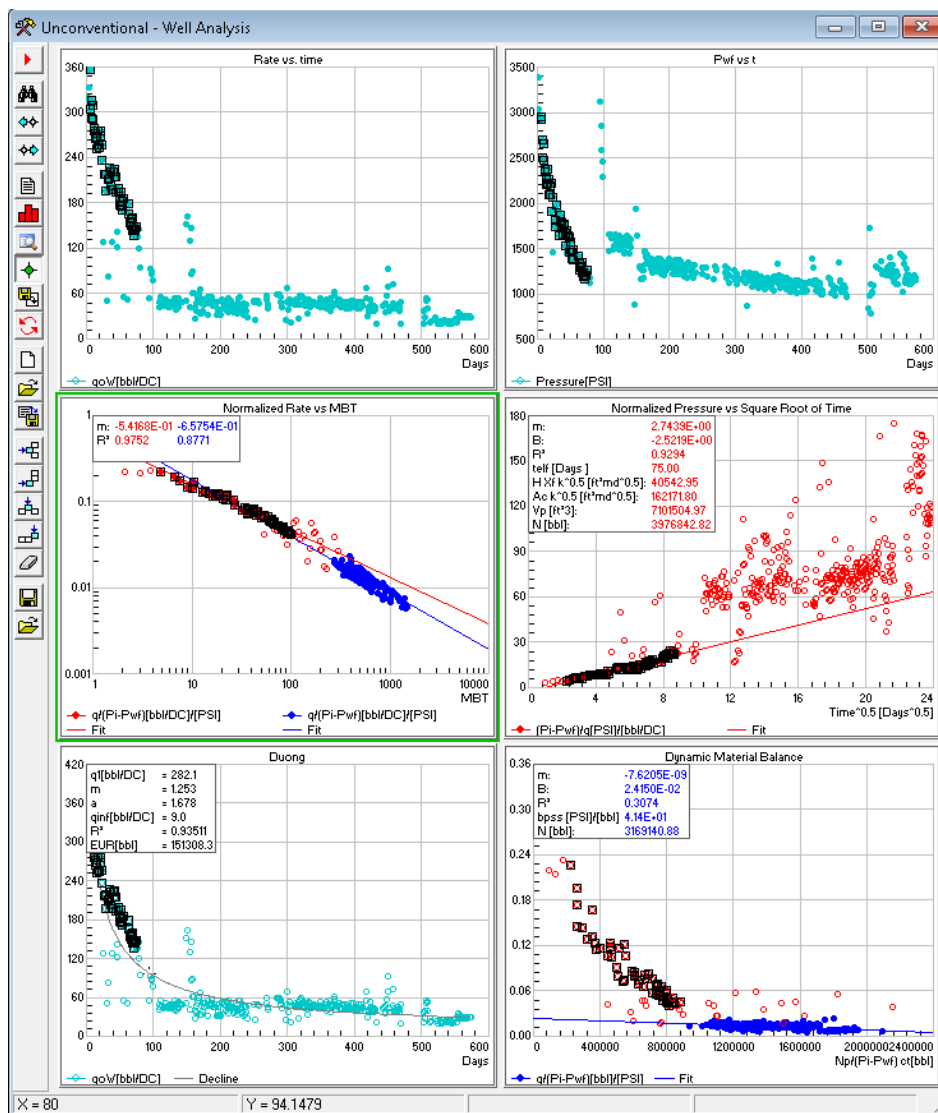


UNCONVENTIONAL RESOURCES ANALYSIS

Sahara Unconventional is a complete suite of tools and methodologies specifically designed to analyze unconventional resources data. Data analysis is available at individual well level or well group level.

The Well Analysis window enables the user to define different workflows through production data visualization and diagnostic plots, specialized rate transient analysis (RTA) and decline curve analysis (DCA) for unconventional resources.

The Group Analysis window allows performing analogue well analysis and identifying the behavior of a new well within a group, running Monte Carlo simulations to obtain statistical forecasts, applying statistical analysis tools, and comparing different methodologies to obtain type wells.



Easily define different workflows to standardize your work.

Sahara

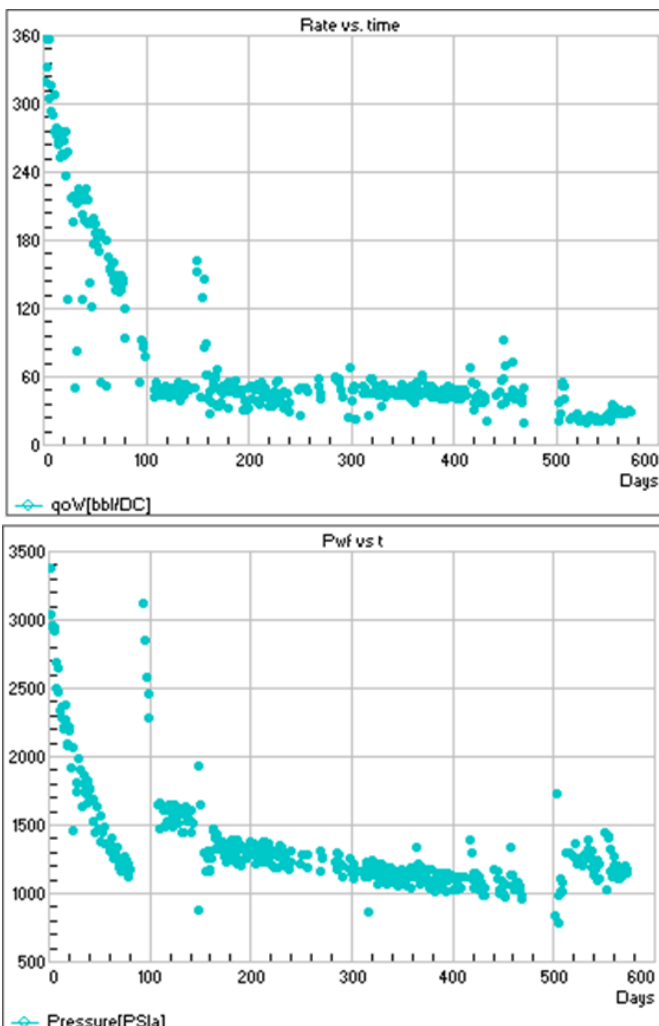
Visualization and preprocessing of the production data is crucial to achieve good results from rate transient analysis and decline curve analysis. Sahara Unconventional provides an integrated visualization of historical production data, easy detection and removal of outliers, and helps identify the behavior of wells and evaluate the impact of data in each chart at a glance.

For this purpose, the Well Analysis window has a set of charts divided into three categories that can be combined in order to generate different display panels for data visualization and analysis.

Each chart configuration can be saved as a template to be accessed later or used in a different project. The three charts categories are listed below:

- **General:** These charts are used for raw data visualization, identification of well production behavior, correlation variables and as diagnostic plots.

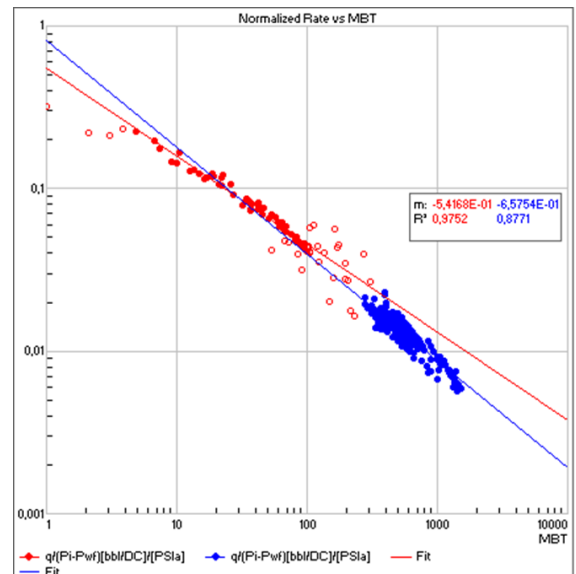
The Statistical Analysis tool can be accessed from the toolbar in order to generate a histogram for production data. This window can be useful to identify anomalous values or outliers and to calculate statistical measures.



General Charts: Rates and pressure daily production history for a typical unconventional well.

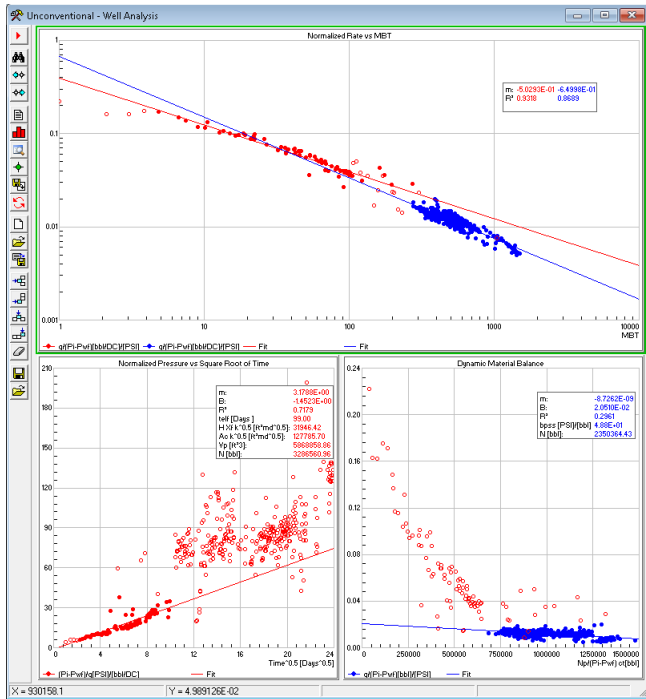
- **RTA (Rate Transient Analysis):** A complete Rate Transient Analysis for unconventional oil or gas wells will provide valuable information of the reservoir. This kind of analysis can help to construct a reservoir model and/or obtain initial values to perform analytical or numerical modeling. Different diagnostic plots are available to identify the different flow regimes, obtain values to characterize the reservoir system and estimate the SRV (stimulated reservoir volume). Specialized charts have been developed for each of these purposes:

- Normalized Rate vs. Time plots: These charts are used to identify production data points under different flow regimes (bilinear, linear or boundary dominated). The corresponding points can be selected to perform a linear regression using a rectangle, a polygon or editing the points manually. These points can be later highlighted in all the other charts so they can be used according to the corresponding model. The proper identification of the production data points flowing under the different flow regimes is critical to perform a good Rate Transient Analysis



RTA Diagnostic Charts: Identification of the points corresponding to different flow regimes in the Normalized Rate vs MBT diagnostic plot.

- Normalized pressure vs. Square Root of Time plots: These are the specialized charts for linear flow. A linear regression of the points under linear flow provides the parameters that characterize the reservoir zone with linear flow behavior: A_c (cross sectional area), $HXfK^{0.5}$ (linear flow parameter), T_{elf} (time of end of linear flow), X_f (fracture half length), Y_e (distance of investigation), A_d (drainage area), VP (pore volume), $OOIP/GOIP$ (original oil or gas in place).



RTA Charts. Identification and characterization of the linear and boundary flow regimes performed in Sahara Unconventional.

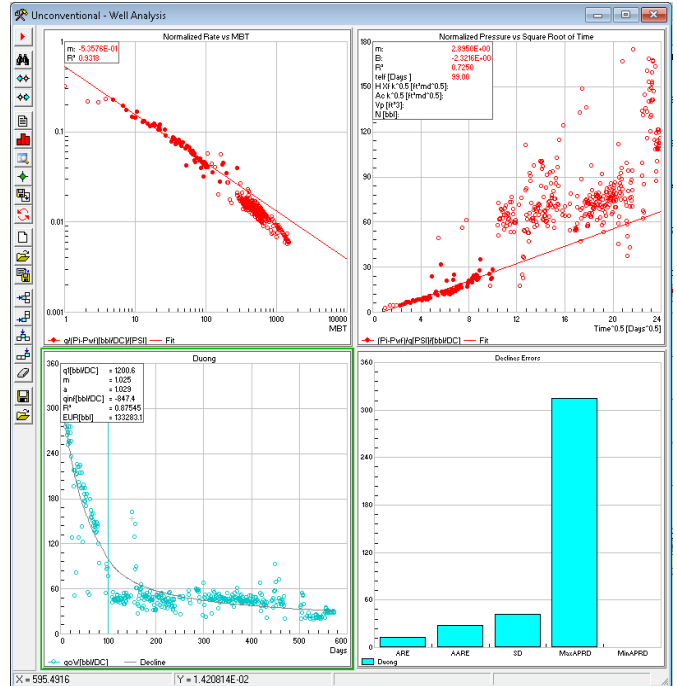
iii. Dynamic Material Balance plot: This chart is used to obtain an estimated value of OOIP or OGIP associated with the SRV from the linear regression of points under boundary dominated flow.

RTA graphics allow the user to perform up to three simultaneous linear regressions per chart. Furthermore, selected points in an active regression can be highlighted in all the other charts of the template by clicking on the "Display Selected Points" button on the toolbar.

• **Declines:** Decline Curve Analysis (DCA) provides a quick way for forecasting production and estimating ultimate recovery (EUR). Methodologies available for DCA include the following methods for unconventional wells:

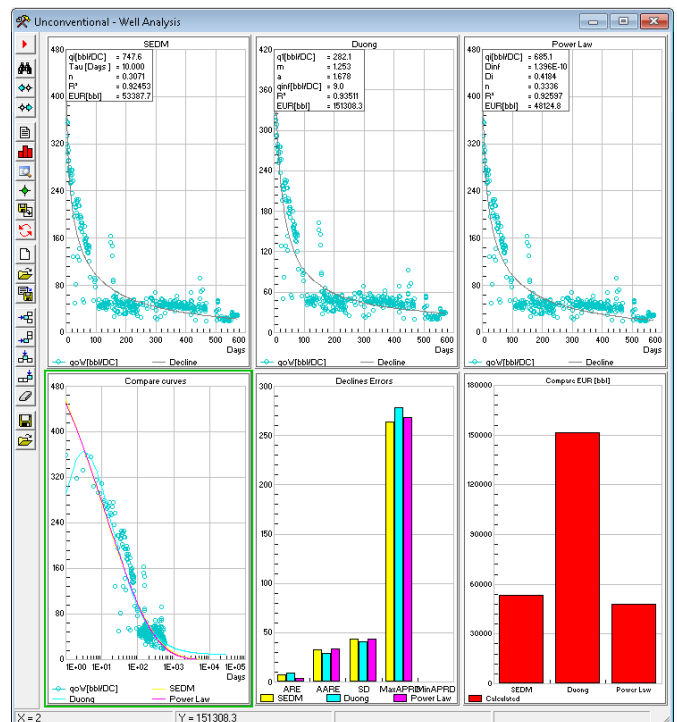
- Hyperbolic ($b > 1$)
- SEDM
- Duong
- Power Law

These models can be used as hybrid decline methods combining the models developed for linear flow with Arps traditional models, when boundary dominated flow has been reached. A time of end of linear flow (Telf) is obtained by RTA or production diagnostic plots. Based on that time, a hyperbolic model is used with a user defined "b" parameter. In addition, it is possible to switch to an exponential decline in the forecast period at a selected decline rate (Dswitch).



Well Analysis window: DCA hybrid analysis using Duong model for linear flow and hyperbolic decline from a Telf defined by RTA.

Sahara Unconventional has a set of charts to perform a complete comparative study of the available methodologies allowing measuring the quality fit in the history matching and comparing EUR for different methodologies. It is also possible to set economic limits in terms of dates or minimum rates, and save a forecast for each methodology in order to be visualized in other Sahara tools, such as the Productions window.



Decline Charts. Comparison for the daily history matching of an unconventional oil well using different methodologies. The last three plots allow quantifying the quality of the fit and making a comparison for the different obtained EUR.

Sahara Unconventional allows obtaining an integrated analysis of historical production data by defining a workflow that can be applied to any well inside a project or multiple projects. It also allows comparing results obtained from different methodologies.

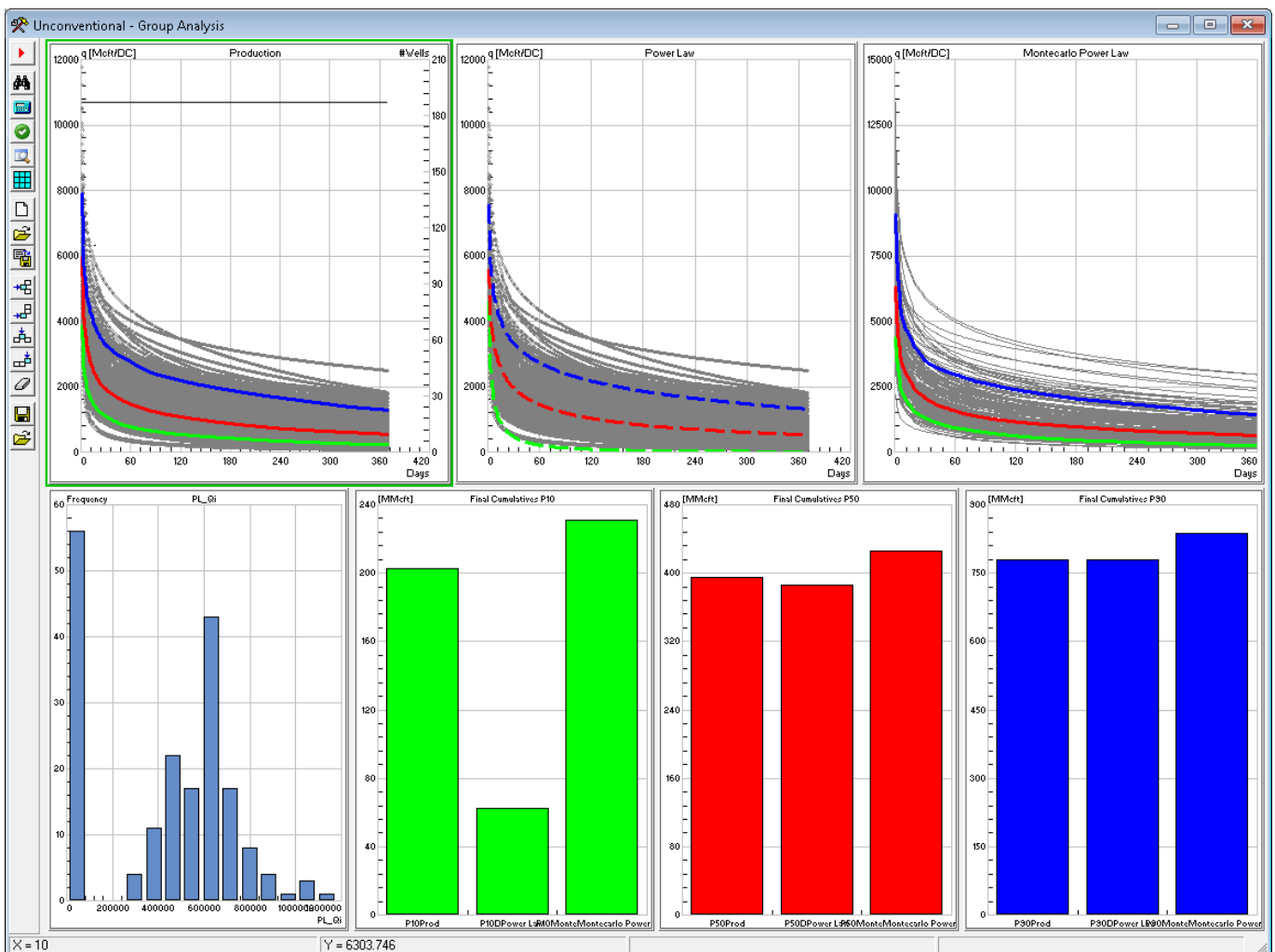
The Group Analysis window allows performing DCA analysis for a group of unconventional wells and calculating the statistical wells from production data.

For each decline model, it is possible to calculate and decline the curves for each well individually or the statistical wells (average, P10, P50, P90). By selecting a single well inside a group, the user can study its behavior within the group. The results from the different methodologies can be compared, and the fitted parameters for each model can be visualized. These parameters can be saved to be later displayed in the Map Window or analyzed in the Statistical Analysis Tool.

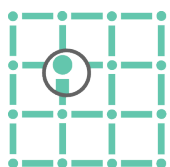
Monte Carlo simulations can be run for any of the available DCA methods in order to get statistical forecasts. This methodology requires a probability distribution assigned for each of the DCA parameters. Statistical analysis tools are available for this purpose.

DCA and Monte Carlo charts allow saving the regression results as type wells. These type wells can be used later in the Forecast Exercises window.

The Group Analysis window also allows visualizing histograms for any variable of the project considered of interest. Furthermore, the Control Panel window can be accessed from the toolbar in order to configure different visualization templates for the studied group of wells.



Group Analysis Window. Comparison of the different statistic wells for Power Law and Monte Carlo Power Law decline models.



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