مجلة جامعة بني وليد للعلوم الإنسانية والتطبيقية
تصدر عن جامعة بني وليد – ليبيا
Website: https://jhas-bwu.com/index.php/bwjhas/index
العدد التاسع والعشرون، 2023

ESP Design Optimization and Sensitivity Analysis for Oil Well (E-05) using Prosper software

Elnori Elhaddad[1*], Mohammed Garoom[2], Hoosam lssa[3]
[1]Petroleum Engineering Department, Faculty of Engineering, Bani-Waleed University
[2]Petroleum Engineering Department, Faculty of Engineering, Bani-Waleed University
[3]Petroleum Engineering Department, Faculty of Engineering, Bani-Waleed University

*Crosspnding author: norimab2014@gmail.com

تاريخ الاستلام: 2023-06-07 تاريخ القبول: 2023-06-25 تاريخ النشر : 2023-09-07

Abstract: The natural reservoir pressure is often sufficient to lift the fluids to the surface. However, when excessive water and gas production occurs, the reservoir pressure may no longer be sufficient. In such cases, an artificial lift method is required to lift the fluids to the surface. The objective of this study is to improve the efficiency of the ESP system and to identify the critical parameters that affect the system's performance of oil well E.05 using Prosper software. Results were obtained and analyzed to determine the optimal design for the well. In this paper, we discussed the ESP model and its impact on productivity. The ESP model is designed to optimize parameters such as reservoir pressure, pump sitting depth, operation frequency, and number of stages. Specifically, the model recommends a reservoir pressure of 3100 psi, a pump sitting depth of 5000 ft, an operation frequency of 60 HZ, and number of stages of 225 stages. By implementing these parameters, the ESP model has been shown to significantly improve productivity. This model boasts best pump and motor efficiency, making it a reliable choice for optimizing production. The oil flow rate for the well has increased from 916 STB / D to 1008 STB / D, indicating a successful current design for the well. Further research is needed to better understand the factors that affect ESP performance, such as wellbore conditions, fluid properties, and pump design.

Keywords: 103 E oilfield, ESP, optimization, prosper software, Sensitivity Analysis.

Introduction

The petroleum engineer can select the most suitable artificial lift method based on technical, economic, and other parameters [1 ،2].

We require an artificial lift method the natural pressure of the reservoir is not sufficient to lift the fluids to the surface because of excessive water and gas production. But every method has specific requirements.[3 ،4]

If the Electrical Submersible Pump (ESP) does not operate at recommended parameters, the ESP efficiency will decrease and it may get failure [5].

This work aims to optimize the ESP design for the oil well E.05 and study the impact of various parameters on the well's performance using Prosper software, which is a crucial step in ensuring efficient oil production. By utilizing PROSPER software, we can analyze and optimize the design parameters of the ESP system, including reservoir pressure, pump setting depth, operation frequency, number of stages, water cut, wellhead pressure, and gas oil ratio. This optimization process can greatly improve the performance of the well., resulting in an increased production rate and reduced operating costs. It is essential to study the impacts of various parameters on well performance.

ESP delivers high efficiency and reliability but with high maintenance and workover costs. The design model's results will have a significant impact on both the oil production and future performance of oil wells [6].

In the field of oil and gas production, the setting depth of electrical submersible pumps (ESPs) near the producing zone is a critical factor in optimizing flow efficiency and well completion. By setting the ESP close to the producing zone, we can improve the efficiency of fluid production and reduce the risk of damage to the wellbore, the less distance the fluid has to travel, reducing the pressure drop and increasing the flow rate. [7].

ESP provides operating flexibility for changing conditions, allowing for adjustments to be made as needed. This is particularly important in high water cut oil wells, where the water to oil ratio can vary greatly [8].

The productivity of a well is influenced by various parameters. These parameters include factors such as reservoir pressure, water cut, tubing size, and wellhead pressure. Each of these parameters plays a crucial role in determining the productivity of a well. It is essential to carefully consider and optimize to ensure maximum productivity of the well. Electrical submersible pumps (ESP) will also be impacted by the number of stages and operation frequency, these parameters can have a significant impact on the production of a well. [9].

The ESP design for oil well E.05 has been optimized and a sensitivity analysis has been conducted. Results indicate that the optimized design will lead to improved efficiency and performance. Further details on the specific changes made and the results of the sensitivity analysis are available.

In this paper, we present an optimization and sensitivity analysis of ESP design for the Oil Well (E-05) using Prosper software. The purpose of this study is to improve the efficiency of the ESP system and to identify the critical parameters that affect the system's performance. To achieve this, we use the Prosper software to simulate the ESP system and evaluate its performance under different operating conditions. We also perform a sensitivity analysis to identify the critical parameters that affect the system performance. Our results show the optimal ESP configuration for the E-05 well.

Methodology

In this paper, several steps were run to achieve the main objectives of this research. These steps start with gaining the technical and practical knowledge about aspects of production engineering, then proceed through software training for PROSPER software, and finally processing data to be suitable for the project objectives and summarized as follows:

1. Collecting the required data for the study such as PVT, well schematic, production, and pressure tests. For example, GOR, Oil & Gas Gravity, Water Salinity, Bottom hole temperature and pressure, Oil Volume Factor, Oil Viscosity, and Bubble Point Pressure.

2. Study the performance of a well's productivity using production and pressure history. As Total fluid, Water cut, Total Gas, wellhead pressure, Casing Pressure, Flowing Line Pressure, and Choke.

3. Matching the data of the well with correlations in PROSPER starts with PVT through the IPR curve and VLP matching process.

4. Building the well model in PROSPER after completing the matching with less error percentage.

5. Prediction of future production performance as optimization of reservoir parameters and its effect on well productivity using the ESP method as one of the artificial lift methods.

6. Optimization of ESP parameters such as pump setting depth, frequency of pump, wellhead pressure, and pump stages.

7. Selecting the best pump type and optimum ESP parameters to improve well productivity.

Reservoir (A), is limestone with a rather high porosity and low permeability, the oil system is medium to light and is highly under-saturated. The Reservoir (A) Data can be summarized in the following tables.

Table 1: Shows Reservoir (A) Data.

Reservoir (A)		units
Formation Depth, (D)	6764	Ft
Avg. Net Pay, (h)	100	Ft
Initial Pressure, (P_i)	3002	Psia
Current Pressure, (P)	2576	Psia
Reservoir Temperature, (T_{res})	196	F°

Table 2: Shows Rock Properties Data.

Rock Properties		Units
Avg. Porosity, ($\phi_{avg.}$)	25	%
Initial Water Saturation, (S_{wi})	27	%
Avg. Permeability, ($k_{avg.}$)	13	Md

Table 3: Shows Fluid Properties Data.

Fluid Properties		Units
Saturation Pressure, ($P_{sat.}$)	435	Psia
Gas Oil Ratio, (GOR)	185	SCF/STB
FVF @ Initial Pressure, (B_{oi})	1.169	RB/STB
Oil Viscosity, (μ_o)	1.74	Cp
Oil Gravity, (API)	33	API°

Table 4: Shows Fluid Reserves Data.

Reserves		
Original Oil in Place, (N)	172	MMSTB
Initial Oil Reserves, (N_p)	64	MMSTB
Original Gas in Place, (G)	29	BSCF
Initial Gas Reserves, (G_p)	12	BSCF

The Reservoir (A) started production in early 1976 with six producer wells. In 1979, after severe pressure decline was observed, the two peripheral injectors were put into operation.

From 1976 until the end of 1991, (10.87 MMSTB) of the reserves, have been produced which equals (16.93%) of the initial oil reserves with, a recovery (6.32%) of the original oil in place which, representing a low pool recovery.

In the early 1990s, production development projects were initiated in a reservoir consisting of nine vertical producer wells, six horizontal producer wells, and ten injectors. This marked a significant step forward in the field of reservoir engineering, as the use of both vertical and horizontal wells allowed for more efficient extraction of oil and gas. The injectors, meanwhile, were used to maintain reservoir pressure and increase production rates.

1. PROSPER Software

PROSPER is the industry standard single well-performance design and optimization software. It can model most types of well completion and artificial lifting methods. PROSPER is used by major operators worldwide. The software allows the building of well models with the ability to address all variables such as well configuration, fluid characteristics (PVT), multiphase VLP correlations, and various IPR models. Tuning of the models is possible by matching real field production data. The benefit of matching is the ability to model different scenarios with increased accuracy [10], **Figure (1)**.

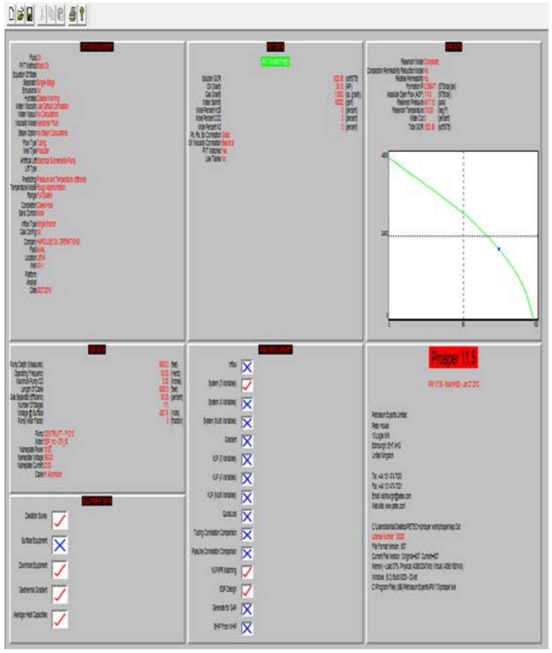

Fig. 1: Shows PROSPER front display

Calculation of VLP using multiphase flow correlations with the evaluation of VLP variables is the major application of the PROSPER software. Sensitivity analysis on future changes of parameters that affect VLP and IPR is easily assessed.

A full range of well types can be modeled in PROSPER including gas, oil, water, condensate, and steam. Different configurations such as angled, multi-layer, and multi-laterals can also be modeled. A full range of IPR models can be used in Prosper including PI entry, Vogel, Composite, Fetkovich, Jones, horizontal well model, and several others. Various completion configurations such as gravel pack, open, cased, and perforated hole are also available [11-13].

2. Building a base model

The first step when modeling a new well in PROSPER is to fill out a system summary as shown in **Figure (2)**. The Black Oil model, with the oil and water option describing the fluid. It is also here the choice of artificial lift method is made, we can input the necessary data and create a design.

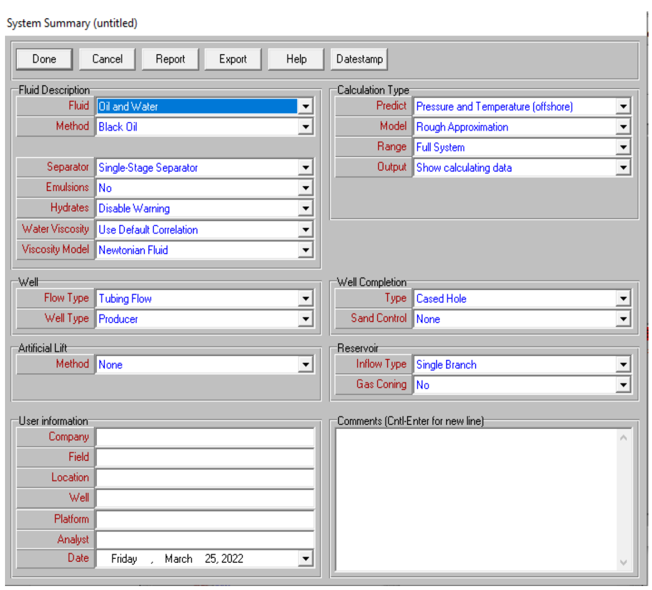

Fig. 2: Shows a black oil model data

RESULTS and DISCUSSION

1. Well Modeling

The well has been successfully modeled after all input data was completed. The results of the PVT data were found to match the laboratory results when compared using empirical correlations which are shown in **Figure (3)**, **Figure (4)**, and **Figure (5)**.

1.1 PVT Modeling

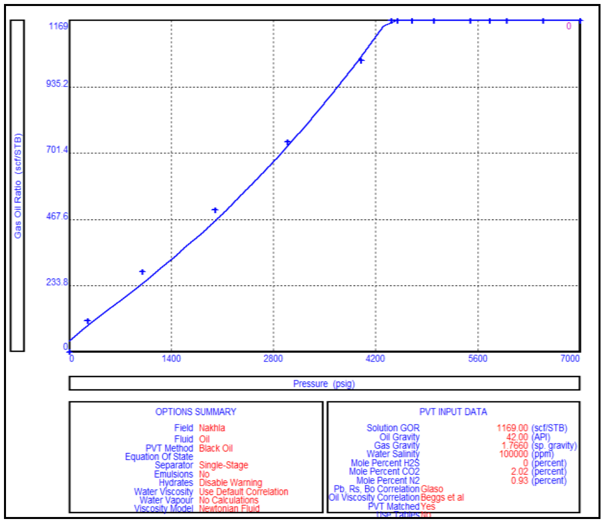

Fig. 3: Shows Gas Oil Ratio vs pressure

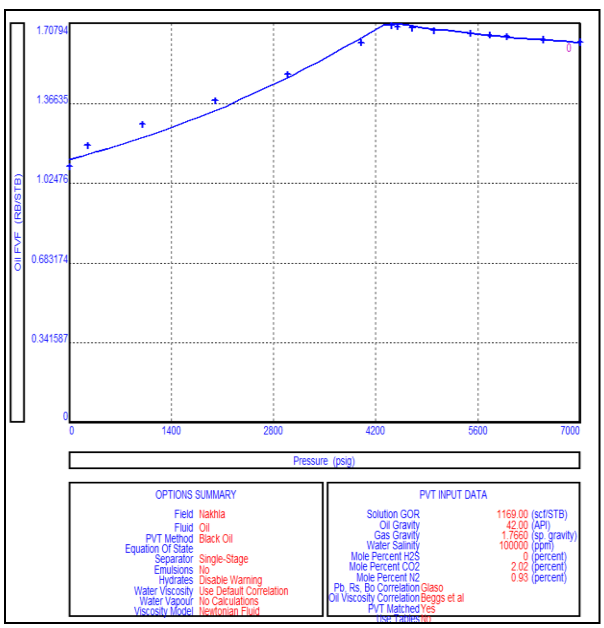

Fig. 4: Shows Oil Formation Volume Factor vs. Pressure

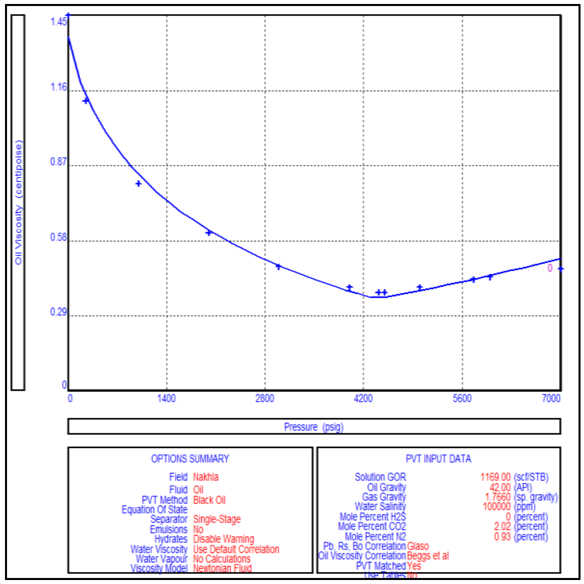

Fig. 5: Shows Oil Viscosity vs. Pressure

1.2 IPR and VLP Modeling for E.05

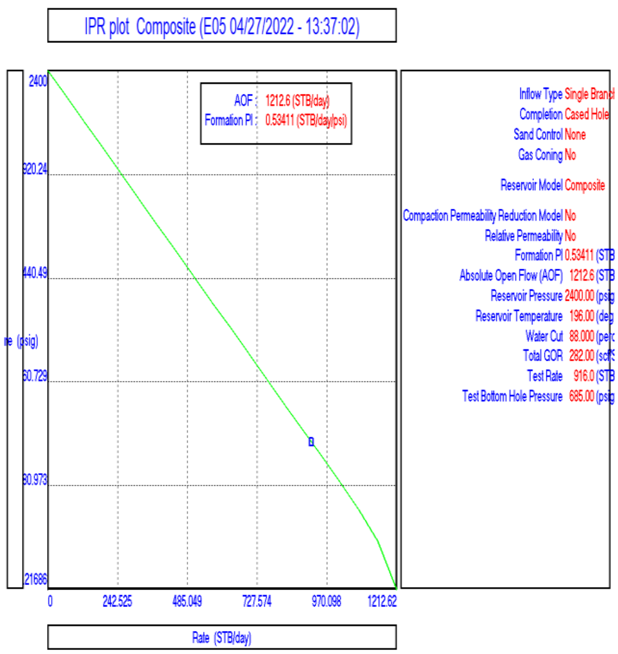

Fig. 6: Shows Inflow perfofmance relation ship (IPR) plot for the well E-05

After several trials and steps using various correlations, the matching of Inflow performance (IPR) and Outflow performance (VLP) was successfully improved. The most effective correlation was found to be Francher Brown, **Figure (7)**.

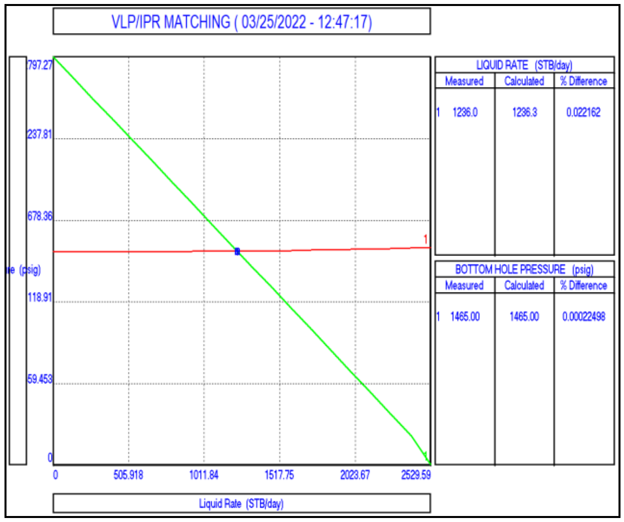

Fig. 7: Shows VLP/IPR matching for the well E-05

2. Sensitivity Analysis

Sensitivity analysis is a valuable method for determining the impact of parameters that will affect ESP performance such as operation frequency, water cut, number of stages, pump setting depth, wellhead pressure, and reservoir pressure for the well (E-05) to identify key variables and assess the impact of uncertainty on the output.

2.1 Operation Frequency

The operation frequency of the pump shown in **Figure (8)**, has a significant effect. In order to understand the impact of the frequency, it is important to consider the specific application and the desired flow rate. A higher frequency typically results in a faster flow rate but also increases energy consumption and can lead to premature wear and tear on the pump. Conversely, a lower frequency may result in a slower flow rate but can reduce energy consumption and extend the lifespan of the pump. Careful consideration of the operational frequency is crucial in optimizing the performance and efficiency of the pump.

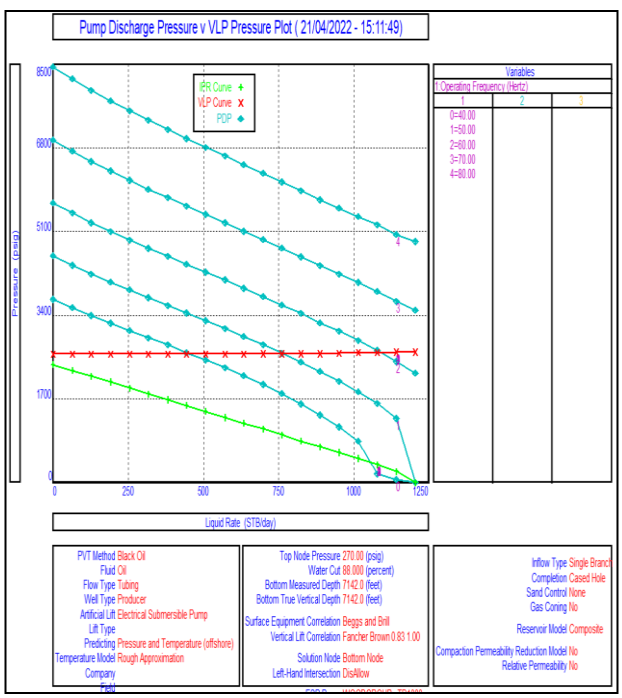

Fig. 8: Shows the effect of operation frequency on ESP performance for the well E-05

The study on the effect of operation frequency on production performance for well E.05 using ESP has revealed that the optimum operating frequency is 60 HZ. This frequency has been identified as the maximum value for the operation, as the well ceases to produce beyond this point.

Table 5: Optimization results of operation frequency

Well No	Operation Frequency	Current Liquid Production	Optimum Liquid Production
E.05	54-60 HZ	916 STB/D	1091STB/D

2.2 Water Cut

Water cut can have a significant impact on the performance of the Outflow (VLP) and ESP systems, as demonstrated in **Figures (9)**. It is important to consider the effect of water cut when analyzing the efficiency and productivity of these systems.

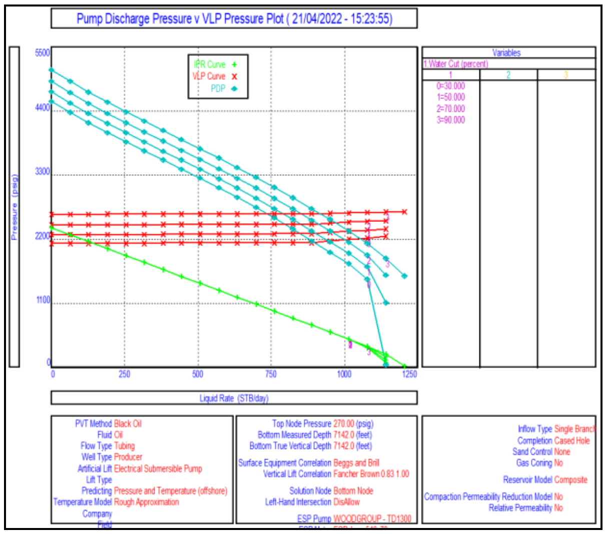

Fig. 9: Shows the effect of water cut on ESP performance for the well E-05

After conducting a study on the impact of water cut on production performance using ESP for the well E.05, it has been determined that the high water cut is negatively affecting both oil production and ESP performance. Therefore, it is necessary to reduce the water cut to improve overall production efficiency.

Table 6: Shows the Optimization results of water cut

Well No	Water cut	Current Liquid Production	Optimum Liquid Production
E.05	88-30 %	110 STB/D	627 STB/D

2.3 Number of Stages

In this section, we analyzed the impact of multiple pump stages on the overall performance of the pump, as illustrated in **Figure (10)**. As we know, the number of stages in a pump can significantly affect its efficiency and effectiveness. By increasing the number of stages, the pump can generate a higher pressure head and flow rate, but this also results in higher energy consumption. On the other hand, reducing the number of stages can lead to lower pressure head and flow rate, but also lower energy consumption. Therefore, it is crucial to carefully consider the number of pump stages required for a particular application to achieve the desired performance while minimizing energy consumption.

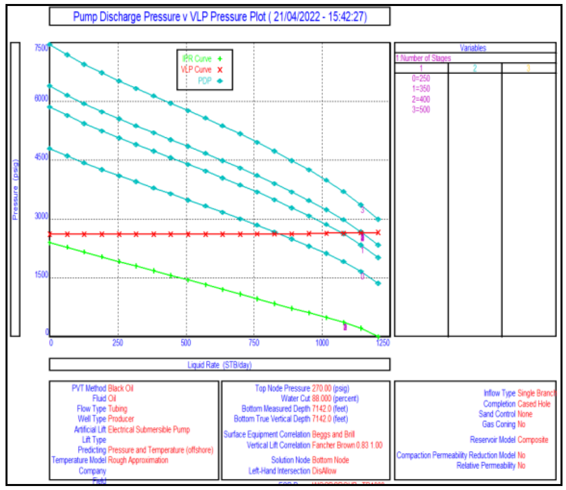

Fig. 10: Shows the effect of pump number of stages on ESP performance for well E-05

In this study, we present an analysis of the impact of the number of stages on production performance using ESP for well E.05. Our results indicate that the optimal performance of ESP was achieved by utilizing 400 stages for this particular well. We observed that the increased number of stages is dependent on the pump and pump depth and that increasing the number of stages can lead to improved ESP efficiency. These results are significant as they provide valuable insights for optimizing ESP performance in oil and gas production. Our study highlights the importance of considering the number of stages when designing ESP systems, as it can have a significant impact on production performance. By understanding the relationship between the number of stages and ESP efficiency, operators can optimize their systems to achieve maximum production performance. Overall, our study contributes to the ongoing efforts to improve oil and gas production efficiency and provides a foundation for future research in this area.

Table 7: Optimization results of pump number of stages

Well No	No of stages	Current Liquid Production	Optimum Production
E.05	277-400	916 STB/D	1148 STB/D

2.4 Pump setting depth

We examined the impact of pump setting depth on pump performance, as illustrated in **Figure (11)**. Our results reveal that the pump setting depth can significantly affect the pump's performance. Specifically, as the pump setting depth increases, the pump's efficiency decreases, resulting in a reduction in a flow rate. This decrease in efficiency is due to the increased head required to lift the fluid to the pump intake, resulting in higher energy consumption. Therefore, it is crucial to consider the pump setting depth when designing and operating a pumping system to ensure optimal performance.

We set ESP's close to the producing zone for various reasons related to flow efficiency and well completion. The setting of ESPs is crucial for the optimization of production rates and the longevity of the well. By setting the ESP close to the producing zone, we can reduce the pressure drop between the formation and the pump, which leads to higher flow rates. Additionally, the close proximity of the ESP to the producing zone allows for better control of the fluid level in the wellbore, which helps to prevent gas locking and other issues that can impede production. Furthermore, the placement of the ESP close to the producing zone can also aid in the prevention of sand production, which can damage the pump and decrease production rates. Overall, the setting of ESPs close to the producing zone is a critical factor in the success of the well and should be carefully considered during the design and completion phases.

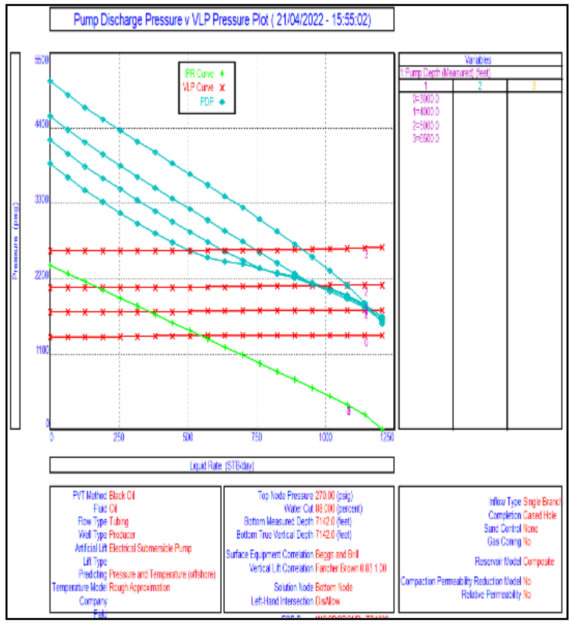

Fig. 11: Shows the effect of pump setting depth on ESP performance for well E-05

In this study, we analyzed the impact of setting pump depth on production performance using ESP for the well E-05. Our results indicate that the higher the pump, the better the performance of ESP. Specifically, we observed the best performance of ESP by setting the pump depth at 5000 ft, which resulted in a significant increase in ESP efficiency. These results suggest that carefully selecting the pump depth can have a significant impact on the overall production performance of ESP.

Table 8: Shows Optimization results of pump setting depth

Well No	Pump depth	Current Liquid Production	Optimum Production
E.05	5000 ft – 6500 ft	916 STB/D	967 STB/D

2.5 Reservoir pressure

We analyzed the impact of reservoir pressure on the performance of the pump, as illustrated in **Figure (12)**. It is well known that the pressure of the reservoir plays a crucial role in determining the efficiency and effectiveness of the pump. The higher the pressure, the better the performance of the pump. This is because the pump can extract more fluid from the reservoir, resulting in a higher flow rate. However, it is important to note that there is a limit to the pressure that can be applied, beyond which the pump may become inefficient and even fail. Therefore, it is necessary to carefully monitor and regulate the reservoir pressure to ensure optimum pump performance. In the conclusion, the relationship between reservoir pressure and pump performance is a critical factor that must be taken into consideration in any pumping system.

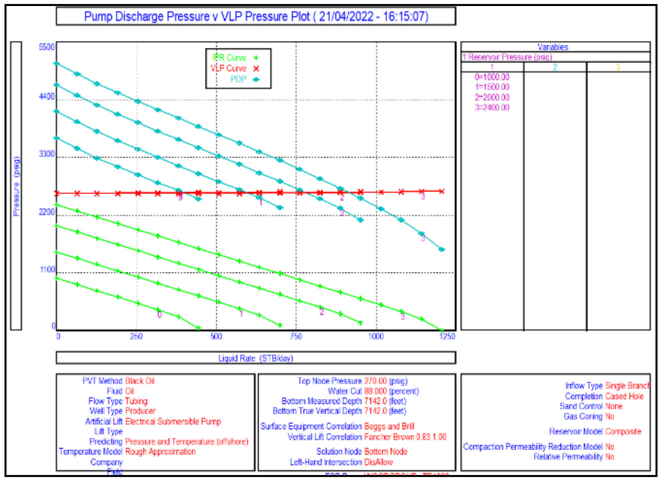

Fig. 12: Shows the effect of reservoir pressure on ESP performance for well E-05

We present the results of our study on the impact of reservoir pressure on production performance using ESP for the well E-05. Our results demonstrate that an increase in reservoir pressure leads to a corresponding increase in the productivity index, resulting in enhanced oil production. This highlights the importance of monitoring and supporting the reservoir pressure to ensure optimal production performance. Our study emphasizes the significance of reservoir pressure management in the oil industry and provides valuable insights for future research in this field. These results have significant implications for the oil industry.

Table 9: Shows the Optimization results of reservoir pressure

Well No	Reservoir Pressure	Current Liquid Production	Optimum Production
E.05	2400 – 3100 psi	916 STB/D	1576 STB/D

2.6 Well Head Pressure

We have explored the impact of wellhead pressure on pump performance. As depicted in **Figure (13)**, the pressure at the wellhead has a significant influence on the efficiency of the pump. If the pressure value exceeds a certain threshold, it can ultimately affect the overall production of oil and gas. Our study focused on small values of wellhead pressure ranging from 100 psi to 400 psi. It is imperative to understand this relationship to optimize pump performance and maximize production. Through careful analysis and experimentation, we can determine the optimal wellhead pressure for a given pump and ensure that it operates at its highest efficiency. This understanding is critical for the success of any oil and gas operation and can lead to significant improvements in production.

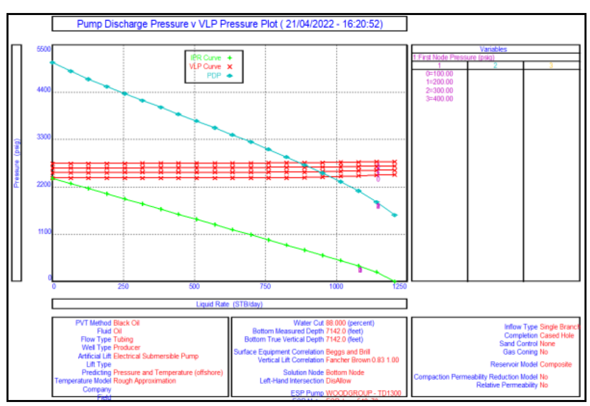

Fig. 13: Shows the effect of wellhead pressure on ESP performance for the well E-05

In this study, we investigated the effect of wellhead pressure on production performance using ESP for the well E-05. Our results indicate that the wellhead pressure has no clear effect on production performance. These results suggest that other factors, such as reservoir pressure and water cut, may have a greater impact on production performance. Overall, our study contributes to the growing body of knowledge on optimizing oil and gas production through efficient well design and operation.

2.7 Gas Oil Ratio

In this study, we investigated the impact of Gas Oil Ratio (GOR) on pump performance. As shown in **Figure (14)**, GOR, defined as the ratio of gas volume to oil volume, plays a crucial role in determining the efficiency of the pump. IF GOR increases, the pump performance decreases due to the reduction in fluid density. This reduction in fluid density leads to a decrease in the pump's head and efficiency. Conversely, as the GOR decreases, the pump performance improves due to the increase in fluid density. It is worth noting that the effect of GOR on pump performance is more pronounced at higher flow rates. Therefore, it is imperative to consider the GOR when designing and operating pumps in the oil and gas industry. However, it is important to mention that in our study, we used a small amount of GOR that had no effect on the pump performance. These results highlight the importance of considering GOR in pump design and operation to ensure optimal performance and efficiency in the oil and gas industry.

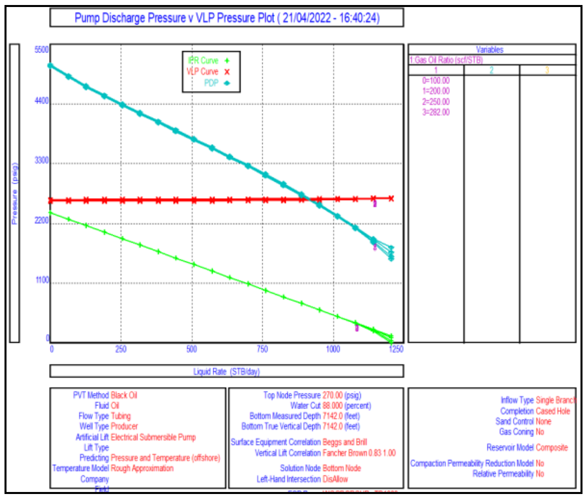

Fig. 14: Shows the effect of GOR on ESP performance for the well E-05

3. Final Optimization for the well E-05

In order to investigate the impact of various parameters on the performance of ESPs, it is necessary to carefully select the optimal operating parameters. As depicted in **Figure (15)**, we can observe the best operation parameters that have been identified through our research. By studying each parameter individually, we can gain a deeper understanding of its influence on ESP performance. This analysis is crucial for optimizing the performance of ESPs and improving their efficiency.

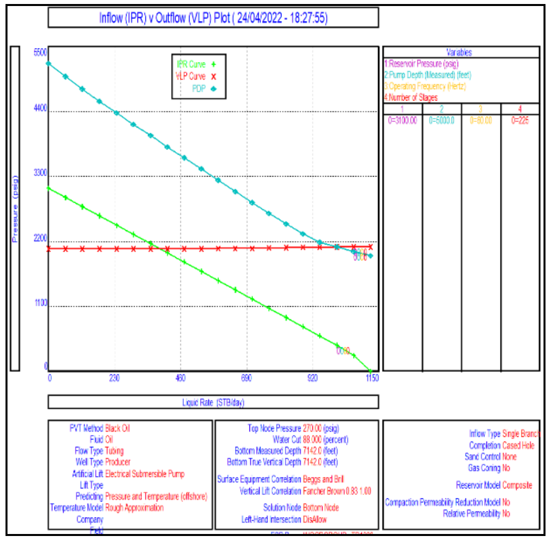

Fig. 15: Shows Final Optimization for the well E-05

We present the optimization results of the installed ESP and their impact on the production rate. As shown in **Tables (10) and (11)**, the results indicate a moderate increase of 92 STB/D after the optimization process. Although this increase may not seem significant, it is important to note that even small improvements in ESP performance can have a positive impact on overall production. These results highlight the importance of regularly monitoring and optimizing ESPs to ensure maximum efficiency and productivity in oil production operations.

Table 10: Shows Final Optimization Results for the Well E-05

Well No	Reservoir Pressure	Operation Frequency	Number of stages
E.05	3100 psi	60 HZ	225

Table 11: Shows Final Optimization Results for the Well E-05

Well No	Current Production	Pump Depth	Optimum Production
E.05	916 STB/D	5000 ft	1008 STB/D

We have completed the selection process for the ESP model that improves production. After careful consideration of all available options, we have selected the TYEP model based on the required power of 28.35hp. This model has the lowest power requirement compared to other models and provides the best pump and motor efficiency with 63% and 83%, respectively. The expected operation oil rate is approximately 1500 STB/day. The pump type selected is the CENTURION - P17 4 inches, while the motor type is CENTRLIFT 450 30HP. The cable type chosen for this setup is Aluminum 50 A. Our selection process was based on thorough analysis and consideration of all available options, ensuring that we have made the best decision for our needs.

CONCLUSION

We present the results of our study on ESP design optimization and sensitivity analysis for oil well (E-05) using Prosper software.

Our study highlights the importance of conducting sensitivity analyses during the design phase of ESP systems to ensure optimal performance and efficiency. We believe that our results will be useful to engineers and researchers working in the field of oil well production optimization.

We have completed our study and have arrived at the following conclusion:

1. The frequency of the pump is directly related to its flow rate. A higher frequency results in a faster flow rate, while a lower frequency may result in a slower flow rate. However, it is important to note that a higher frequency also increases energy consumption and can lead to premature wear and tear on the pump. On the other hand, a lower frequency can reduce energy consumption.

2. We have addressed the issue of high water cut and their negative impact on both oil production and electric submersible pump (ESP) performance. High water cut can lead to decreased oil production and increased wear and tear on ESPs. To improve overall production efficiency, it is necessary to reduce the water cut.

3. In our observation that the number of stages in an ESP system is heavily reliant on the pump and pump depth. Increasing the number of stages has been shown to have a positive impact on the efficiency of the ESP system.

4. The benefits of setting the Electric Submersible Pump (ESP) close to the producing zone in oil wells. By doing so, we can significantly reduce the pressure drop between the formation and the pump, resulting in higher flow rates. This is due to the fact that the closer proximity of the ESP to the producing zone allows for better control of the fluid level in the wellbore.

5. Our results indicate that an increase in reservoir pressure leads to a corresponding increase in the productivity index, which in turn enhances oil production. This highlights the critical importance of monitoring and supporting the reservoir pressure to ensure optimal production performance. Our observations suggest that maintaining optimal reservoir pressure is crucial for the sustainable production of oil.

6. By studying each parameter individually, we can gain a deeper understanding of its influence on ESP performance. This analysis is crucial for optimizing the performance of ESPs and improving their efficiency. Through our research, we aim to contribute to the advancement of this important technology and its applications in various industries.

7. One of the main advantages of ESP Design Optimization is its ability to optimize designs with multiple objectives. This is achieved by using a multi-objective optimization that can simultaneously optimize multiple objectives, such as minimizing cost of maintenance, increasing efficiency and maximizing performance. However, there are also limitations to ESP Design Optimization. One limitation is the need for accurate models of the system being optimized. If the model is inaccurate, the optimization may produce suboptimal results or even fail to converge. Another limitation is the computational cost of the optimization process. ESP Design Optimization can be computationally expensive, especially when optimizing complex systems with many design variables.

8. Sensitivity Analysis is another useful tool that can be useful in identifying critical parameters that have a significant impact on the performance of the system. Sensitivity Analysis can also be used to identify areas where further research and development is needed. However, like ESP Design Optimization, Sensitivity Analysis also has limitations. One limitation is the assumption of linearity. Sensitivity Analysis assumes that the relationship between the input parameters and the output of the system is linear. This may not be the case for all systems, and non-linear relationships may be missed. Another

RECOMMENDATIONS

1. As academic researchers, it is important to continue to study and analyze the effects of various factors on production performance, in order to improve the efficiency and effectiveness of oil production.

2. Further research is needed to fully understand the complex interactions between wellhead pressure and production performance using ESP.

3. Further research is needed in this area to fully understand the underlying mechanisms and optimize the use of ESP in oil and gas production.

4. Our research provides a foundation for future studies in this area. We believe that our results will be valuable to those in the oil and gas industry who are looking to improve their production processes. Overall, our study provides important insights into the factors that impact oil and gas production efficiency and lays the groundwork for future research in this area.

5. We recommend implementing regular monitoring and support measures to maintain the reservoir pressure at optimal levels. By doing so, we can ensure the continued success of oil production operations.
6. Further research is needed to better understand the factors that affect ESP performance, such as wellbore conditions, fluid properties, and pump design.

REFERENCES

[1].Nguyen T, Artificial Lift Methods: Design, Practices, and Applications. 1st (Edn), Springer Nature, Germany, (2020), pp-347.

[2]. Nguyen H, Del Mundo F, Improving Artificial Lift Design Through Dynamic Simulation, SPE North America Artificial Lift Conference and Exhibition, Society of Petroleum Engineering, Texas, USA, (2016) .

[3].Alemi M, Jalalifar H, Kamali G, Kalbasi M, (2010) A prediction to the best artificial lift method selection based on TOPSIS model. Journal of Petroleum and Gas Engineering Vol. 1(1), pp 009-015.

[4].Brown K E. Technology of artificial lift methods. Volume 1. Inflow performance, multiphase flow in pipes, the flowing well. United States: N. P., 1977.Web.

[5]. O.J. Romero, "Subsea Electrical Submersible Pump Significance in Petroleum Offshore Production", Universidade Federal do Espírito Santo, March 2013.

[6]. Abdelhady A, Gomaa S*, Ramzi H, Hisham H, Galal A and Abdelfattah A, (2020), Electrical Submersible Pump Design in Vertical Oil Wells, Petroleum & Petrochemical Engineering Journal, ISSN: 2578-4846, Volume 4 Issue 5, MEDWIN PUBLISHERS.

[7].Bader Abdullah Alqahtani; et al. Electric Submersible Pump Setting Depth Optimization- A Field Case Study, Paper presented at the SPE Middle East Artificial Lift Conference and Exhibition, Manama, Bahrain, October 2022. https://doi.org/10.2118/206934-MS

[8]. A. Suat Bagci, SPE, Murat Kece, SPE, ESP Performances for Gas-Lifted High Water Cut Wells, SPE Annual Technical Conference and Exhibition, Florence, Italy, 19–22 September 2010.

[9]. Hamzah Amer Abdulameer, et al, (2020), Production Optimization for Natural Flow and ESP Well A Case Study on Well NS-5 Mishrif Formation-Nasriya Oil Field, ISSN: 2710-1096. Journal of Petroleum Research and Studies. VOL. 10 NO. 2: ISSUE 27. DOI: https://doi.org/10.52716/jprs.v10i2.342

[10]. https://www.petex.com/products/ipm-suite/prosper/

[11]. Kermit E. Brown, "The Technology of Artificial Lift Methods- Volume 2b"1980

[12]. Brown, K.E. et al.: "The Technology of Artificial Lift Methods", "Production Optimization of Oil and Gas Wells by Nodal Systems Analysis," Penn Well Publishing Co., Tulsa, OK(1984), Vol. 4. (2)

[13]. T. Ahmed, Reservoir engineering handbook (Gulf Professional Publishing, (2006), (3).