliability (Oyewole, 2017).

In this work, the Electrical Submersible Pump selected as the feasible options from AL to predict the reservoir performance in particular field in term of the recovery factor and production life time, which evaluate by technically with pump constraint approach. ESP are preferable because it deals with hight production. And the ESP was designed to be produces a high rate, which reaching at the 1000 bbl/d (Del Pino et al., 2017). Moreover, it allows the production of light and heavy oil with a considerable free gas fractions in the suction (Fraga et al., 2020). And also in a deep and deviated wells, with a low, medium or high flow rate of liquid (Pankaj et al., 2018). In adversely affected by the sand, scale or free gas (Clegg, 1988). The selected of the ESP is relatively good to adequate to this tank that acquired the minimum of recovery factor in a particular field. Ounsakul et al. (2019) stated that, the right selection of AL will attains the ultimate recovery and profitability of oil reservoir .

A recovery factor define as the amount of hydrocarbons recovered from a reservoir (da Silva et al., 2020). RF is more essential tasks for an reservoir engineering to determine the withdrawal rate carry out from the geological subsurface. Hence, to maximize the recovery of a field as much as possible in other to gain a profit (Onuka & Okoro, 2019). In

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

other condition, RF is not linear to the production life time, the more produce the hydrocarbon from a reservoir (NP or GP) and the otherwise production life time will be shortened. But the RF and production life time as function of reservoir performance are determine by the natural drive mechanism to flow the fluids to the wellbore (Ahmed, 2001). A several case, the reservoir performance forecasting desmostrated by the material balance.

Material balance is a tool to perform the estimation of reserve that had produced ordinally, 10-20 years. However, to do the prediction is require the fluids equations currently (e.g., Darcy's equation) (Ahmed & McKinkey, 2005). A reservoir characteristic perhaps changing due to production activity by a time. Consequently, enginering must to be anticipated the undesirable condition in the future and helps the decision maker to determine the life of the field, additionally the development planing which require a detailed understanding of reservoir characteristics and production operations optimizations (Sylvester & Onyekonwu, 2015).

2. Literature Review

Reservoir performance is a capacity to push the fluids onto the surface. In other hand, the ability to permit the fluids, it depends on the characteristic of reservoir and drive mechanism. Oil and gas rates are achievable on the surface is a function of reservoir derivability at a given bottom-hole pressure (Guo et al., 2007). Nevertheless, the reservoir performance will decline constantly owing to the production phase. During the production stages, many problems are always encountered, for instance paraffin, scale, water coning and liquid loading. These problems led the reduction in Inflow Performance Relationship (IPR). Moreover, a tubing size-in can be smaller because the deposition of material solid, consequently the flow rates are low and the backpressure occurred. Futhermore, excessive of water prodution are more challenging for the production performance, paticularly resulting from the strong aquifer in a reservoir, it damaged the profitability and reduction an ultimate recovery of hydrocarbon (Botermans et al., 2001).

A major problem in oil and gas production, which affected to the capabilities of production over the time is water production (Karmakar et al., 2002). In way, Arslan et al. (2018), Using the Downhole Water Sink (DWC) to evaluate the hydrodynamic interaction between the two well in terms of the pressure interference, water saturation (coning) and water cut producing from the heterogeneities reservoir. Addtionally, Azari et al. (1997) in their studies demonstrated the affected between the water production in early and later of life the well. If the water breakthrough occurred quickly the operator may suspent the undesired production from a channel behind the casing, a perforation into or close the water zone and have a fracture surrounding the pay zone. And visa versa, may examined the bottom drive by causing the high permeability of the water, a casing leak and reservoir depleted.

The quantity of a water in a well may affects the well productivity, by reduction of the oil mobility and lowering the Vertical Lift Performance (VLP), since increasing the hydrostatic pressure in a fluid column (Arslan et al., 2018). Undoubtedly, massive water production as a result of increasing the relative permeabilities in the reservoir. The increased of water cut constantly can be reduced of the capabilities of a well, in term of its ultimate recovery and the wells perhaps will be shuted down ASAP. Therefore, Karmakar et al. (2002), controlling a water production is by using the tetramethylorthosilicate (TMOS) material that reacted with the water, as the result formed to being a semi-solid that can be modified and reduce the permeability of water. We see that the penhomenon of water into a gels. Thus, the oil productions are achievable in a surface with a large volume, in case of maximizing the recovery of oil. Recovery factor is a key to obtain all parameters for constract a reservoir description in reservoir modeling (Akpara, 2007). For a water drive applying on improving oil rate from a reservoir, then the recovery factor equation for oil is.

$$Recovery\ Factor = \frac{(1-S_w-S_{or})}{(1-S_w)}100\%$$

Where:

$S_w = Water\ saturation$

$S_{or} = Residual\ oil\ saturation$

However, the well is also to be considered because to manage the fluid flow onto the surface. The pump ESP is a optional better to improve the oil recovery by providing an additional energy to push the fluid as a result of the increasing of the bottom hole pressure (Nguyen, 2020). Ratcliff et al. (2013) in their study in Rockies field proved that the ESP can maximize the recovery of production with higher drawdown and large of fluid in volume. Even, the ESP can be installed in Enhanced Oil Recovery (EOR) process and uncoventional reservoir to improving the oil rate. Bartolomeu & Rahmawaty (2014) was implemented the ESP to increase the oil recovery in EOR Process, the recoverable was higher compared to Gas and Water injection alone. This approach can be advantageous in developing marginal filed. Moreover, Del Pino et al. (2017) do the comparasion concerne to the run life of the pumping system in Caño Limón field, which between the Beam Pump and ESP, as the result the number of equipment failures in BP systems is very high in comparison to the ESP failures. Which the ESP system are a technical and economical alternative for low flow rate wells, and also can be handle the fluids with high solid content. However, the BP system dosen't meet the expectations.

From the development of a field moves its ultimate abandonment is essensial task be in the estimation of the volume of oil and gas reserve (Onuka & Okoro, 2019). The

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

oil production rate of the wells may decrease by the time and the wells will be abandonment when the rates are undesirable. However, the bechmark for measuring the life of a field is when the revenue of production can only recovery the operation cost and taxes (Qing et al., 2013), approaching by ecomical point of view.

To model the future performance frequently using the actual production data (Henson et al., 1961). The historical production as a references data to determine the future performance of a well and to describe the behavior of the production declining. Petroleum Experts (2010) was introduced computation approach MBal sofware to predict the behavior of reservoir accordance with a production fluids. The concept of the fluids easily assists engineering to predict future performance well with the production data are esential to attainnig a good historical matching and calibration the model. In other hand, the transmissibillity and aquifer modeling are factor in achieving reasonably reliable of Mbal model (Idogun et al., 2015).

According to Ahmed & McKinkey (2005) stated that prediction the future peformance to acquire a several information on production behave, there are, (1) estimation of cumulative production, (2) recovery factor by time. Those reservoir and wells performances are correlated with time, defines as production life time. In a case, Predicted using the material balance is appropriate when the data and time are limited (Idogun et al., 2015).

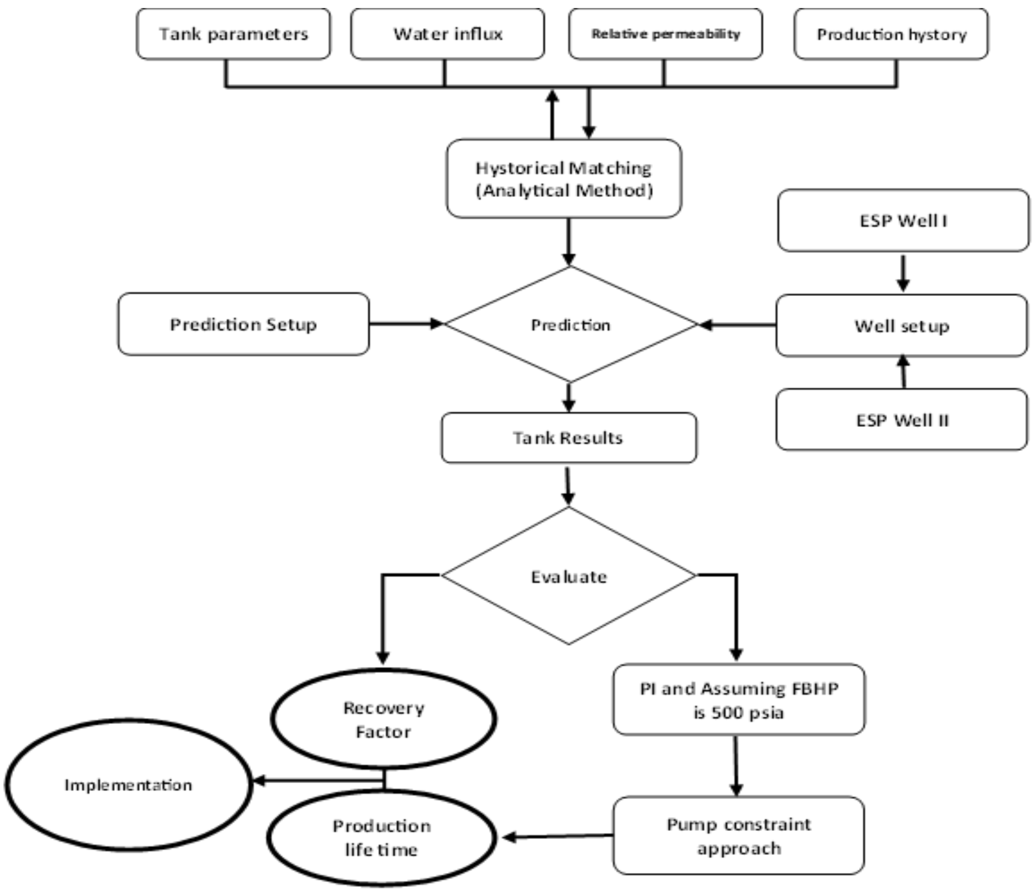

Figure 1. Research Diagram Workflow

3. Research Methodology

3.1. Data Collection

This study classify into quantitative data from Y field. There are available data from reservoir homogenous such as porosity is 23%; intial pressure 4000 psig; temperature 250 ^{0}F; conate water saturation 15%; and the initial in place 120.27 MMSTB. The first production by tank in 01 january 2018 by Natural Flow method incluiding historical production. Reservoir identify with water drive of thicknesss 250 ft; radius 2500 ft; permeability aquifer 10 milidarcy.

3.2 Diagram Research

a) Methodological Approach

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

The study was conducted to understand how far is the production life time and how much it recoverable from Y field (count in Recovery factor). Production at surface define as the condition in resevoir. Therefore, predicting the reservoir performance help the engineering acquire more understanding on reservoir behavior. The data to constract the model are PVT data, tank data and historical production data. These data classify into secondary data.

b) Data Pre-processing
Production historical data considered as important data to imput in mbal sofware, before predict reservoir performance, the data must to be matched by analitical method.

c) Data Analysis
Field Y consist with two well (I, II). The productivity Index of the wells are 4.73 Stb/day/psi and 3.79 Stb/day/psi respectively. These well equiped with Electrical Submersible Pump to predict the reservoir behavior in the future. This analyzed using Mbal software and predicting by the well model. Thus, Mbal assist to perform the reservoir performance based on a tank model. Therefore, to obtain the recovery factor and production life time, which evaluated in pump constraint approaching and by assuming the FBHP is 500 psia.

4. Result and Discussion

4.1. Historical Matching in Y field

Reservoir performance forecasting are normally uncertain due to the lack of data (Okano & Corp, 2013). Therefore, the physical parameters are adjusted in order to obtained the simulation profil can be matched to the historical data.

Figure. 2, illustrate the best fit of historical data and the simulated data in aquifer model. Where, the trend of declining pressure is to 3749 psi and the comulative production up to 1.827 MMstb were obtained during by the Natural Flowing method. By the absolutelly matched will be attained a reasonable comparison of reservoir performance forecasting.

Firstly, the production by Natural Flowing with two wells in 2018 to 2023. The productivity index of the wells are 4.73 Stb/day/psi and 3.79 Stb/day/psi, respectively. These capacity of the wells are quite higher due to the fact the water as natural provides energy. During the production were obtained the cumulative productions approximately 1.827 MMstb from the OOIP around 120.271 MMstb or 1.5% seeing in Recovery factor (RF). The pressure is decreasing by the time. Consequently, improving the rate using the ESP system.

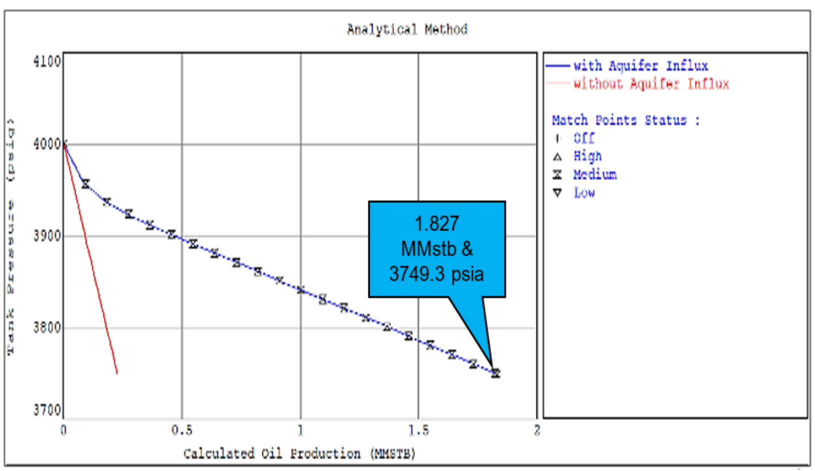

Figure 2. Analytical Plots in Aquifer Model

4.2. Prediction the performance of Y field

After the pressure declined. The wells equiped with Electrical Submersible Pump to do the predictions in order to maximize the recovery factor. In adition, the ESP's pump is set up at 60 herz as operating frequency. And the constant bottom hole flowing pressure is assuming 500 psia, The pressure may not describe a real conditions of productions fluids owing to the value is not changing.

By the results of Figure. 3 and 4 reveals the model of the well performance using Electrical Submersible Pump. The predictions carried out of understanding on production behavior to 2050. In the future, the pressure will have depleted to the 3156.25 psia along with the well I obtaines the cumulative production of 4.415 MMstb with the average production rate is 448.64 stb/d. And the other hand, for the well II acquire more less, which 3.537 MMstb with the average production rate is 359.48 stb/d. These production are quite similar higher of both of the wells. Overall of the wells are 7.952 MMstb is a function of the recoverable oil by the ESP, in term of predictions. In particular field will be gaining around 6.6 % of the recovery factor. With is the

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

pumps working at velocity of 60 hz (as manufactured speed). The recovery factor will be higher than prior, if increasing the pump speed (normally above the manufactured speed) (Nguyen, 2020).

The total field production from natural flow including the predictions is up to 8.14%, shown in Figure 5. The average of the oil rate will have been obtained from both of wells in 2050 around 620.71 stb/d. the rate is quite highe as a result from and water drive and ESP system. And the Figure 6 reveals the water production are 0.986 MMbbl and with the average percentagem of water cut which obtaine at surface as big 11%. The percentagem where lower than 20%, it means not to be affected to oil rate in barrel (Arslan et al., 2018). Moreover, no water breaktrough that can reduce the oil rate. In contrast, the pressure have will been depleted drastically due to the gas liberted in a solution which produced in large volume. The gas are liberted from saturated oil may decreasing the oil rate and pressure (Dake, 1978). The total gas production show in Figure 6, are 6392.47 MMscf and with the average daily produced of gas as big 0.404 MMscf/d. The massive of gas production can be reduced the capabilities of a well to produce the oil in large volume and have a more challenging to attain efficiency of ESP'pump in pump intake.

4.3. Production life time using ESP'pump constrainst

A norm the limitations of production is when the net cash flow is zero or negative, evaluation in economical term. In standard of PetroChina defined as the industrial boundaries

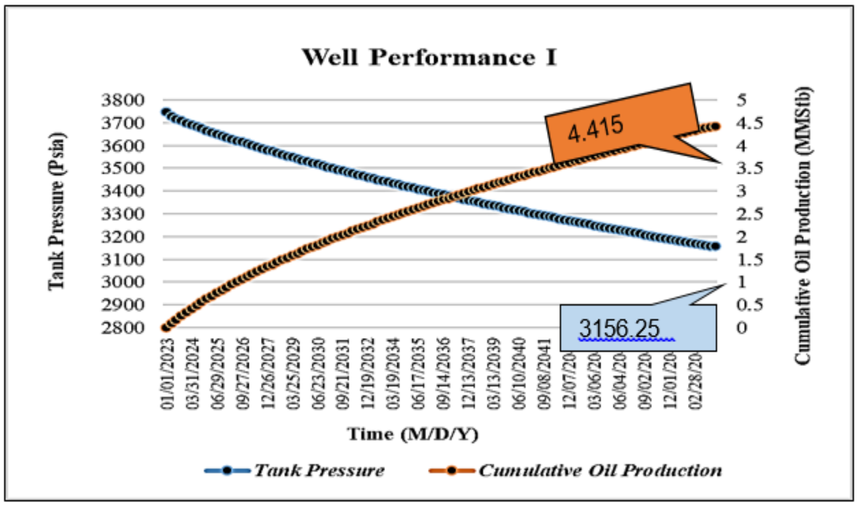

Figure 3. Prediction Well Performance of Well I Using ESP to 2050 in Y field

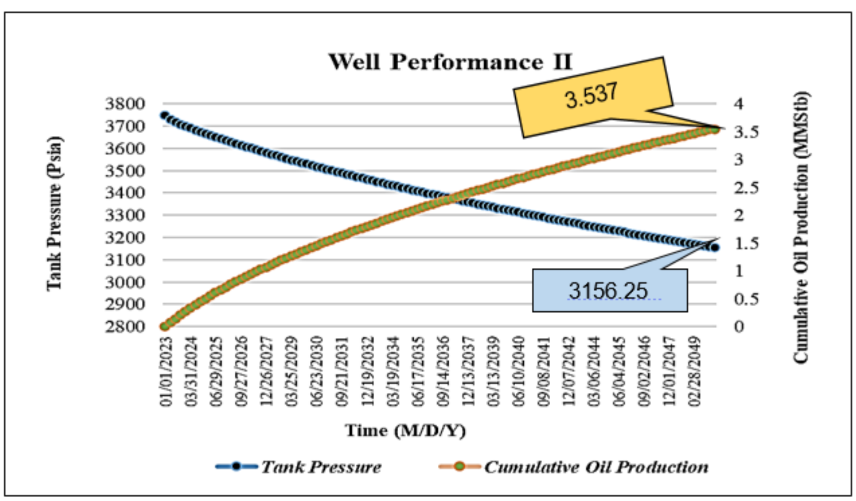

Figure 4. Prediction Well Performance of Well II Using ESP to 2050 in Y Field

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

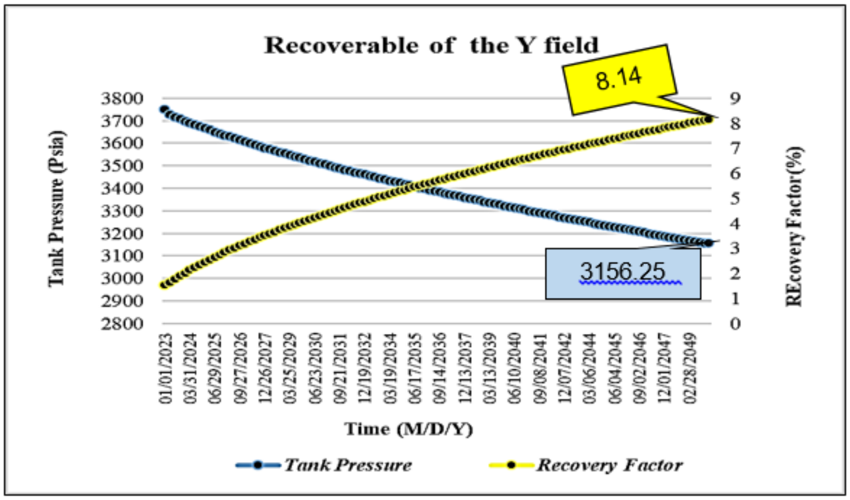

Figure 5. Recovery Factor of Field Using ESP in 2050 in Y Field

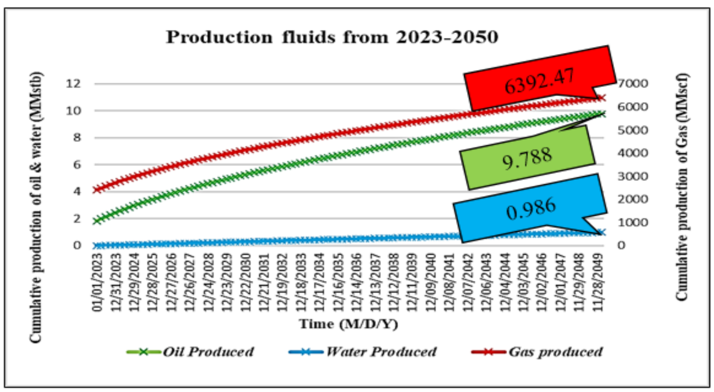

Figure 6. The Production Fluids (Oil, Water and Gas) Using ESP in Y Field

When the revenue of production can only recovery the operation cost and taxes (Qing et al., 2013). Unfortunately, this study will not focused in a economic aspect, which is a broad work. Instead of the determine the industries boundary is by evaluate in technically, using pump constraint in production phase. According to Brown (1977) stated that the production using pumping system should not lower than the 40% of AOFP in other to avoid the pump thrust which acting from axial force. In this approach may not be recognised in the industry because is not existed. But we proposed as a hypothesis by the assuming FBHP is 500 psia, which not defined the pressure in a real.

Even though is not realistic pressure. But it could define the production boundary by the Productivity Index equations in summarize the total of productions of the wells:

$$PI = \frac{620.7}{3156.25 - 500}$$

$$PI = 0.233 \quad bbl/d/psia$$

Literally, the FBHP real is 3084.11 psia, and will ignore. In order to attain the production limitations of the field. 500 psia will be considered. Where, the composite IPR of the wells are very loweer, suppose the wells in a critical condition and can not to be produced continually.

Table 1. Production profil of wells in 2050 in Y field

Reservoir Pressure (psia)	Pressure Flowing Well (psia)	Production Rate (bbl/d)	
		Well I	Well II
3156.25	500	344.59	276.11

But, the production limitation determines by the pump working capacity. The maximun of production rate of an well expressed by following equations, and the presurre flowing well should be in zero psia state.

$$Q_{max} = 0.233 * (3156.25 - 0)$$
$$Q_{max} = 735.40 \; stb/d$$

Vol.4, Issue 1, pp.36-44, 2023
Available online at: http://tljes.org/index.php/tljes/data

The minimum production rate produced using ESP at 40% is 294.16 stb/d, which defines as the minimum of capacity, in contrast the maximum capacity of ESP'pump are neglible.

Figure 6 reveals the no have a intersection between the production rate and production limitations in the Y field. It means, in 2050 the prodcution will be continually until hit the boundary at a given rate, accorded to ESP. This approach is applicable to determine the production life time in technically capabilities of pumping system.

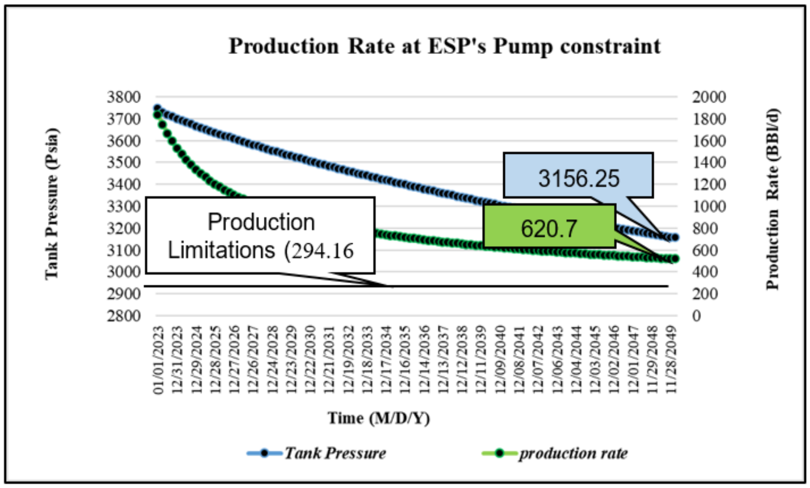

Figure 7 Production Rate Measuring by ESP'Pump Constraint in Production in Y Field

5. Conclusion and Recommendation

5.1. Conclusion

Based on the results of study conducted by the author, it can be concluded as follows:

1. The final of the recovery factor in Y field is increasing to 8.14 % in 2050 by the using Electrical Submersible Pump, which working at normal speed (60 hz). The ESP equiped into the two wells and will have obtained the average rate 808.12 stb/d.
2. The production will be continually in 2050 because no have a intersenction between the final rate and the boundary rate at given 294.16 stb/d. the production limitation approach by the pump's minimum constraint, which considered as an hypothesis. (shown Fig. 6). Additionally, this approach is aplicable for technical evaluation in spite of not recognised from an industry.

5.2. Recommendation

In this work, the recovery factor in Y field were acquired is very low due to the lack of the data Therefore, suggestion for study in the future should populate the real data of outflow performance to attain a proper results. In other hand, increasing the pump speed to improve the recoverable or by adding the well injector. For defines a production limitation is better when demostrated by an economical limit approach.

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