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Selection of Artificial Lift Method

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Abstract
For most of producing oil and gas wells to be profitable over the long term, the appropriate artificial lift technique must be chosen. The present research examines the key selection criteria for the eight current primary artificial lift techniques and offers useful recommendations on the performance and applicability of the techniques based on real-world and tested technology. This paper discusses plunger lift, gas lift, hydraulic jet pumping, beam pumping, progressive cavity pumping, electric submersible pumping. The main goal of this study is to choose the best method, such as natural drive and artificial lift methods for accelerating and optimizing hydrocarbon production in the ARC oil field using the PROSPER software package and fictitious well data from Well WE1. The electrical submersible pump method is the subject of the nodal analysis for both natural drive cases and artificial lift techniques on PROSPER. Natural drive, ESP have calculated oil production rates of 57.2sm3 /day, 94.4 sm3 /day respectively. According to this study, using artificial lift techniques dramatically boosts oil production.

Keywords: Artificial Lift techniques, Nodal Analysis, Natural Drive, Prosper.

Introduction

Selecting the optimal lift technique correctly is frequently based on strong convictions. Operating staff unconsciously chooses the lift technique that they are most accustomed to. Equipment manufacturers or even internal experts on a certain approach frequently advise that the standards might be adjusted to meet their preferred way. Getting accurate operational cost information on the lift method over the well's life is the most challenging aspect of the analysis. If possible, data from wells that are similar should be used. The present value profit of the particular artificial-lift method can be determined using those Figures along with forecasts for salvage value, inflation, taxes, and other factors (Clegg et al., 1993). The characteristics of reservoir fluids are distinguished using the measurement of oil reservoirs and their performance with hydrocarbon reservoirs, which is significant in numerous reservoir investigations. Using the necessary methodologies to get precise property values is therefore crucial in the various oil sectors (Abdurazzaq, 2021). The idea of production optimization became necessary when the first oil reserves began to experience serious depletion. Exploring new fields involves a lot of risk and uncertainty, thus it's critical to explore every option available in the existing reservoirs as soon as possible (Surajo, 2017).

Petroleum Production Wells

The parts of a naturally flowing well are the reservoir segment, wellbore, and wellhead (Figure 1). Production fluids are sent from the reservoir portion to the wellbore. The wellbore provides a pathway for the fluids to travel from the bottom hole to the surface. At the wellhead, the fluid output rate can be changed. An oil or gas reservoir is defined as a single porous and permeable subterranean rock formation that is enclosed by impermeable rock or water barriers and contains a discrete bank of fluid hydrocarbons. Based on the hydrocarbon content and initial reservoir state, engineers classify oil, gas condensate, and gas reservoirs. (Guo, 2008)

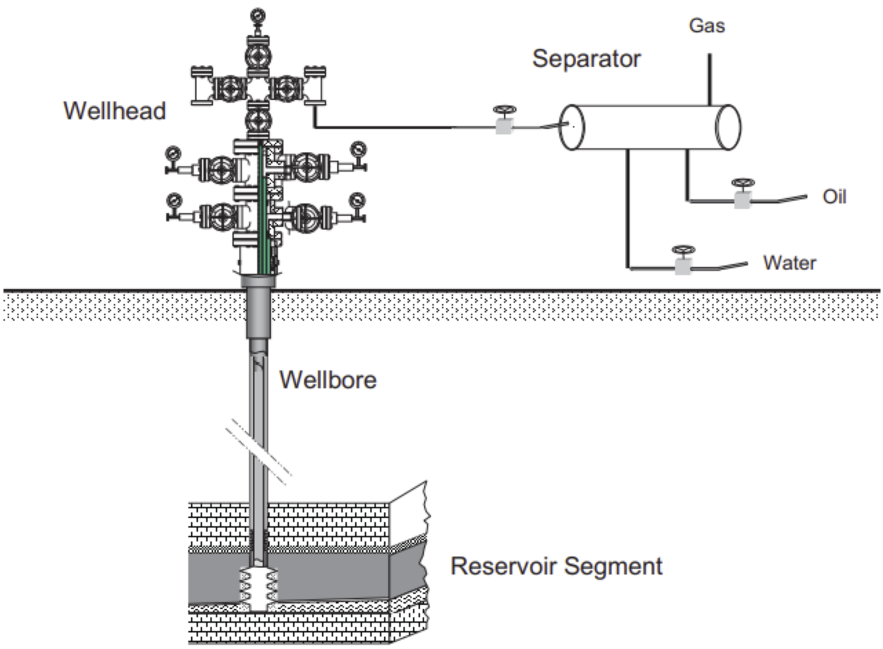

Figure 1. Oil and gas are produced by naturally flowing wells under their own pressure. (2008 by Gulf Publishing Company)

Pumping

In order to raise the pressure in the well and compensate for the total flowing pressure losses, pumping is used. It can be further categorized using a variety of characteristics, such as the pump's working principle. However, the most widely used classification separates rod and rodless pumping based on how the downhole pump is operated. The surface drive mechanism and downhole pump are connected by a series of rods that, depending on the type of pump being used, either oscillate or rotate. Positive displacement pumps that needed an alternating vertical movement to work were the first types to be used in water and oil wells. A recently developed rod pumping system makes use of a progressive cavity pump, which requires rotation of the rod string to function. This pump operates on the same positive displacement concept as the plunger pumps used in other kinds of rod pumping systems, but it lacks valves. As the name indicates, rodless pumping techniques do not use a rod string to control the downhole pump from the surface. The downhole pump is therefore driven by means other than mechanical, such as electric or hydraulic. Rodless pumping can use centrifugal, positive displacement, or hydraulic pumps, among other types of pumps. A multistage centrifugal pump is powered by a submerged electrical motor in electric submersible pumping (ESP). Electricity is delivered to the motor via a cable that is run from ground level up. These machines are perfect for producing large amounts of liquid. The other rodless lifting techniques all use a high-pressure power fluid that is injected into the hole. The first technique created was hydraulic pumping, which uses downhole units with a positive displacement pump powered by a hydraulic engine. Despite being a hydraulically powered method of fluid lifting, jet pumping operates entirely differently from the rodless pumping concepts previously covered (Gabor, 2017).

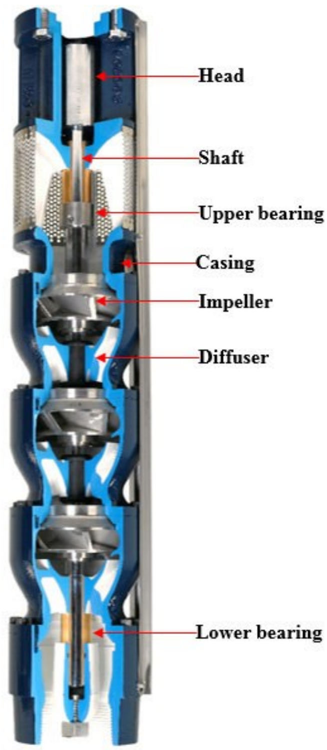

Figure 2. Main components of an electrical submersible pump (ESP). (Multistage assembly http://www.franklinwater.com).

Main objective of Electrical Submersible Pumps

ESPs are frequently employed in the petroleum sector to boost the production rates of hydrocarbon fluids, particularly for offshore deep-water oil fields. The revolving impeller and stationary diffuser are components of each stage of a multistage ESP that is typically installed in series (Figure 2). Due to the substantial depth of the reservoir, the ESP system in oil fields often consists of hundreds of stages to achieve the boosting pressure need. The impeller, which spins the blades to force fluid flow and impart kinetic energy to the fluids, is the main component of ESP. The majority of the fluid's kinetic energy is transformed to pressure potential by diffuser vanes at the impeller's exit. (Zhu and Zhang, 2018).

ESP has a higher flow rate and a greater drawdown than the majority of other artificial lift techniques. (Yudi, S., 2013). However, ESP has the following advantages and disadvantages:

The benefits of ESPs

- ✓ Adaptable to wells with high deviations, up to 80°.
- ✓ Adjustable to needed 6'-diameter subsurface wellheads.
- ✓ Quiet, secure, and hygienic for proper operations.
- ✓ Usually regarded as a large volume pump.

ESP drawbacks as well

- ✓ Will put up with low levels of sand production.
- ✓ Expensive pulling operations to fix downhole issues
- ✓ Production decline when on a DHF
- ✓ Less than 150 B/D gross in volume does not work well.

Gas Lift Technique

Gas is often injected during the gas lift operation into the space between the production tube and casing. A single or more typically a number of gas lift valves then permit the gas to enter the flow stream within the production tubing at a particular depth. The fluids flowing in the tubing at that depth and throughout the tubing above the injection point have a gradual increase in the gas liquid ratio due to the injection of gas into the production tubing. (Production Technology - 1, 2015). Compressors are used to supply the gas pressure necessary for pipeline gas transportation as well as to raise oil in gas-lift activities. The two main types of compressors utilized in the production of natural gas nowadays are reciprocating and rotary compressors. In the natural gas business, reciprocating compressors are the most widely utilized equipment. Practically all pressures and volumetric capabilities are supported by their design. (Guo, 2007).

Details of the Simulation Model's components

After collecting all data for the reservoir simulation model related to reservoir fluid properties is taken https://www.researchgate.net/publication/355270858 with some additional parameters, and table containing the data needed for the software is created for well. The Prosper Software is used to enter the data, and the model with the lowest error rate is chosen. The program then uses the black oil model, which functions at the expense of the characteristics of the other reservoir fluids, to match the input values.

Prosper Information

One of the most critical aspects of well analysis is evaluating whether wells may be capable of producing at a higher rate than the existing one. PROSPER, a well modeling software, is intended to help ensure that well models are accurate and consistent. It also handles every component of well modeling, including PVT (fluid description), VLP correlations (for computing flow-line and conduit pressure loss), and IPR (reservoir inflow).

Simulated Well Modelling.

The ARC field produces oil and gas via WE1 wells . The long-term plan for the ARC field, optimization of oil well output in the ARC field, and the efficiency of gas production to improve oil well production are all factors driving the implementation of this research. The goal of this research is to examine oil wells in the ARC Field that have the potential to boost production through Artificial Lift.

Methodology

The PROSPER software package, which aims to get inflow/outflow performance curves, create IPR and VLP models, select the best artificial lift method, perform well perforation design, and so on based on the minimum required input data, is used to generate the inflow performance relationship (IPR) and vertical lift performance (VLP) curves for this study. To improve the accuracy of models created using the program, genuine manufacturing history data can also be entered. The program is a creation of Petroleum Experts Limited (PETEX), a UK-based company that produces some of the petroleum industry's most frequently utilized software (IPM PROSPER User Manual, Version 11.5, January 2010).

Data Requirements

- ✓ PVT data
- ✓ Reservoir Data
- ✓ Equipment data, including as downhole equipment, deviation surveys, geothermal gradients, and average head capacities
- ✓ ESP case data

Table 1. Reservoir and fluid properties

Properties,Unit	**Value**
Reservoir pressure, atm	89
Bubble point pressure, psi	3600
Reservoir Temperature, F	250
Gas Oil Ratio, scf/stb	800
Water cut, %	50
API	35
Gas specific gravity	0.78
Water salinity, ppm	80.000
Oil FVF, bbl/stb	1.45
Oil viscosity, cp	0.3
Reservoir permeability ,md	20
Reservoir thickness ,m	15
Drainage area,m^2	820000
Dietz shape factor, unitless	23.9
Skin factor, unitless	2
Wellbore radius, inches	9
TD,m	780
MD,m	560

Table 2. Input PVT Data

PVT properties, Unit	**Value**
Solution GOR, scf/STB	800
Oil gravity ,API	35
Gas gravity,sp	0.78
Water salinity,ppm	80000
Mole percent H2S, %	0
Mole percent CO2 ,%	0
Mole percent N2,%	0

The Well Model

Building a Model for Well-Performance PROSPER is used.
There are 6 areas on the PROSPER primary screen:

1. Options Summary
2. PVT Data
3. IPR Data
4. Equipment Data
5. Analysis Summary
6. PROSPER Version

Model ConFigureuration for Natural Drive Case

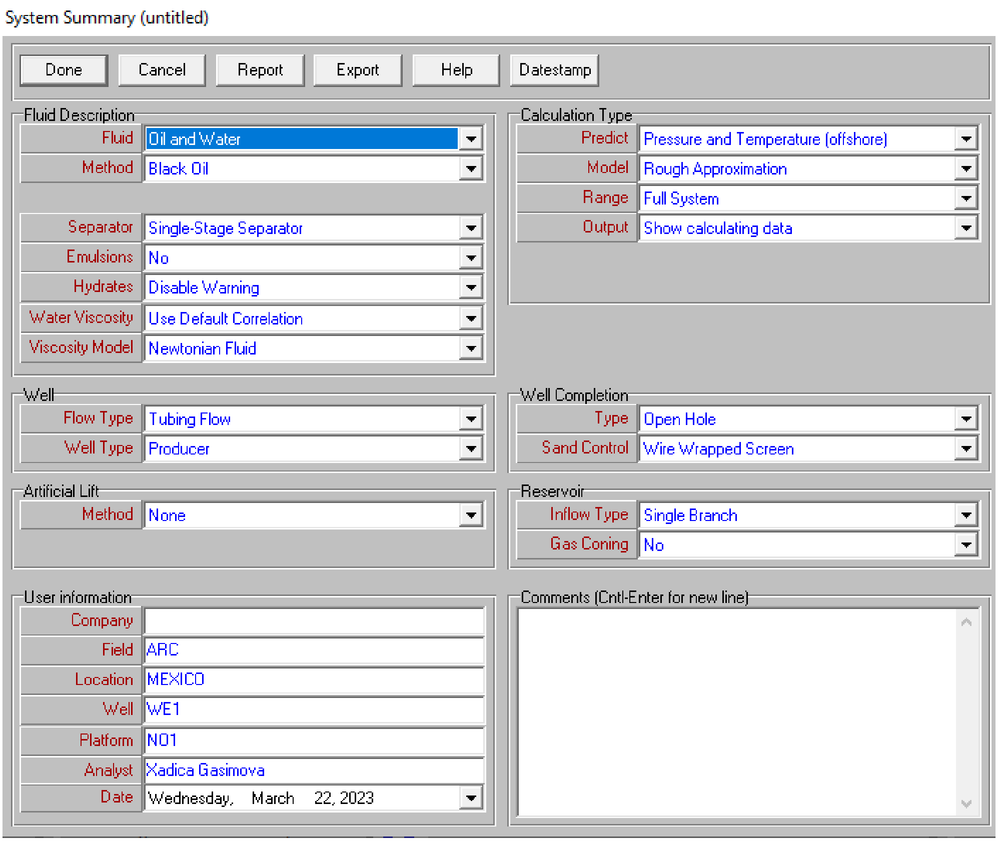

Figure 2. Prosper System Summary

The software use the Vogel's model below the bubble point and the Darcy's equation above the bubble point.Vogel's method is one of the most often used techniques for creating inflow curves.The "Darcy" model is applied here. To build the IPR curve, production rates at varied drawdown pressures are used. In order to match the PVT test data to the Black Oil correlations that are available on PROSPER, basic PVT input data from offset wells, such as GOR, API gravity, Gas gravity, Water salinity, and impurities present in reservoir fluid, are first introduced into the software. The software calculates the previously mentioned PVT properties after taking into account the entirety of the available data as well as the "Calculate" option used for building the IPR curve.

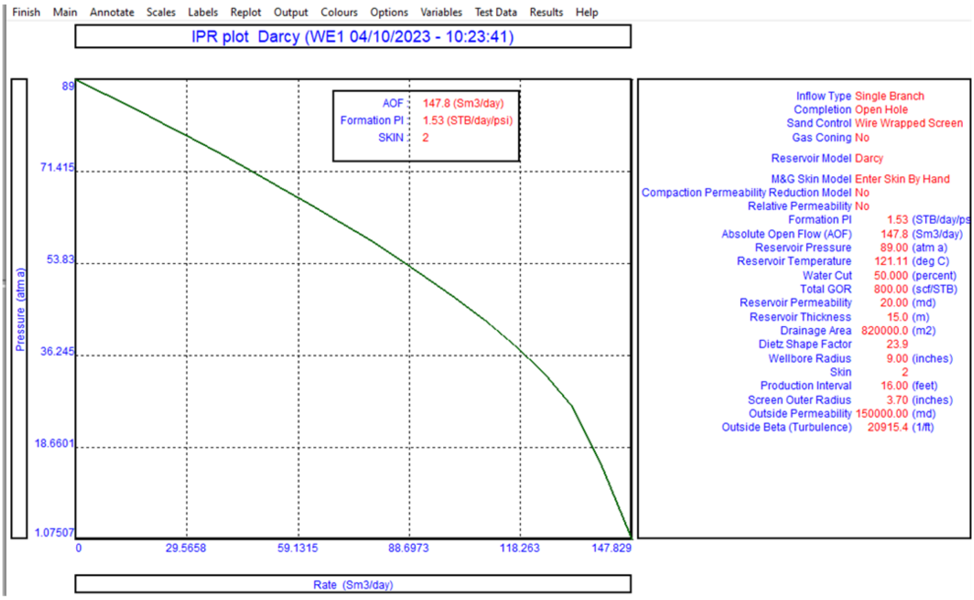

Figure 3. Plot of IPR according to Darcy Reservoir Mode

According to the Figure observed above, the estimated absolute open flow (AOF) 147.8 sm^3 /day and the formation productivity index (PI) is 1.53 STB/day/psi.

As seen in the graphic above, the oil rate and bottom hole flowing pressure (BHFP) are 57.2 sm^3 per day and 39.63 atm, respectively. It means that the intended well may flow naturally based on the input parameters.

Model ConFigureuration for ESP Case

The PROSPER model requires that the PVT data be matched with the matching parameters using the appropriate correlation. There are numerous relationships that might be relevant. In order to get the optimal correlation to represent the features of the reservoir fluid, Prosper software will go through numerous iterations. A combination of a pump, motor, and cable is chosen from a list provided by PROSPER as the last step in the ESP design process. The Schlumberger REDA D1440 (101.6 mm OD) pump, which offers the finest performance among the pumps, is chosen to provide the most efficiency.

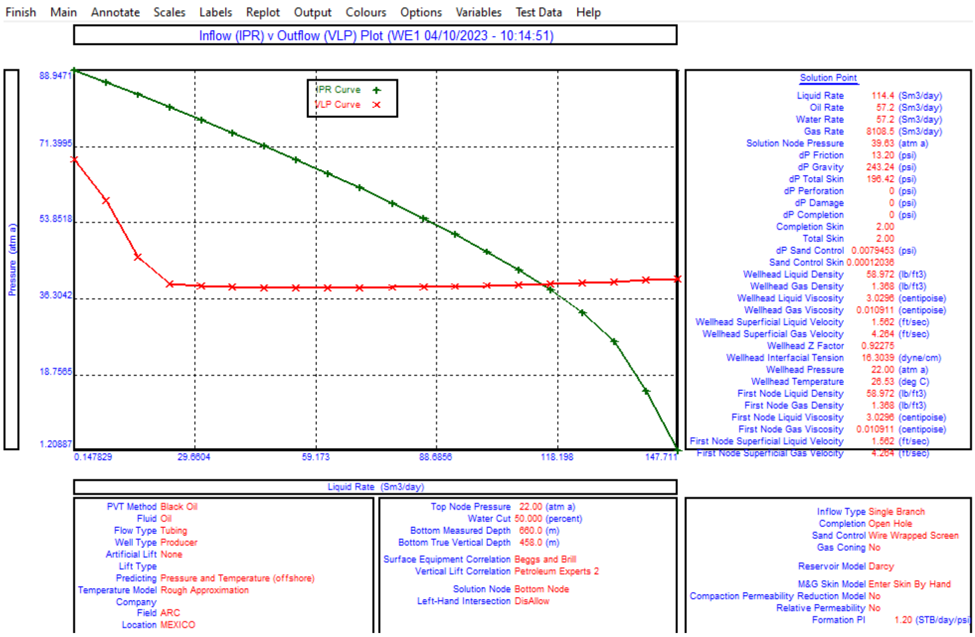

Figure 4. IPR and VLP curves for the natural drive situation

From the wellhead to the pump discharge, the Pump Discharge Pressure is displayed in the picture above as a blue curve, the IPR as a green curve, and the VLP as a red curve.

The liquid rate and oil rate determined by PROSPER for this scenario are clearly shown in the above Figure to be 188.9 sm^3 per day and 94.4 sm^3 per day, respectively. In order to get the best performance out of the pump, the ESP case is modelled on PROSPER.

Discussion and Conclusions

The software receives all necessary data from PVT, deviation survey, geothermal temperature profile, and downhole equipment, and then creates the IPR curve. Following the modeling of the natural drive case and the ESP case the operating points at the intersection of the IPR and VLP curves are obtained for each scenario using the system calculations menu. The obtained findings demonstrate that the well modelled oil production in the natural drive case for the oil rate and bottom hole flowing pressure (BHFP) are 57.2 sm^3 /day and 39.63 atm, respectively. However, the production rate is dramatically raised when artificial lift techniques are used. It is clear from the data that applying ESP results in increased production rates, and that this can be used to improve and optimize production. Given that ESPs have a limited existence and that it will be necessary to replace the downhole ESP lifted wells, careful planning is essential to completing this project. In order to get the best performance out of the pump, the ESP case is modelled on PROSPER. The system calculations show that the oil production rate is equal to 94.4 sm^3 /day.

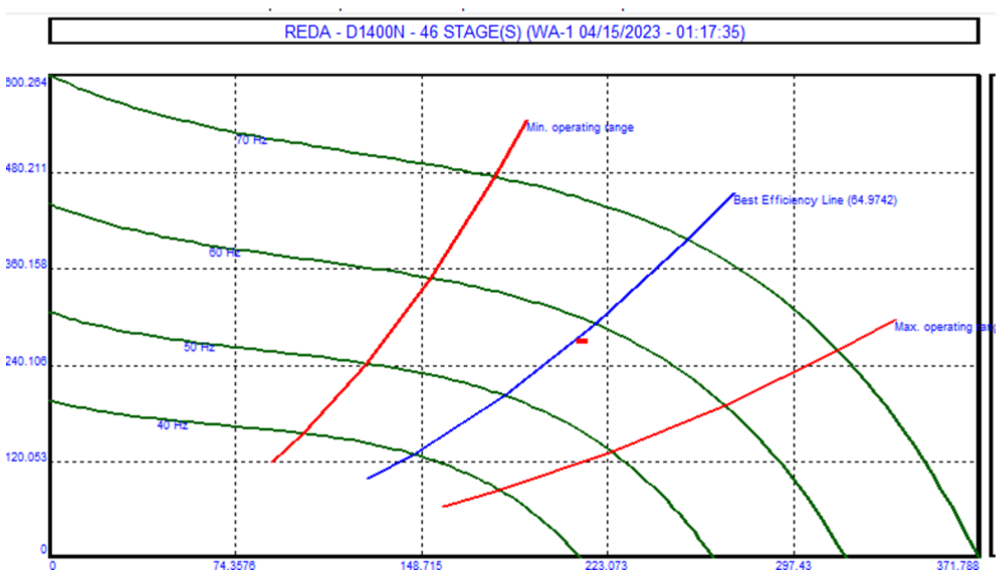

Figure 5. Performance Curve of REDA1440

Recommendations

The PROSPER modeling used for this research was effective and the best choice for maximizing and optimizing hydrocarbon output. More advanced software is needed to make an integrated approach when it comes to field production optimization and enhancement, taking into account the surface network of existing wells and available subsurface data.

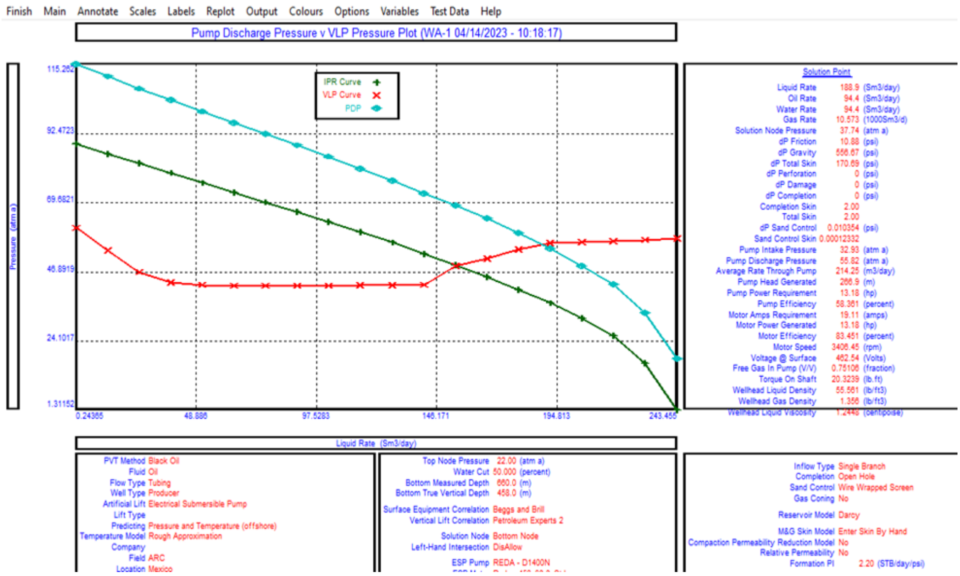

Figure 6. Pump Discharge Pressure vs VLP Plot for ESP-lifted well

References

Abdelhady, A., Gomaa, S., Ramzi, H., Hisham, H., Galal, A., Abdelfattah, A. (2020). Electrical Submersible Pump Design in Vertical Oil Wells, Pet Petro Chem Eng J. 4(5): 000237.

Abdurazzaq, T., Togun, H., Haider, D., Hamadi, **M.A.** (2021) Determining of reservoir fluids properties using PVTP simulation software- a case study of buzurgan oilfield ,1-2

Clegg, J.D. et al. (1993). Recommendations and Comparisons for Selecting Artificial-Lift Methods. 6-8.

Gabor, T. (2017). Electrical Submersible Pumps Manual Design, Operations, and Maintenance. 43-44.

Guo, B. (2007). Petroleum Production Engineering, A Computer-Assisted Approach. Gulf Professional Publishing. 31-32.

Guo, B., Sun, K., Ghalambor A. (2008). Well productivity handbook by Gulf Publishing Company.10-11

IPM PROSPER User Manual,Version 11.5. (2010). United Kingdom: Petroleum Experts.58-60.

Production Technology. (2015). Edinburgh, United Kingdom: Heriot Watt University, Institute of Petroleum Engineering. 22-23.

Surajo, A. I. K. (2017). Nodal Analysis and Artificial Lift Methods. 24-25.

Yudi, S. (2013). Analytical Study of Oil Recovery on Gas Lift and ESP Methods. 5-6.

Zhu, J., Zhang, Hong-Quan. (2018). A Review of Experiments and Modeling of Gas-Liquid Flow in Electrical Submersible Pumps. 2-3.