**Alqalam Journal of Medical and Applied Sciences**. 2026;9(2):454-469
https://doi.org/10.54361/ajmas.269223

*Original article*

# Post-Acidizing Productivity Index Evaluation Using an Integrated Analytical and Multi-Software Nodal Approach: A Case Study of Well O-08, El-Sharara Oil Field, Libya

**Nisreen Alkhoja*[1], Darin Touba[2], Mohammed Alshaebi[1]**

[1]*Department of Petroleum Engineering, University of Tripoli, Tripoli, Libya.*
[2]*Department of Reservoir Engineering, Akakus Oil Company, Tripoli, Libya.*
***Corresponding Email***. n.alkhoja@uot.edu.ly

**ABSTRACT**
This study displays an accurate evaluation of the productivity index (PI) of the well O-08 located in the NC115 El-Sharara O-field, Libya, following matrix acidizing treatment. The well was shut in during 2014 due to the country's security situation, resulting in severe formation damage around the wellbore and a zero value of the productivity index. A matrix acidizing operation for sandstone formations was conducted, and it successfully regained production when the well was reactivated. However, the absence of reliable data before treatment has been a major obstacle to obtaining accurate estimates for its effect on well productivity. The main objective of this study is to accurately determine the post-acidizing PI in order to evaluate the consistency, predictive capability, and reliability of integrated analytical and multi-software modeling techniques. An integrated approach was employed, which consisted of utilizing both the equations' analytical calculations (conducted in Microsoft Excel) and nodal analysis techniques (implemented in the PROSPER and PIPESIM software packages). The results revealed remarkable consistency across all evaluation methods: analytical calculation yielded a PI of 8.90 STB/D/psi, while PROSPER and PIPESIM produced PIs of 8.83 and 8.81 STB/D/psi, respectively, with an average of 8.82 STB/D/psi, with less than 0.80% deviation from the analytical result. This high consistency confirms the validity of integrated modeling, which effectively mitigates uncertainties in data-limited conditions. The restored PI of ~8.90 STB/D/psi confirms the success of the sandstone acidizing design. It is recommended that future well interventions in similar settings adopt this integrated modeling framework to enhance decision-making, improve performance forecasting, and support sustainable reservoir management under data limitations.
**Keywords.** Productivity Index, Nodal Analysis, Reservoir Performance, Matrix Acidizing.

## Introduction

Nodal analysis is an engineering methodology used to assess the well performance of a complete production system and is a key approach in reservoir and production engineering. It provides a structured framework for evaluating and optimizing the operation of oil and gas wells—including those using Electric Submersible Pumps (ESP)—from the reservoir all the way to the wellhead [1]. Inflow Performance Relationship (IPR-curve) and Vertical Lift Performance (VLP-curve) are two primary methods used to evaluate and optimize well performance. IPR describes the relationship between the production rate of a well and the bottomhole following pressure; it provides valuable insights for enhancing production efficiency and the behavior of reservoir management. On the other hand, VLP examines how the production rate correlates with tubing head pressure, helping engineers assess the performance of artificial lift systems and surface facilities [2].
In reservoir and production engineering, the Productivity Index (PI), also commonly referred to as the J-index, is the main indicator for measuring the efficiency of wellbore production and quality of reservoir performance under given reservoir conditions. Fundamentally, PI represents the ratio of the hydrocarbon flow rate ($Q$) to the drawdown of the pressure (difference between average reservoir pressure ($P_r$) and bottomhole flowing pressure ($P_{wf}$). It is typically expressed in units of stock tank barrels per day per pound per square inch ($STB/D/psi$) [3].
The J is usually measured during a well production test. Begin shutting the well in until the static reservoir pressure is reached, then allow the well to produce under a constant flow rate until bottomhole pressure stabilizes. It is important to emphasize that stabilizing a surface pressure does not guarantee a stabilized bottomhole flowing pressure; it must be continuously monitored from the moment the well begins to flow. Once stabilizing conditions are achieved, the PI is calculated using recorded flow rate and pressure data [4].
A decrease or zero productivity index reflects poor efficacy of the reservoir performance, resulting from:

- Formation damage (skin factor S) around the wellbore, caused through drilling, completion operations, or long-term shut-in wells, reduces the reservoir permeability (K).
- A decrease in average reservoir pressure due to a depletion of the natural drive mechanism or delayed implementation of pressure support by gas or water injection [5].

In such situations, improving the productivity index becomes the primary objective for restoring well productivity. Two primary strategies are commonly used to investigate this objective, the first including increasing the drawdown of the pressure by decreasing the bottomhole flowing pressure ($Pwf$). This can be done by using optimization of surface production facilities or applications of artificial lift techniques, such

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

as electrical submersible pumps (ESPs), gas lift, or rod pumps. The second and more direct strategy is to use a reservoir stimulation process, such as hydraulic fracturing or matrix acidizing, to increase or improve the reservoir rock permeability around the wellbore, reduce the viscosity of the oil, or increase the reservoir pressure, thereby improving the inflow efficiency [6].

These strategies have become particularly important in the El-Sharara Field, the largest and most important oil field in Libya, which represents approximately one-third of Libya's oil production. The Sharara field has experienced significant production disruptions, with the onshore field shut down several times since 2011 due to the country's security situation, impacting the entire oil and gas industry, where many of the wells had several problems, such as declines or zero productivity index (PI), directly impacting recovery efficiency and field performance [7].

This study investigates the O-08-NC115 well in the El-Sharara oil field, a well that historically exhibited negligible productivity with no measurable output and a near-zero productivity index (PI), indicating severe wellbore damage. In 2021, a matrix acidizing treatment was implemented, successfully restoring production. While this outcome represents an operational success, evaluating the valid efficacy of such stimulation interventions is fundamentally challenged by the scarcity of reliable pre-treatment field data—a common limitation in reservoir diagnostics. This data paucity undermines confidence in performance assessments and long-term predictions. To overcome this constraint, this work employs a rigorous cross-validation framework leveraging multiple independent modeling platforms—PROSPER and PIPESIM—supplemented by analytical calculations. By reconciling results across these tools, the study demonstrates how integrated simulation enhances result reliability and mitigates uncertainty under data-limited conditions. The consistency achieved between PROSPER and PIPESIM outputs not only strengthens the validity of PI estimation but also highlights the methodological advantage of multi-platform validation in the absence of comprehensive field measurements.

The main objective of this study is to accurately determine the productivity index (PI) following matrix acidizing treatment of the well O08 located in the NC115 El-Sharara O-field, Libya, in the absence of credible pre-treatment data, by using integrated analytical and multi-software modeling techniques.

This study bestows the following three contributions to reservoir and production engineering:

A) Methodological Hybrid Approach: Provides an integrated and proven workflow model that combines basic analytical calculations with multi-platform simulation analysis, which can be repeated for performance evaluation in data-deficient circumstances.

B) Cross-Platform Validation Framework: Confirms the value of utilizing multiple industry-standard programs to cross-validate results and minimize software-specific bias.

C) A Success Field Case: This field case describes a successful production recovery from well matrix acidizing treatment in a shut-in well and provides an opportunity to improve the productivity index and optimize sandstone reservoir treatment, thus advancing best practices for sustainable well performance management. These objectives advance technical best practices in well performance analysis and sustainable production optimization, demonstrating that integrated modeling and cross-validation enable reliable decision-making in complex, data-limited environments.

### *Geological and Reservoir Background*

The El Sharara oil field, situated in the Murzuq Basin in southwestern Libya, is the largest and most important oil field in the country. The Sharara field is considered to have the largest proven oil reserve recognized in North Africa, covering a wide area of approximately 8,700 square kilometers from the Murzuq Desert. It contains the blocks NC115 and NC186 concessions.

The NC-115 concession is located in the southwest of Libya in the western Sharara desert near Ubari village, some 720 km from the Mediterranean Sea; it covers an area of 9,969 square miles (25,850 km$^2$). It comprises 10 producing fields, including El Sharara A, B, C, H, J, M, N, O, P, I, and R. Currently, the NC115 concession is operated by the Akakus Oil Operations Company, with the Spanish Repsol, the French TotalEnergies, the Austrian OMV, and the Norwegian Equinor [9].

The field of interest in this study is the O-NC115 oil field, approximately 15 km to the south of the H field, close to the southeast boundary of the NC115 concession, and the field size extends approximately 5.1 km x 2.8 km, and is up to date. The first exploration well in the O-field was O1-NC115, drilled in June 2003; the field was put into production at the start of December 2004 [10].

The O Field is produced from the Hawaz multi-layered sandstone reservoir, which has moderately good reservoir rock properties, a permeability ranging from 30 to 500 mD, and a porosity range between 9 and 16%. The formation oil volume factor value is Rs of 254 scf/stb with a proportionately lower bubble point pressure of 544.7 psi. Aquifer support is not indicated through pressure history. The initial productivity index ranged between 1.0 and 20 STB/D/psi. Electrical submersible pumps (ESPs) are currently used by all producers [11].

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

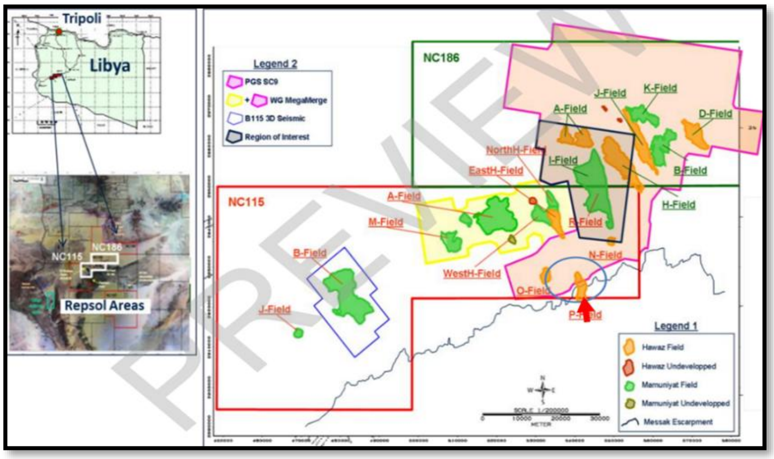


***Figure 1. Location Map for El Sharara Oil Field, Concession NC115 and NC186 [9].***

The O-08 NC115 well is located in the southeast part of O-Field, approximately 1100 meters south of O-02 and 600 meters northeast of O-07. It has been drilled between 7 March 2009 and 3 April 2009 down to the top Hawaz at a depth of 5230 ft KB, where 9-5/8" casing was run until 5700 ft. Standard logs were run; after putting a cement plug, the final PBTD was 5599 ft KB. The well was drilled with 1100 psi overbalance pressure, which caused mud invasion and possible formation damage. The table below summarizes the history of the O-08 well. All this historical information about the well made it the focus of consideration to conduct an advanced study to know and determine its productivity accurately and correctly.

***Table 1. O-08 Well History.***

| | Date | PBTD (ft) | Reservoir/Zone | Type of work |
|---|---|---|---|---|
| Drilled | March,2009 | 5,599 | Hawaz | Drilling |
| Initial Completion | Oct, 2010 | 5,599 | Hawaz | Completion |
| Workover #01 | Sep, 2012 | 5,599 | Hawaz | ODH |
| Workover #02 | Sep,2013 | 5,599 | Hawaz | ODH |
| Proposed Workover | Jul,2021 | 5,599 | Hawaz | Matrix Acidizing |

## Methods

In this study, a tight methodology was prepared to calculate the productivity index accurately:

### *Software Overview*

The study leveraged industry-standard production and reservoir modeling software, including PROSPER and PIPESIM, to enable integrated well and reservoir performance analysis, especially in the correct estimate of the productivity index (PI).

PROSPER®, from the Petroleum Experts package developed by PE Limited (Petex), is widely used in the petroleum industry as an extensive analysis tool utilized for well performance modeling, inflow-outflow (IPR/VLP) relationship curve generation, designing for artificial lift methods, and optimization of completion and production strategies. It integrates PVT data, reservoir inflow models, and multiphase flow correlations calibrated with actual production and reservoir data for accurate Productivity Index (PI) estimations. This study uses PROSPER to model and optimize well performance following matrix acidizing treatment and utilizes validated PVT data with test data to prove production forecast and operational efficiency [12].

PIPESIM is a Schlumberger steady-state and dynamic multiphase flow simulator in surface and subsurface production. PIPESIM contains a range of industry-standard multiphase flow correlations and mechanistic three-phase flow models, which enable the correct assessment of flow regimes and pressure–temperature behavior in all production system segments. This capability provides dependable IPR–VLP coupling, which is essential for PI determination. This study highlights the importance of PIPESIM software in improving PI estimation by conducting a comprehensive analysis of an integrated production system [13].

### *Productivity Index Estimation Methods*

In this study, a tight methodology was prepared to calculate the productivity index accurately, which is schematically represented by the following:

**Copyright** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

https://doi.org/10.54361/ajmas.269223

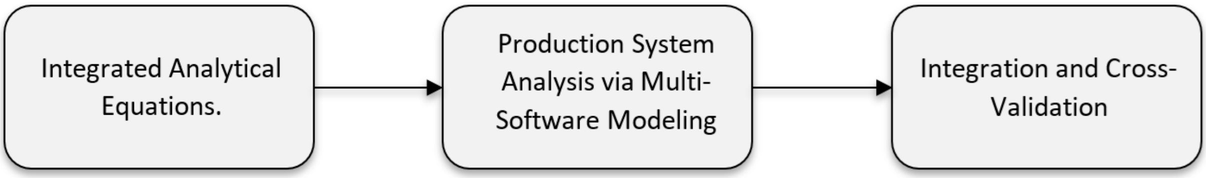


***Figure 2. Schematic Representation of Methodology.***

***Integrated Analytical Equations***

A first-principles approach was adopted to calculate the PI manually, using available data from the buildup test pressure. Bottomhole flowing pressure (Pwf) and average reservoir pressure (Pr) were extracted through careful reconstruction of the pressure buildup curve in Excel, following the monitoring and drawing of the BU test shown in (Figure 3).

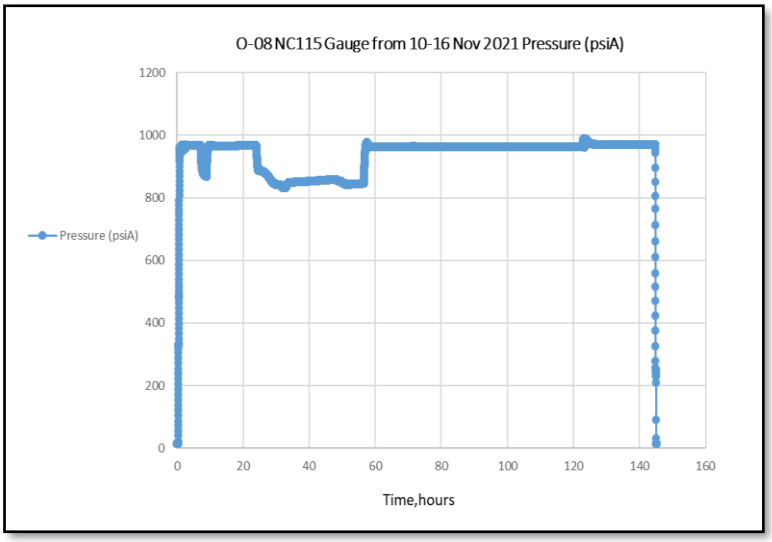


***Figure 3. Build Up Test Curve in Microsoft Excel.***

After estimating the bottomhole and reservoir pressures at the gauge depth, we performed calculations to determine the pressure at a reference datum, along with the well's productivity index. This process involved the following steps:

- Data acquisition from the production test, utilizing OFM and Advocate software.
- Water cut calculation using the following equation:

$$\mathbf{WC} = \frac{Q_w}{Q_l} * 100\% \quad (1)$$

- The liquid gradient was determined using the following equation:

$$Liq\ grad = \frac{Q_o * 0.32 + Q_w * 0.433}{Q_l} \quad (2)$$

- The bottomhole pressure at datum was determined using the following equation:

$$P_{wf@datum} = P_{wf@guge} + (Datum - Guge\ depth) * liq\ grad \quad (3)$$

- Reservoir pressure at the datum was determined using the following equation:

$$P_{R@datum} = P_{R@guge} + (Datum - Guge\ depth) * liq\ grad \quad (4)$$

- Determined the well productivity index (PI) using the following equation:

$$J = \frac{Qo}{P_{R@datum} - P_{wf@datum}} = \frac{Qo}{\Delta p} \quad (5)$$

(Table 2) summarizes the data and calculated results used in subsequent analyses.

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

https://doi.org/10.54361/ajmas.269223

***Table 2. Summary of Data Used in Equations for O-8 Well.***

| **well** | **O8-NC115 at 50 HZ** |
|---|---|
| QOIL BOPD | 987.98 |
| QWATER BWPD | 12.61 |
| QLIQ BLPD | 1000.59 |
| DFL ft | 2325 |
| W.C% | 1.3 |
| WHP psi | 405 |
| Datum ft, Kb | 5507 |
| Gauge depth ft | 5172 |
| (Pwf) psi at gauge | 867 |
| PR @ gauge | 978 |
| Liq grad psi/ft | 0.32 |

### *Production System Analysis (PSA) via Multi-Software Modeling*

This study used multi-software modeling by PROSPER and PIPESIM to perform a dynamic nodal analysis framework to construct a complete production system model from the well to the surface. Inflow Performance Relationship (IPR) curves were developed based on reservoir properties and fluid characteristics, while Vertical Lift Performance (VLP) models incorporated tubing performance, multiphase flow correlations, and surface constraints; their intersection represents the best value of the flow rate and pressure optimum, through which the productivity index will be estimated [14]. This model consists of four distinct steps, each crafted to offer a systematic approach to the scientific objectives. The encompassing data collection, model creation, model validation, and result finalization. Each of these steps is essential for a comprehensive understanding and interpretation of the results. The schematic diagram presented below (Figure 4) illustrates the interconnectedness of these methodological components.

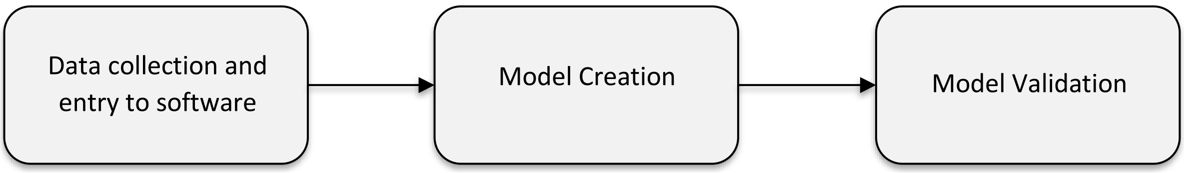


***Figure 4. Schematic Representation of Production System Analysis (PSA) via Multi-Software Modeling Methodology.***

### *Data Collections*

The dataset utilized in this study was obtained from a producing oil well equipped with an Electric Submersible Pump (ESP) system, operating under real-field conditions in the NC115 El-Sharara O-Field. This comprehensive and high-resolution dataset encompasses a wide array of operational, petrophysical, and engineering parameters, forming a robust foundation for integrated performance analysis and multiphysics modeling. The production data for this analysis were retrieved from the calculations of integrated analytical equations. Subsequently, the PVT data retrieved from the PVT report, the deviation survey data, the heat transfer data, the tubulars data, and the downhole equipment data from the completion report were detailed. Reservoir parameters from the pressure test analysis report. In addition, the ESP data is important for this model. After obtaining all the data required for the accurate calculation of the productivity index, it was entered into the PROSPER and PIPESIM software, verified, and matched with the features of the used platforms. This step is very significant to create the production model of the well.

### *Model Creations*

All modeling in PROSPER and PIPESIM software depends on nodal analysis principles, which will be the primary method utilized in this study to accurately predict the productivity of the well. This strategy allows for an in-depth investigation of the parameters affecting well performance.

Inflow Performance Relationship (IPR) is one of the basic elements of production system analysis, specifically nodal analysis [15].Darcy's law for radial flow is one of the basic models for single-phase oil inflow modeling in software programs like PROSPER and PIPESIM. The Darcy's analytical equation is used to construct IPR curves based on permeability (k), skin (s), well drainage radius (re), and fluid properties (μo, Bo) [4]. Equation No. 6 represents the general equation of Darcy, and equation No. 7 represents the equation for calculating the value of the productivity index using Darcy's law:

$$q = \frac{0.007082\, kh(P_r - P_{wf})}{\mu_o B_o \left[\ln\left(\frac{r_e}{r_w}\right) - 0.75 + s\right]} \quad \textbf{(6)}$$

**Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0
**Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026

$$\mathbf{PI} = \frac{\mathbf{0.00708}\, kh}{\mu_o B_o \left[\ln\left(\frac{r_e}{r_w}\right) - 0.75 + s\right]} \quad \textbf{(7)}$$

In this study, Darcy's law was selected as the foundational model for constructing the inflow performance relationship (IPR) due to its physical consistency with single-phase liquid flow under laminar conditions, which characterizes the reservoir-wellbore system in the O08-NC115 well. While empirical models such as Vogel's or Standing's correlations are commonly applied in multiphase flow scenarios, the present case involves a predominantly undersaturated oil reservoir with minimal gas evolution at downhole conditions—confirmed by fluid analysis and production data. [16].

Furthermore, the presence of an Electric Submersible Pump (ESP) does not invalidate the applicability of Darcy's law to the reservoir inflow component; rather, it necessitates a clear distinction between inflow (reservoir to wellbore) and outflow (wellbore to surface) systems. The ESP influences the bottomhole flowing pressure and vertical lift performance but does not alter the fundamental mechanism of radial flow into the wellbore, which remains governed by Darcy's principles. By using Darcy's law to model IPR and coupling it with rigorous multiphase flow simulations in PROSPER and PIPESIM—both of which fully account for ESP performance curves and artificial lift dynamics—the methodology ensures a physically consistent separation of reservoir and completion effects from artificial lift contributions. This approach enhances the accuracy of productivity index estimation and supports reliable pre-stimulation comparisons, particularly under data-limited conditions.

The intersection between the IPR and the VLP curves, known as the operating point, is a fundamental concept in well performance analysis and yields the deliverability of the well, a reflection of what a well will actually produce *under a given operating condition (Pr, PI, WC, GOR, THP, Tubing size…)*. The figure below describes the intersection between the IPR and the VLP curve.

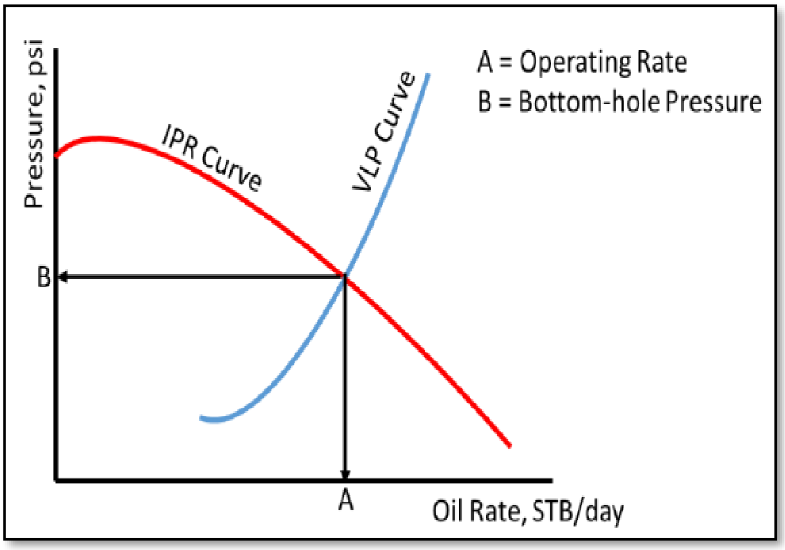


***Figure 5. Inflow Performance Relationship (IPR) and Vertical Lift Performance (VLP) curves showing the operating point of a produced well [17]***

After constructing and calibrating the simulation model based on the Darcy equation and inputting field data into the specified software packages, validation was done to verify the accuracy of the predicted productivity index. The fact that results are the same on two different simulators increases model credibility and use in performance forecasting and optimization.

***Model Validation***

To validate the model successfully (either in PROSPER or PIPESIM), actual production data has to be closely matched with the model we build. It is important to realize that some discrepancies between the modeled data and actual measurements will occur regardless of the software used. If the model does not match the actual well data for any reason, it is necessary to adjust some parameters that are not available or reliable. These adjustments are necessary to improve the accuracy and prediction quality of the models.

***Integration and Cross-Validation***

A robust methodology based on the integration of industry-standard simulation tools and rigorous cross-validation was employed to ensure the accuracy, consistency, and credibility of the calculated Productivity

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

Index (PI) in this study. Given that PI is a critical performance indicator—especially when evaluating the effectiveness of matrix acidizing treatments—minimizing uncertainty in its estimation is paramount. This validation is done through the following steps:

1. Calculating the average productivity index (PI) values from two industry-standard simulation tools—PROSPER and PIPESIM—to assess overall model consistency:

$$PI_{avg} = \frac{PI_{prosper} + PI_{pipesim}}{2} \quad (9)$$

2. Estimating the relative deviation of the simulated mean PI from this reference is:

$$Relative\ Deviation = \frac{PI_{\text{equations } calculations\ reff} - PI_{\text{simulator}}}{PI_{\text{equations } calculations\ reff}} \quad (10)$$

This dual-track strategy—combining both commercial simulations and first-principles calculations—enables comprehensive validation of the results.

## Results and Discussion

This analysis focuses on accurately determining the productivity index (PI) following matrix acidizing treatment of the well O08, equipped with an electrical submersible pump (ESP) system. In the integrated analytical equations, downhole pressures were corrected to a common reference level (kb = 5507 ft) to accurately represent the true pressure drop across the well-reservoir system. This correction is necessary to remove depth-related effects and enable consistent and identical performance comparisons between wells in the field.

- *Pwf*@datum=975 psi.
- *PR*@datum=1086 psi.

The resulting drawdown, Δ*p*=*PR*@datum−*Pwf*@datum=111 psi, was applied in Equation (5) (Productivity Index model):

$$\text{PI} = \frac{Qo}{\Delta p} = \frac{988}{111} \approx 8.90\ \text{STB/D/psi}$$

To validate this result, an independent manual calculation of PI was performed using the Darcy-based analysis equation implemented. This approach replicated the same input parameters—permeability, skin, fluid properties, and geometry—and applied the basic radial flow solution:

$$\text{PI} = \frac{0.00708 \times 151 \times 126}{0.463 \times 1.243 \left[\ln\left(\frac{2633}{0.5014}\right) - 0.75 + 18.5\right]} \approx 8.89\ STB/D/psi$$

The dual approach—utilizing integrated field data analysis and initial Darcy modeling—demonstrates a robust methodology for estimating PI. The resulting coefficient of performance, approximately 8.9 STB/D/psi, provides a sound scientific basis for evaluating well performance, optimizing artificial lift, and planning interventions in the NC115 block of the Sharara oil field.

In Production System Analysis (PSA) via Multi-Software Modeling, a well model was generated using PROSPER and PIPESIM software.

### *PROSPER Model*

The PVT data for this analysis were retrieved from the PVT report. Subsequently, the various correlations available within the software were assessed to identify the one that exhibited the best fit for the data. Based on the correlation coefficient, the chosen correlation was then employed to generate the model depicted in (Figure 6).

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

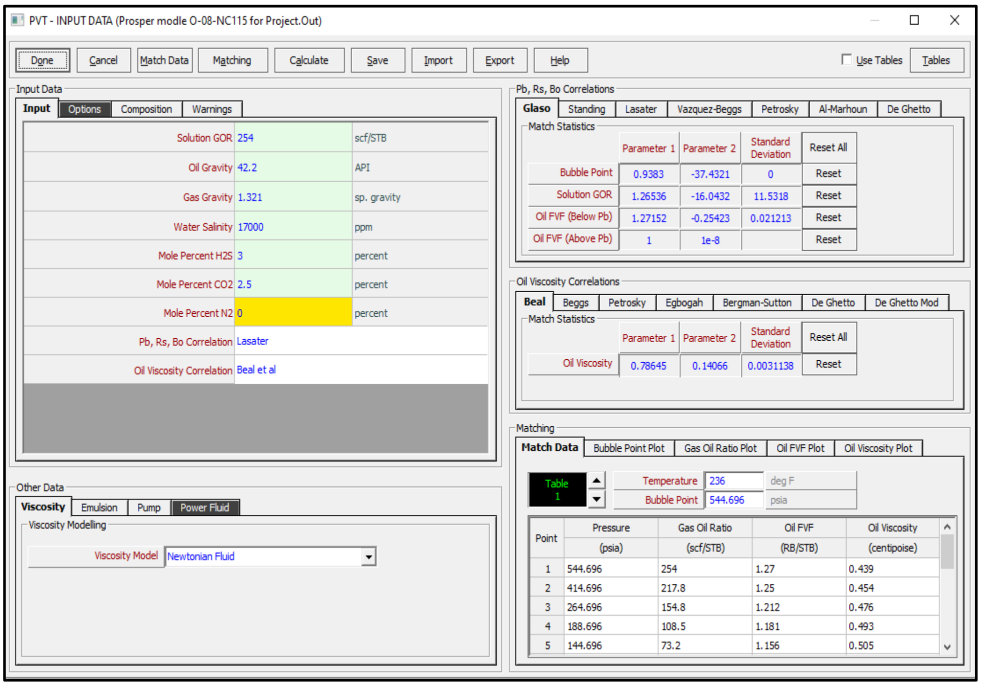


***Figure 6. PVT Input Data for O8-NC115 in PROSPER Software Model.***

Following the modal construction (refer to (Figure 7) for details on EQUIPMENT DATA), the ESP data will be incorporated as outlined in (Figure 8).

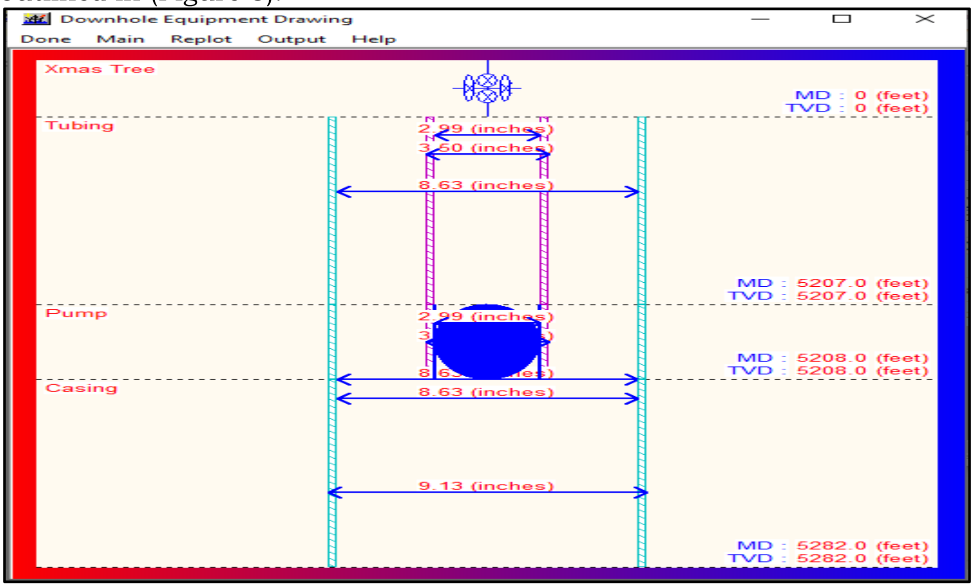


***Figure 7. Downhole Equipment Data for O8-NC115 Using PROSPER Software Model.***

***Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

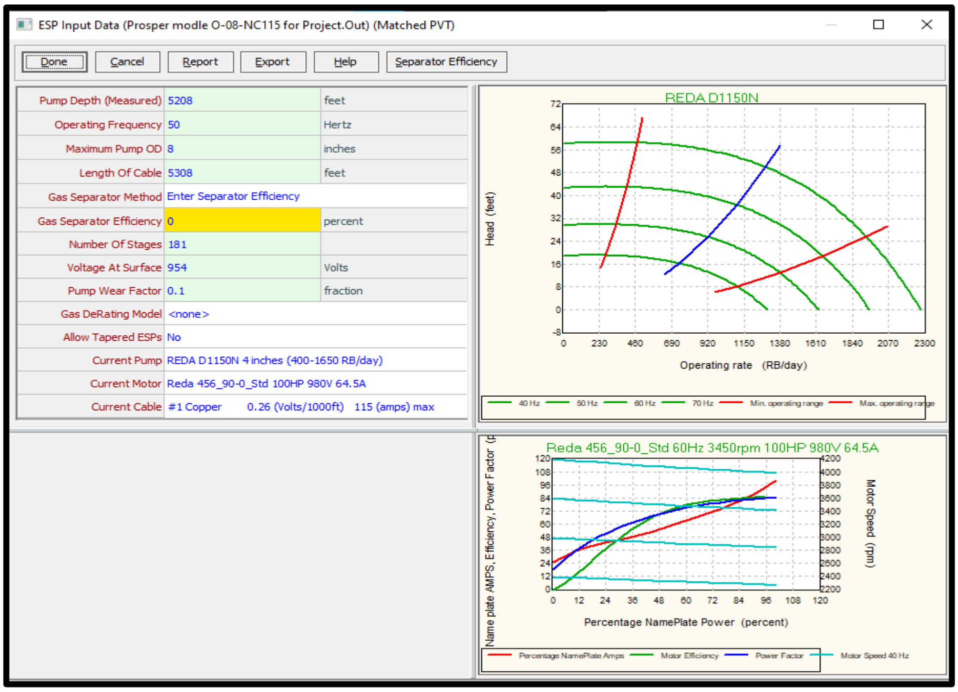


**Figure 8. ESP Input Data for O8-NC115 Using PROSPER Software Model.**

The next step involves processing the production data to facilitate modal execution. This will involve selecting the model with the highest correlation coefficient. Subsequently, IPR (Inflow Performance Relationship) curves will be generated using the Darcy method (Figure 9).

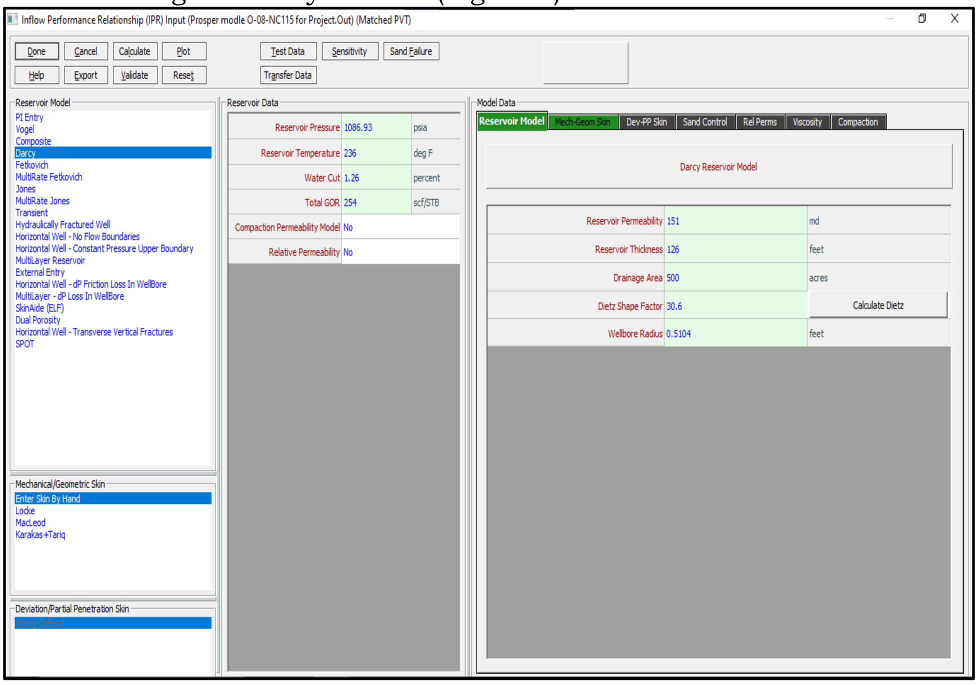


**Figure 9.Input Data by Darcy Method for O8-NC115 Using PROSPER Software Model.**

Inflow Performance Relationship (IPR) curves for the well were developed using Darcy's law, which describes steady-state, single-phase flow in a homogeneous reservoir. This approach provides a theoretical basis for estimating the relationship between bottomhole flowing pressure and production rate under idealized conditions. The resulting IPR curves, shown in Figure 10, illustrate the well's deliverability potential and serve as a key input for nodal analysis. By assuming laminar flow and constant permeability, Darcy-based IPR offers a simplified yet effective means of evaluating reservoir inflow performance, particularly for oil wells operating below the bubble point. These curves are essential for identifying optimal production rates and assessing the efficiency of stimulation treatments such as matrix acidizing.

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

https://doi.org/10.54361/ajmas.269223

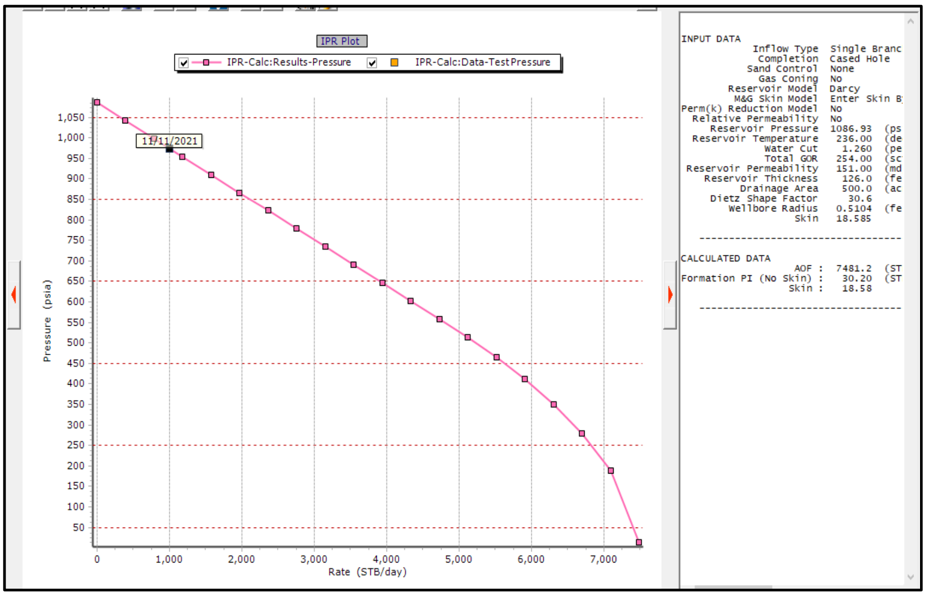


***Figure 10. Inflow Performance Relationship (IPR) Curve by Darcy Model for O8-NC115 Generated Using PROSPER Software Model.***

Following the data preprocessing stage, the PROSPER model workflow involves correlating software outputs with well failure data. This will be achieved by plotting the intersection between Inflow Performance Relationship (IPR) and Vertical Lift Performance (VLP) curves for the defined operating points of the wells presented in (Figures 11 and 12).

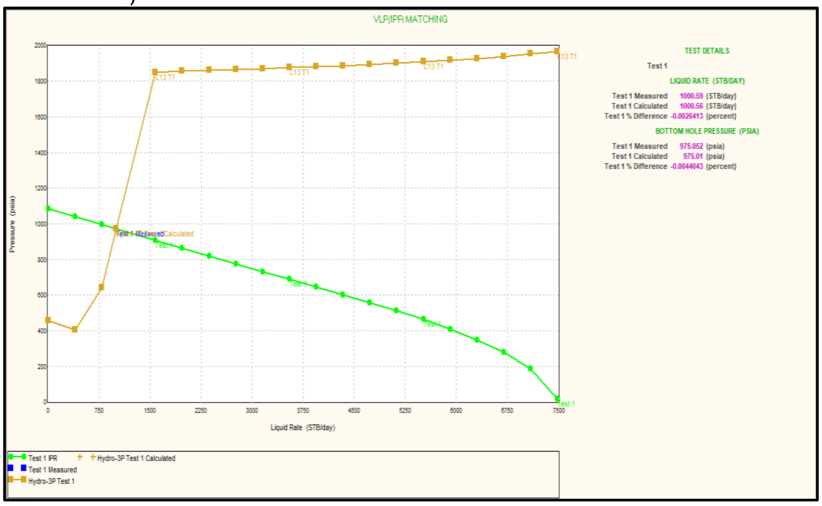


***Figure 11. IPR and VLP by Matching for O8-NC115 Using PROSPER Software Model.***

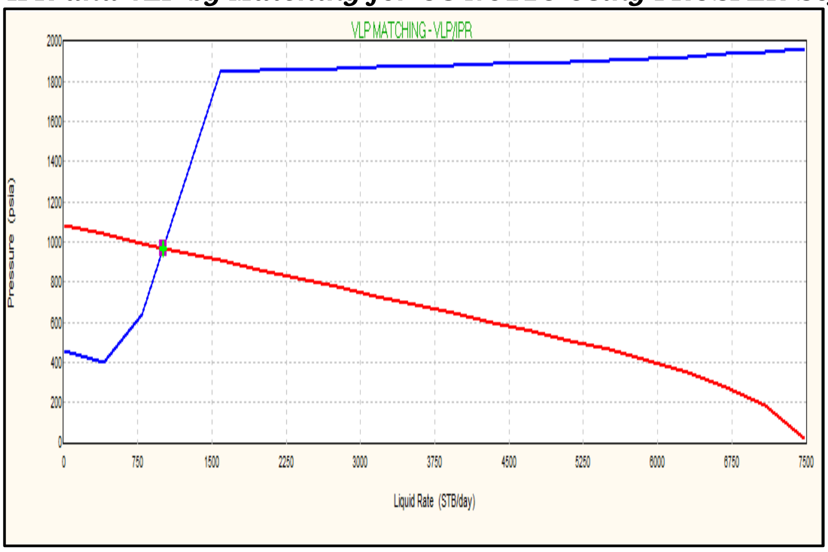


***Figure 12. IPR and VLP Intersection for O8-NC115 Using PROSPER Software Model.***

***Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026* 

Following the data reconciliation between field measurements and software outputs and the subsequent intersection of Inflow Performance Relationship (IPR) restrictions and VLP (likely Volumetric Liquid Product) data, key production parameters were identified within the resulting combined dataset. These parameters are summarized in **(**Figure 13).

| Label | Value | Units |
|---|---|---|
| Calculated Liquid Rate | 1000.56 | (STB/day) |
| Calculated Oil Rate | 987.956 | (STB/day) |
| Calculated Water Rate | 12.6071 | (STB/day) |
| Calculated Gas Rate | 0.25094 | (MMscf/day) |
| Calculated Bottom Hole Pressure | 975.01 | (psia) |
| Measured Liquid Rate | 1000.59 | (STB/day) |
| Measured Oil Rate | 987.983 | (STB/day) |
| Measured Water Rate | 12.6074 | (STB/day) |
| Measured Gas Rate | 0.25095 | (MMscf/day) |
| Measured Bottom Hole Pressure | 975.052 | (psia) |
| % Difference Liquid Rate | -0.0026413 | (percent) |
| % Difference Oil Rate | -0.0026441 | (percent) |
| % Difference Water Rate | -0.0026324 | (percent) |
| % Difference Gas Rate | -0.0026365 | (percent) |
| % Difference Bottom Hole Pressure | -0.0044043 | (percent) |

***Figure 13. Matching Between Measured Data and Calculated for O8-NC115 Using PROSPER Software Model.***

The calculated and measured values demonstrate exceptional agreement, with differences in all parameters less than 0.005%, indicating:

- High accuracy in multiphase flow modeling,
- Accurate representation of well hydraulics and artificial lift performance,
- Reliable integration of IPR and VLP curves.

This level of validation enhances confidence in using the model for production prediction, optimization, and future intervention planning in Block NC115 of the Sharara oil field.

***PIPESIM Model***

The following data will be used as initial inputs: deviation survey, heat transfer, tubulars, and downhole equipment. This data is sourced from the completion report presented; (Figures 14, 15, and 16) show the initial input data.

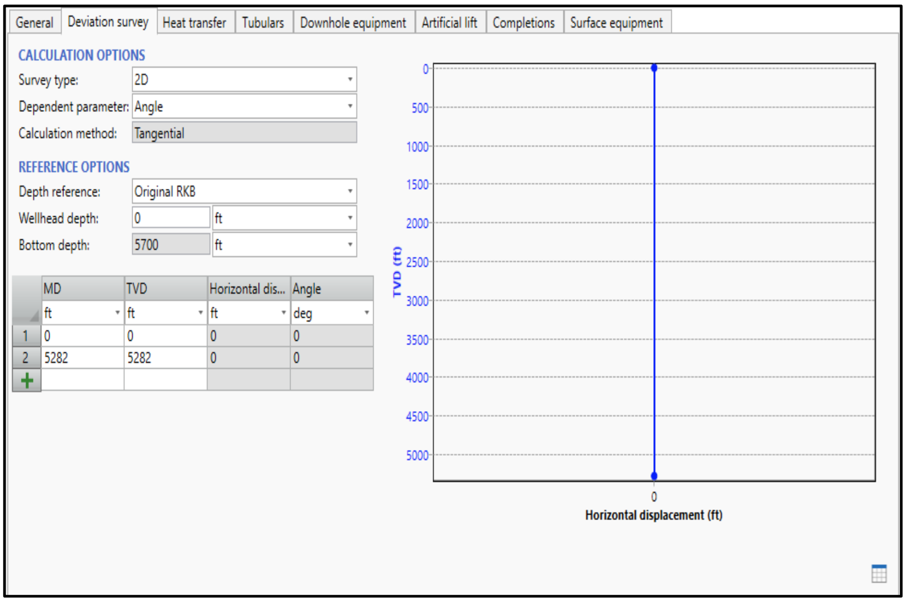


***Figure 14. Deviation Survey Data for O8-NC115 Using PIPESIM Software Model.***

**Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0
**Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026

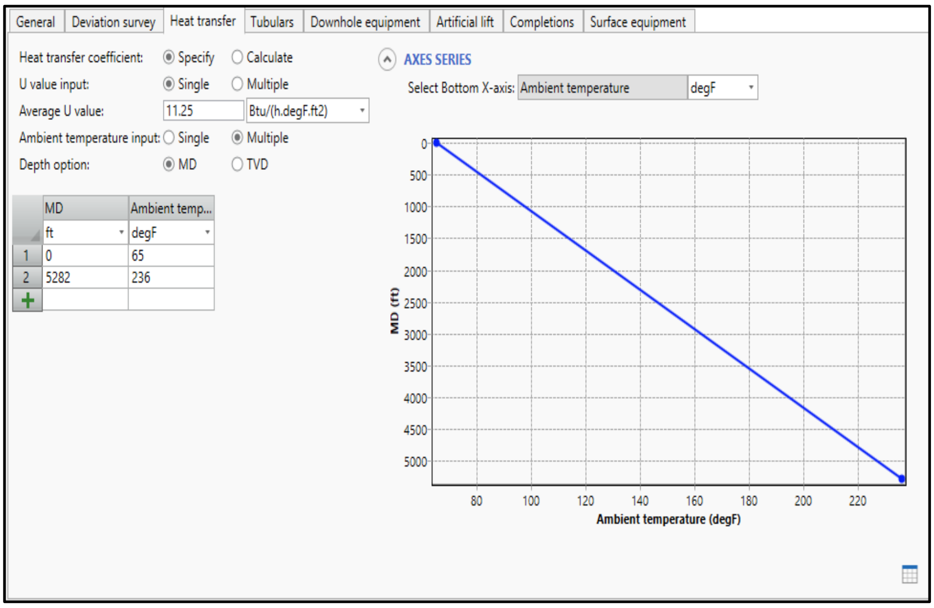


***Figure 15. Heat Transfer Input Data for O8-Nc115 Using PIPESIM Software Model.***

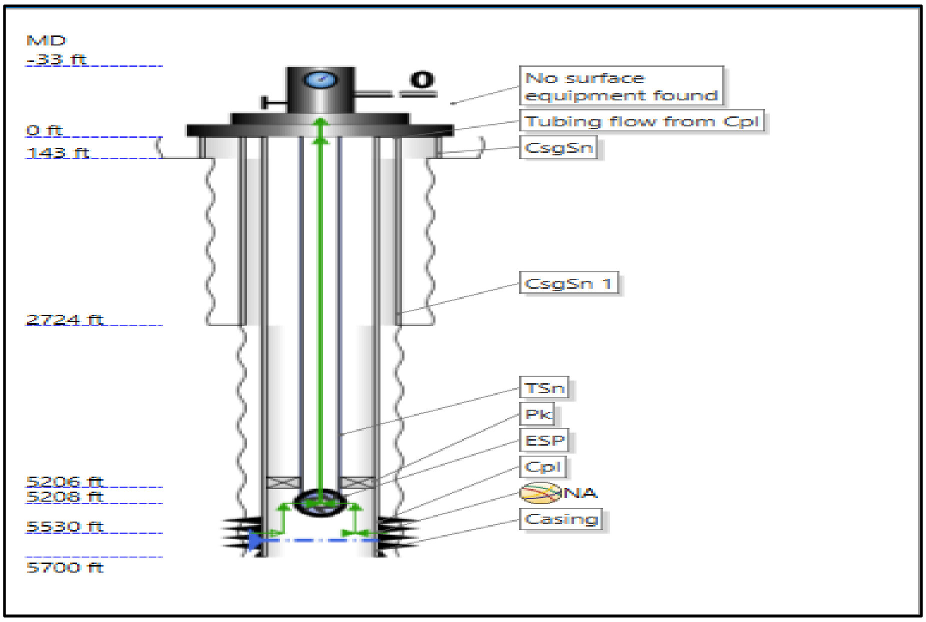


***Figure 16. Well Schematic for O8-NC115 Using PIPESIM Software Model.***

Following the ESP data entry depicted in (Figure 17), the next step involves the input of PVT data from the dedicated PVT report. These data are presented in (Figures 18 through 21).

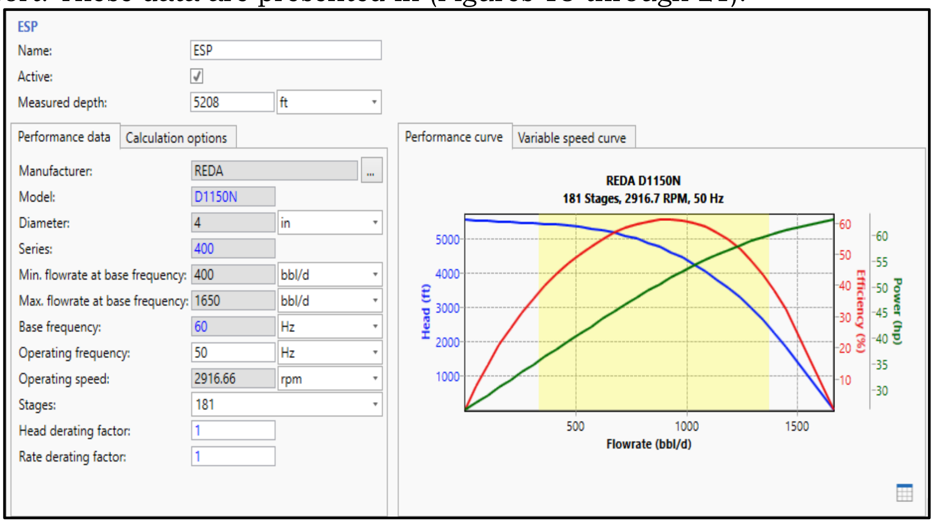


***Figure 17. ESP Input Data for O8-NC115 Using PIPESIM Software Model.***

**Copyright** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

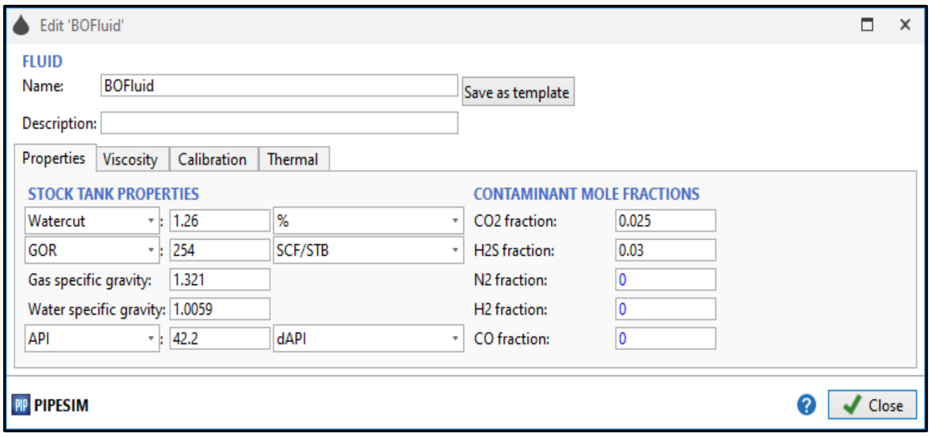


*Figure 18. Fluid Properties Input Data for O8-NC115 Using PIPESIM Software Model.*

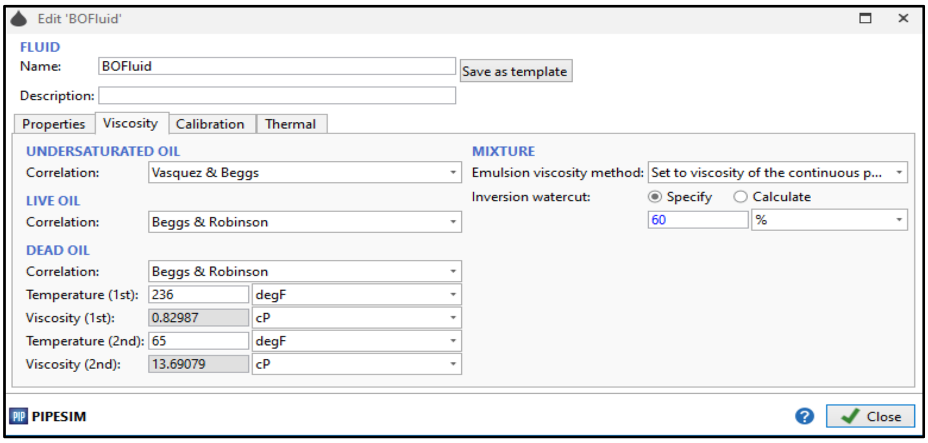


*Figure 19. Viscosity Data for O8-NC115 Using PIPESIM Software Model.*

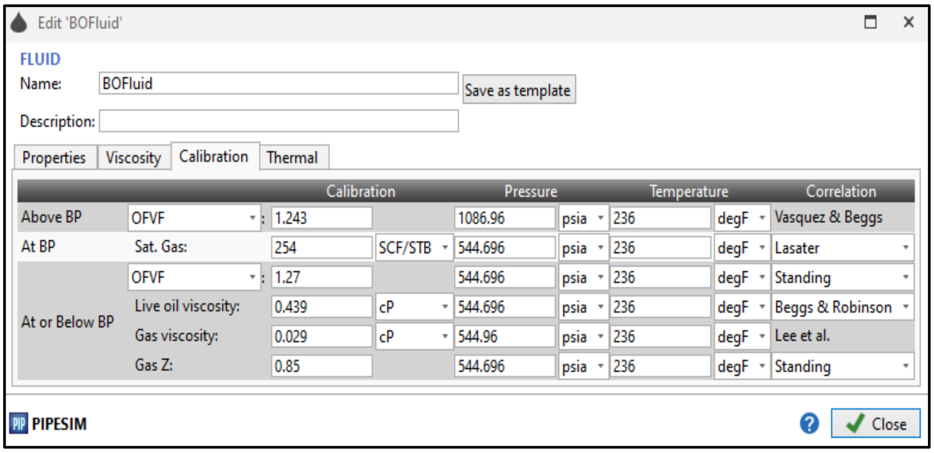


*Figure 20. Calibration Input Data for O8-NC115 Using PIPESIM Software Model.*

**Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0
**Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026

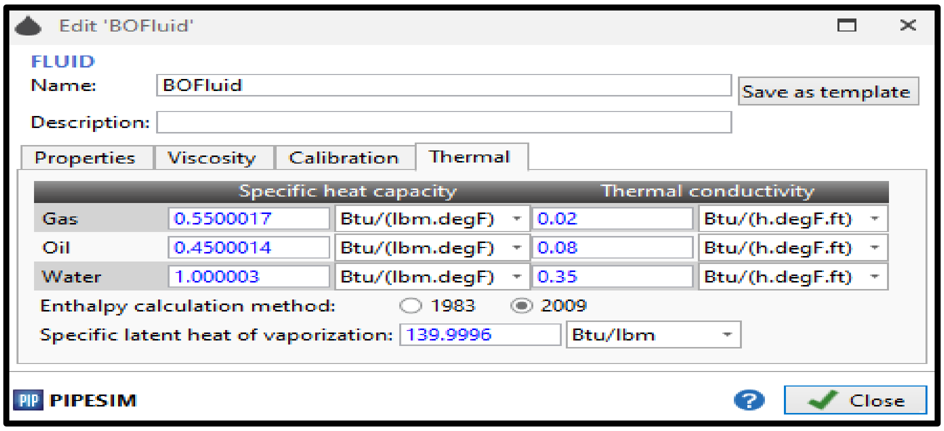


***Figure 21. Thermal Data for O8-NC115 Using PIPESIM Software Model.***

The next step involves processing the production data to facilitate modal execution. The model with the highest correlation coefficient will be selected for further analysis. Subsequently, Inflow Performance Relationship (IPR) will be generated using the Darcy method (Figure 22).

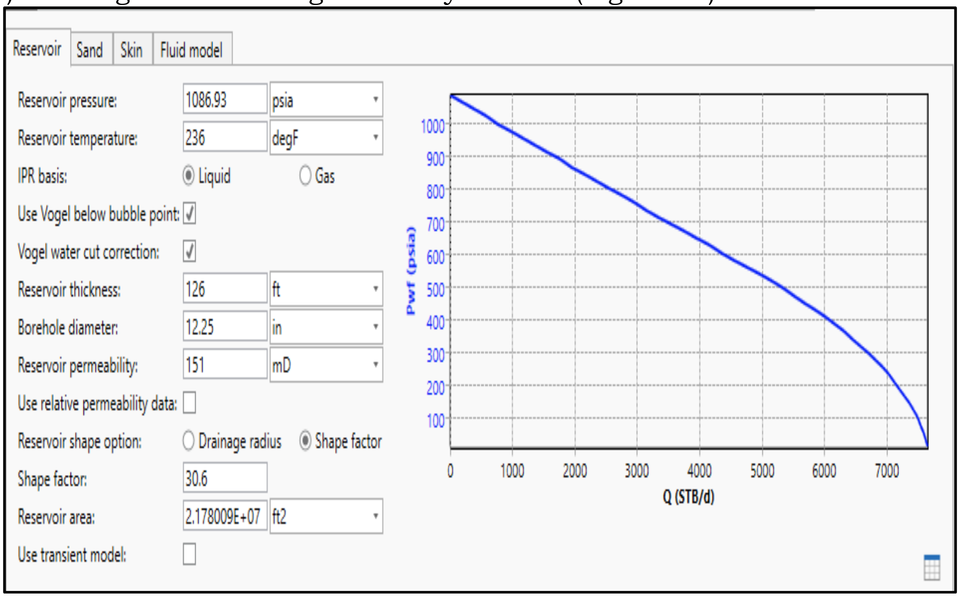


***Figure 22. IPR Input Data by Darcy Method for O8-NC115 Using PIPESIM Software Model.***

Following the modal analysis and the generation of the Inflow Performance Relationship (IPR) curve, (Figure 23) depicts the intersection point between the IPR and the Vertical Lift Performance (VLP).

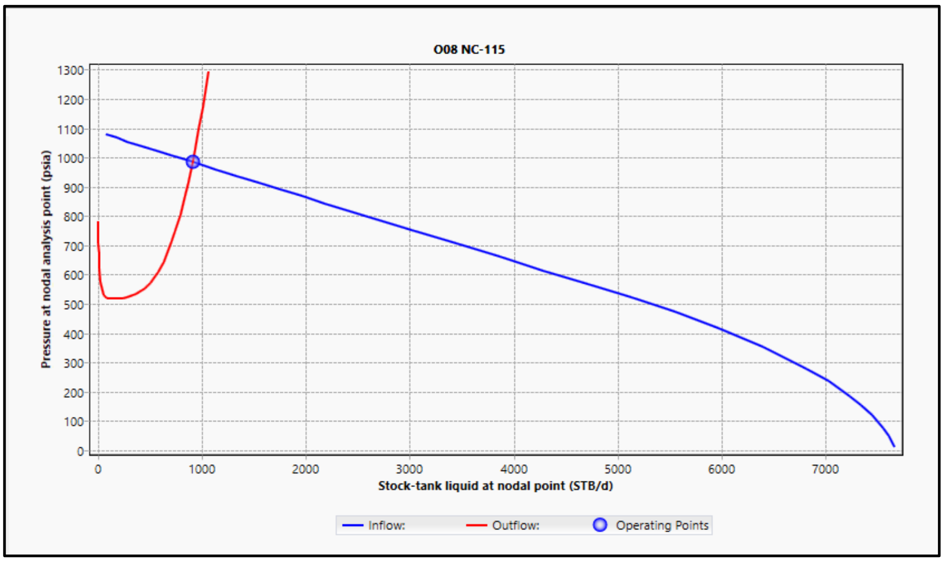


***Figure 23. IPR and VLP Intersection for O8-NC115 Using PIPESIM Software Model.***

***Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

The intersection of the Inflow Performance Relationship (IPR) and Vertical Lift Performance (VLP) curves in the PIPESIM model demonstrates a high degree of consistency in model calibration with the PROSPER model. This strong agreement in representing the actual production condition of the well confirms the reliability of input data, robustness of the modeling approach, and accurate implementation of physical models in PROSPER and PIPESIM.
Following an analysis of the data inputs and outputs of various production optimization software programs, the key findings are summarized in (Table 3).

***Table 3. Compare the Main Parameter Result Between the Integrated Analytical Equations and Production Software for O8-NC115.***

| **parameter** | **Value in O8-NC115** | | | **Unit** |
|---|---|---|---|---|
| **Type of Model** | **Equations Model** | **PROSPER Model** | **PIPESIM Model** | |
| Pr | 1086 | 1086.95 | 1086.95 | Psia |
| $P_{wf\ opt}$ | 975.01 | 975.052 | 975.1 | psia |
| $Q_{opt}$ | 1000.56 | 1000.59 | 998.12 | STB/D |
| $Q_{o\ opt}$ | 987.55 | 987.58 | 985.14 | STB/D |
| PI | 8.90 | 8.83 | 8.81 | STB/D/psi |

To evaluate model consistency, the average PI from the three simulators was calculated:

$$\boldsymbol{PI_{avg}} = \frac{\mathbf{8.83 + 8.81}}{\mathbf{3}} = \mathbf{8.82\ STB/D/psi}$$

Next, the relative deviation between the reference analytical result (Excel: PI = 8.90) and the simulator average was computed:

$$Relative\ Deviation = \frac{8.90\ - 8.82}{8.90} \times 100\% = \mathbf{0.81}\%$$

This minimal deviation (less than 1%) confirms excellent agreement between analytical and simulation-based methods. The close alignment across independent tools validates the robustness of the PI estimation and underscores the effectiveness of a multi-software cross-validation strategy. This integrated approach enhances confidence in performance evaluation, particularly in data-limited scenarios, and provides a reliable benchmark for assessing the success of stimulation treatments.
This low deviation confirms strong agreement among the models and validates the robustness of the integrated approach. Reasons for High Consistency:

1. Integrated Physics: Production models use a more comprehensive physics-based approach, incorporating actual production rates, wellbore hydraulics, and PVT data.
2. Robustness to Gauge Issues: While they use Pwf, the nodal analysis.
3. Calibration: The models can be calibrated to actual production data, increasing their reliability.

Crucially, while each method operates on distinct theoretical foundations and computational assumptions, all three yielded remarkably consistent estimates of the Productivity Index. The close alignment between software-generated results and the manually derived PI underscores the importance of accurate input parameters, proper model calibration, and the value of redundancy in technical evaluation. By combining computational power with analytical transparency, this methodology establishes a reproducible framework for evaluating stimulation success in challenging operational environments, setting a precedent for more resilient and defensible decision-making in reservoir management.

## Conclusions

Matrix acidizing treatment successfully restored production in the long-shut-in Well O08 (NC115), El-Sharara Oil Field, increasing output from zero to approximately 1,000 STB/D—demonstrating effective removal of near-wellbore damage and improved formation permeability. This success was supported by an integrated analytical framework that enabled reliable performance evaluation despite limited historical data, highlighting a best-practice approach for stimulation assessment in mature or data-constrained fields. Post-treatment pressure buildup and production data were analyzed using Integrated Analytical Equations and Production System Analysis (PSA) via multiphysics modeling in two industry-standard software platforms: PROSPER and PIPESIM. Results showed exceptional consistency: the analytical PI was 8.90 STB/D/psi, while the software-derived PIs were 8.83 and 8.81 STB/D/psi, averaging 8.82 STB/D/psi. The deviation from the analytical result was less than 0.80%, confirming high model fidelity and consistent implementation of Darcy-based flow equations. This multi-disciplinary approach—combining field data, first-principles calculations, and cross-platform simulation—transforms uncertainty into confidence by identifying a consensus solution across independent methods. It mitigates the risk of bias from relying on a single tool and underscores that reliability in engineering analysis arises from convergence. In complex, data-scarce environments like El-Sharara, such integration is essential. The study proves that rigorous, physics-based modeling can deliver accurate, actionable insights, enabling informed decisions in well

***Copyright** Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*

intervention, production optimization, and field redevelopment—even with minimal dynamic data.

***Acknowledgments***
The authors gratefully acknowledge Akakus Oil Company for supporting this work and thank the reservoir and production teams for their technical expertise, data access, and continuous support throughout the well evaluation and stimulation project in the El-Sharara Field.

***Conflicts of Interest:*** Nil.

## References

1. Ješić M, Martinović B, Stančić S, Crnogorac M, Danilović D. Mitigating hydrate formation in onshore gas wells: a case study on optimization techniques and prevention. 2023.
2. Jahanbani, A., & Shadizadeh, S. R. Determination of inflow performance relationship (ipr) by well testing. In *PETSOC Canadian International Petroleum Conference* (pp. PETSOC-2009). PETSOC. (2009, June)
3. Ahmed TH, Meehan DN. Advanced reservoir management and engineering. Gulf Professional Pub; 2012.
4. Ahmed TH. Reservoir engineering handbook. 4th ed. Gulf Professional Publishing; 2010.
5. Sun J, Li Y, Shi W, Li H, Wang J, Li J, et al. Formation damage mechanism and control strategy of the compound function of drilling fluid and fracturing fluid in shale reservoirs. Pet Explor Dev. 2024 Apr;51(2):430-9. DOI: 10.1016/S1876-3804(24)60034-0
6. Mascarenhas E, Pessoa OA. Software for evaluating IPR composite in grouped subsaturated reservoirs. 2018.
7. Abousif A, Abdullah M, Albaghdady AA, Ghnia S. Facies analysis of Middle Ordovician Hawaz Formation and the major effect of the ichnofacies on the reservoir quality, an example from the NC115 block in Murzuq Basin, Southwestern Libya. Int J Sci Res (IJSR). 2023 Oct;12(10):952-62. DOI: 10.21275/SR23926184656
8. Sallam S, Ahmad MM, Nasr M. Development of predictive production model for increasing productivity of oil wells. 2014. DOI: 10.13140/RG.2.1.2761.6807
9. Hlal MSO, Naas S, Sultan M. Petrophysical properties of Hawaz Formation- Middle Ordovician, in O-Oil Field, Block-NC115, Murzuq Basin, SW Libya. Libyan J Eng Sci Technol. 2022;2(2).
10. Selim ESI, Kamel A, Kashlaf A. Hydrocarbon probability of Middle Ordovician Hawaz Formation, Murzuq Basin, Southwestern Libya. Arab J Geosci. 2015 Aug;8(8):5531-60. DOI: 10.1007/s12517-014-1633-2
11. Hamoud M. Reservoir simulation study of Libya's O-Field NC-115 in Murzuq Basin. 2021.
12. Aryan R, Shelly B. PROSPER software for gas lift system design and simulation. Int J Res Publ Rev. 2023 Aug;4(8):2874-84. DOI: 10.55248/gengpi.4.823.51837
13. Schlumberger. PIPESIM 2017 steady-state multiphase flow simulator technical reference January 2018. 2020.
14. Zhu J, Zhang HQ. A review of experiments and modeling of gas-liquid flow in electrical submersible pumps. Energies. 2018;11(1). DOI: 10.3390/en11010180
15. Ilk D, Camacho-Velázquez R, Blasingame TA. Inflow performance relationship (IPR) for solution gas-drive reservoirs analytical considerations. In: Proceedings of the SPE Annual Technical Conference and Exhibition; 2007. p. 3845-53. DOI: 10.2118/110821-MS
16. Alakbari FS, Ayoub MA, Awad MA, Ganat T, Mohyaldinn ME, Mahmood SM. A robust pressure drop prediction model in vertical multiphase flow: a machine learning approach. Sci Rep. 2025 Dec;15(1). DOI: 10.1038/s41598-025-96371-2
17. Duru UI, Nwanwe O, Nwanwe CC, Arinkoola AO. Evaluating lift systems for oil wells using integrated production modeling: a case study of a Niger Delta field. J Pet Explor Prod Technol. 2021;11(3). DOI: 10.37591/jopet.v11i3.6057

***Copyright*** *Author (s) 2026. Distributed under Creative Commons CC-BY 4.0*
***Received**: 06-12-2025 - **Accepted**: 10-02-2026 - **Published**: 18-02-2026*