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Better Software Improves Well Design

By Metin Gokdemir
and Greg Stephenson

HOUSTON–For as long as there have been desktop computers, petroleum engineers have used production system analysis software to help them make better decisions. Now a tremendous technology shift has led the demand for enhanced software capabilities that help operators improve front-end well design for better completions and productivity.

Today's strides in improved nodal analysis are geared toward two trends. The first is demand from engineers for tools that are easy to use and have broader functionality. The second is the need for easy-to-integrate petroleum engineering software solutions that help promote a more connected workplace. Anticipating both trends, service companies are delivering re-energized products that offer a wide range of capabilities and virtually limitless potential.

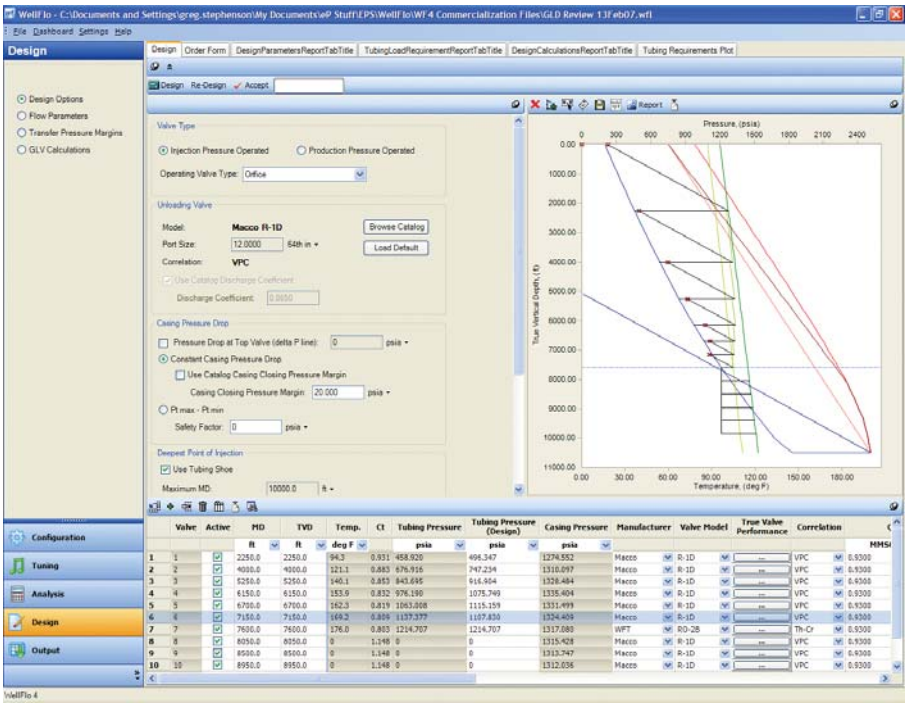
Nodal analysis software, which has been an industry staple for analyzing and modeling well production systems, enables users to match the inflow performance capabilities of a reservoir with the outflow performance characteristics of a well bore. A proprietary software system has helped operators perform rigorous modeling, resulting in optimized capital expenditures through enhanced design of wells and completions. In addition, the software has reduced operating expenditures by finding and curing production problems, and has increased revenues by improving well performance.

Nodal Analysis

Using nodal analysis, a production engineer can examine an entire production system for a range of flow conditions and a variety of "what-if" scenarios. At the well or field planning stage–when reservoir information is incomplete if not unavailable–such an analysis helps develop an optimum completion and surface infrastructure that can serve over a longer time-horizon. And once a well is in production, such an analysis is useful in identifying bottlenecks in the system as additional reservoir data become available.

Previous nodal analysis platforms were built on legacy software systems that relied heavily on technologies that did not deliver the functionality and sophistication available today. In many cases, an unfriendly graphic environment combined with design limitations and the inability to connect with other enterprise data hindered performance and efficiency. In essence, older platforms gradually became obsolete as new technologies evolved.

New capabilities promote greater "extensibility," meaning that companies can connect to other applications and simply do much more complex engineering design work than ever before. One of the greatest advantages is that the industry now has access to a level of analysis that seemed practically impossible a decade ago.



Improved nodal analysis software enables users to examine key well performance parameters and use them to design artificial lift systems that are best suited to a well's production characteristics.

There are a variety of issues to be addressed when a production engineer completes a well. These include the need to understand:

- If and when the well will need artificial lift;
- How to optimize the artificial lift system;
- How to optimize the completion (i.e., Do we have the best tubulars, perforations, sand control, etc. for the conditions?);
- How the inflow performance (i.e., Is the well a candidate for stimulation?) may be improved;
- When a gas well may load up; and
- When the interval should be abandoned and plugged back to a different zone.

Well performance is the area of petroleum engineering that concerns itself with finding answers to each of these questions. And nodal analysis software is the primary tool that production engineers use to evaluate performance as wells progress through their early production surges to their rate plateaus and declines, and as enhanced recovery measures such as artificial lift, stimulation, waterfloods and steam injection are implemented or contemplated.

Enhanced Workflow Efficiency

At the request of users, the new nodal analysis software has been upgraded to deliver a more robust application that enables more dynamic, workflow-based engineering design and analysis. Such feedback provides valuable insight about the role of nodal analysis tools and technologies in today's rapidly evolving petroleum-engineering environment. More important, it helps the industry better understand the impact of nodal analysis software on managing well performance and how lessons learned can be applied under a variety of operating conditions to achieve the best results.

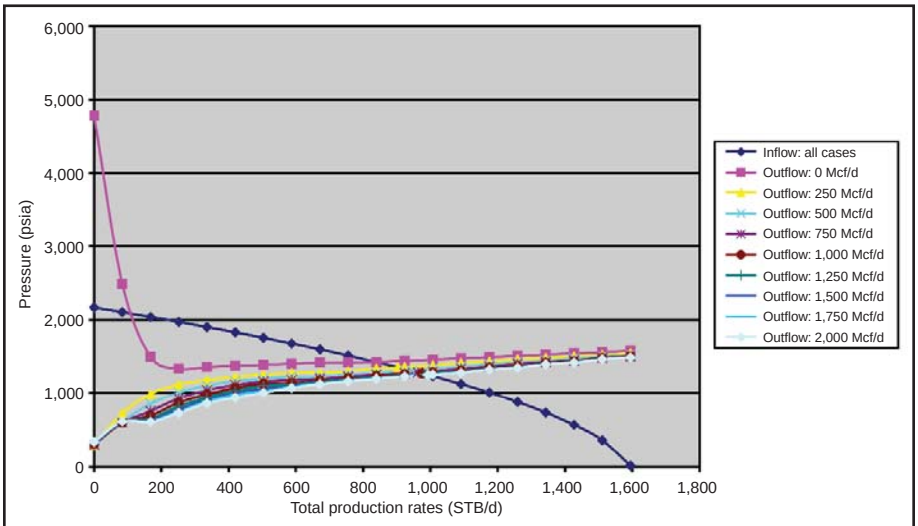
Engineers from major operating and service companies across the industry that used nodal analysis software on a daily basis to perform a wide variety of tasks were surveyed. The result was identifying five key user tasks that mimic the way engineers naturally work when using the application. These habits were used to enhance a new workflow-based software design. The five user tasks are:

- Configuration–model setup;
- Tuning–model data matching;
- Analysis–engineering problem solving;
- Design–artificial-lift system design location; and
- Output–analysis results, document management.

The configuration stage is where the user sets up the engineering design model itself. From the tuning stage, the model is matched with specific data. This ensures the most accurate modeling for a specific set of circumstances.

Data used in solving specific engineering problems come into play during analysis. And at the design stage, the artificial lift system, natural flowing well, or other type of engineering project is developed.

However, among the five key user tasks identified, the output feature surfaced as one of the most popular tools because it enhanced workflow efficiencies and facilitated storage of results–a feature that was not available with previous versions of this type of software.



Inflow/outflow curves such as this one generated by nodal analysis software help engineers understand how a well will perform under a given set of conditions.

System Upgrades

With earlier versions of nodal analysis software, output only existed for as long as it was visible on the user's computer screen. As soon as the program was closed or the user navigated away from that window, the data were gone forever, and that was a major challenge. To retain the data, the user had to either print it or capture a screen shot and paste the captured image into some other application.

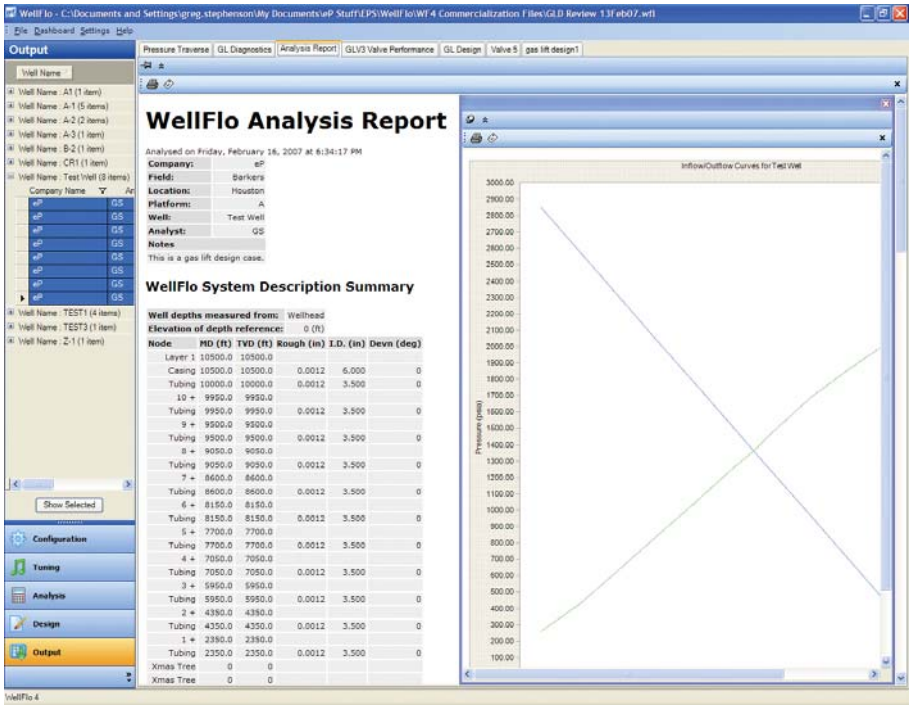
But a capability upgrade to the new system eliminates the need for users to take such archaic steps. Now users can save any chart or report generated during analysis and recall it from any well model at any time. This has proven to be a tremendous enhancement.

In addition, the nonintuitive and complicated user interfaces found in traditional nodal analysis software typically require a substantial learning curve. A user-friendly interface is much more reflective of how engineers work, potentially reducing the learning curve to a few hours.

These kinds of improvements enable engineers to focus more on the tasks they want to perform rather than on how their software is working in the background. Intuitive workflow-based navigation, wizard-based functions for manipulating data similar to those found in Microsoft® products, and improved charting capabilities distinguish this new nodal analysis software from those available in the past.

Typical applications for nodal analysis software systems include naturally flowing wells, gas lift design and optimization, and electric submersible pump design and implementation.

In naturally flowing wells, the software allows approximate modeling when only limited aspects of a well can be entered, such as local reservoir pressure. With gas lift design and optimization, multiple gas lift valves can be modeled because the nodal analysis software is supplied with all the standard gas lift calculations. Finally, electric submersible pump design and implementation also can be modeled using nodal analysis software tools. They are in wide use by ma-



The output function of the improved nodal analysis software provides users with a document management system that enables them to save the results of any analysis and easily call them back for future reference.

jor operators and pump suppliers in designing and diagnosing installations.

Increased Collaboration

A beneficial byproduct of redesigning nodal analysis software has been unearthing new collaboration opportunities within the service provider organization.

For example, discussions about these nodal analysis software enhancements revealed that the developer's gas lift group had a pressing need for improved design and analysis tools with many customized, home-grown design functions that it already was using to some degree, but simply could not be found anywhere else.

So the company's production optimization group worked closely with its gas lift team to develop specifications based on these needs for a new design and analysis module within the software system, which provided a major upgrade from the module the team had been using.

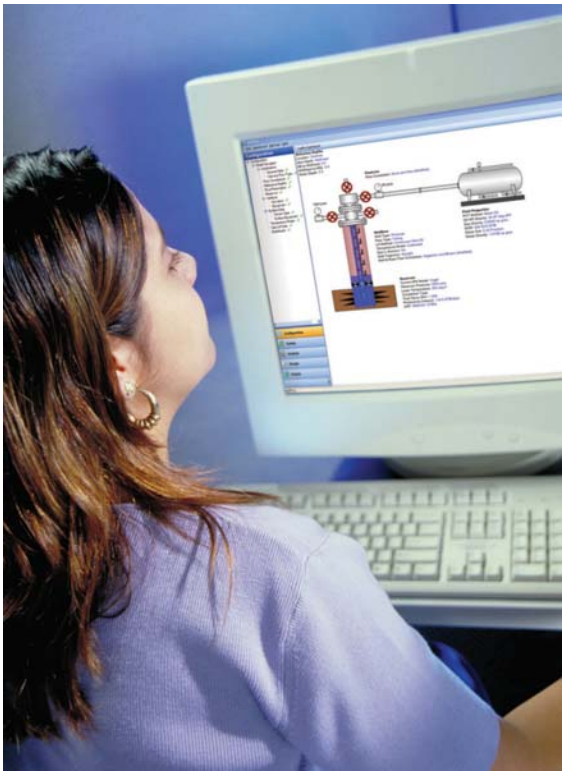
While nodal analysis is useful for all sorts of artificial lift and different types of production engineering, it is important to know that the entire analysis concept was invented by gas-lift people for related applications. This is characterized by the new system's strong gas-lift focus. To effectively model a gas-lift well, an engineer must understand well performance. Nodal analysis software makes it possible, and enhanced capabilities will help engineers perform faster and more efficiently.

Additional features of the upgraded software, such as improved reporting and plotting, will help users design better gas-lift wells and better optimize multiwell systems. Improved efficiencies translate into significant cost savings for operators, and this will be one of the best results realized from enhanced software capabilities.

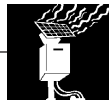
In a gas-lift application in the Gulf of Mexico near South Louisiana, nodal analysis software proved to be a key enabler for a major operator. The objective was to optimize the use of gas lift to maximize production in a developing field with well depths ranging from 3,300 to 9,700 feet.

A gas-lift specialist worked with the operator, reviewing gas-lift designs and production reports for 83 wells. A newly upgraded software program was included among the tools that were used to determine optimization potential. Valve performance spreadsheets generated by the software system were linked with well test reports to give the operator quick access to the operating conditions of each well. The result was an increase in oil production of 728 barrels a day, or 13 percent, for the targeted wells.

In an effort to design an application to support a broader set of users, an un-



Nodal analysis enables production engineers to study changing well conditions to better understand performance and optimize artificial lift and equipment design.



derbalanced design group participated in evaluating new nodal analysis capabilities focused on drilling applications. The calculations and kinds of reports the system provides, combined with the potential for integrating the software into some of the other programs being used across the industry, signal great potential for its application the future. ❐

METIN GOKDEMIR *is the development manager for Weatherford's Production Optimization Group, eProduction Solutions in Houston. A petroleum industry veteran with nearly 20 years of software development experience, Gokdemir was introduced to nodal analysis while working in a research center for a major operator. He has won awards and built an international reputation for developing engineering tools and applications. Gokdemir served as the chief developer for Weatherford's Life-of-Well Information System (LOWIS).*

GREG STEPHENSON *is global product line manager of artificial lift optimization for eProduction Solutions. He is responsible for building integrated solutions to optimize each of the artificial lift methods. This includes gas lifts, electric submersible pumps, progressing cavity pumps, beam pumps and jet pumps.*