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Benefits of Using Automation Software for Gas Production Optimization

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Abstract

This paper describes the cash flow enhancement benefits of using automation software for gas production optimization. Efficiently monitoring well and facility operations, analyzing well performance, and accurately predicting problems with software optimization tools has resulted in significantly decreased failure rates and increased production per well.

The automation software allows producers to move from a reactive mode to a proactive mode. Wells become more stable, and analysts can spend more time fine tuning operations for maximum production rather than fixing emergencies. In short, the networked automation software system calls on computers and other devices to handle the manual and repetitive work of monitoring wells and facilities, as well as collecting and crunching numbers.

The optimization process goes beyond basic operations, but extends into production optimization involving well testing, facilities monitoring and alarming, production monitoring, and gas injection. The net effect is increased runtime and arrested decline curves, resulting in more reserves.

Introduction

The optimization software and automation principles discussed in this paper have been implemented in gas fields with as few as 10 wells to fields with well over 500 wells. These installations have been made in primary recovery fields to optimize both gas production and gas reservoir depletion. These systems have been installed in new fields with no automation in place and in mature fields that have been automated for over a decade. Over the history of all these installations, several of the resulting benefits have been documented from the implementation of these types of systems.

The paper describes the cash flow enhancement benefits of implementing a comprehensive production automation optimization system in the following different categories:

- Increased Production
- Reduced Operating Costs
- Individual Well Management
- Efficiency in Field Operations
- Efficiency in Computer Operations and Automation
- Conclusion

Increased Production

Fine-Tuning Wells As Well Behavior Changes. The analytical features of the automation software system allow the user to make changes to the operational parameters of the wells. Changing the well testing schedule is an example of a parameter change that can be used to fine tune production. By monitoring the performance of the well on a daily basis, the operator can make changes to the well testing schedule that can increase gas production by shifting a high pressure, low volume well into a low pressure header to relieve back pressure on the wellhead, thereby increasing productivity.

Increased Runtime / Decreased Downtime. The concept of managing wells by "exception" promotes the ability to keep downtime to a minimum in two ways. First, when a well does go down, the operator can be notified immediately – even if the operator is off the operating property. Second, these automation tools provide indications that a well may be heading toward a shut-in of one type or another. With the second case, the user can prevent downtime by correcting the factors that are leading the well into a potential shut-in condition rather than just react to it.

Early Detection Of Production-Robbing Problems. Problems that reduce the production of a well can be seen through trends and displays of historical data. By examining the line pressure buildup of a gas well, a user of the system can identify problems, for example; poor compressor performance, liquid buildup in the line, hydrates in the system, deteriorating fail-closed valves, and malfunctioning relief valves or wellhead shut-in valves.

Reconciliation Of Phases For Optimal Performance. The system provides tools for material balancing of gas, gas condensate, and free water production. By recognizing irregular production patterns in any of these phases, potential problems can be identified such as fuel gas leaks, excessive

gas flaring, relief system leaks or malfunction of relief equipment (pop valves).

From the combination of increased runtime along with early problem detection, this type of software typically improves production in the range of 2% to 10%, depending on current producing conditions.

Reduced Operating Costs

Reduced Operating Costs By Optimizing Gas Flow. A comprehensive software automation system goes beyond a basic SCADA system's ability to merely monitor and report on the data from wells. Analytical tools are built into the software so a user can perform a detailed analysis on the data without moving the data into another software product.

The user can evaluate different pressure and flow points. The monitoring software provides the user with a way to compare various field parameters to identify which points are sensitive to extreme pressure drop. Intuitively, the user can then make judgements on where a system upgrade is likely to improve flow, whether it be replacing or sizing chokes or valves, resizing a section of line, or adding a looped section of line.

From field experience and customer dialog, the installation of a comprehensive automation system (and optimizing gas flow) will reduce total field operating costs in the range of 10% to 20%.

Reduced Chemical Costs By Optimizing The Chemical Treatment Plan. In a comprehensive automation system, the user is provided with gas flow rate and pressure trends. These trends are an excellent way to track any change in abnormal line pressure buildup. If the trend is increasing, it is an indication that line pressure is also increasing. Experience with individual wells using this trend enables the operator to better schedule maintenance activities such as chemical treatments.

Chemical Treatments Are Less Frequent But Effective. By frequently analyzing the performance of the wells and incorporating a well analyst's experience with the historical information provided by automation software, the user has accurate information that can help in more efficiently scheduling chemical treatments.

From field experience and customer dialog, the installation of a comprehensive automation system (and optimizing chemical usage) will reduce total field chemical consumption in the range of 10% to 20%.

Diagnose Problems To Minimize Losses. By fine tuning the flow controllers, the monitoring tools allow the user to minimize lost production. Another less tangible benefit is the ability to prioritize work in the field to optimize repair work scheduling. The necessary information becomes immediately available from the field to your desktop. Many problems and their causes are obvious based on the data received from individual wells. Examples of these include:

- Low Pressure Conditions / Line Leaks and Ruptures
- Excess Pressure Buildup / Blockage in the System
- Possible Hydrate Formation Temperatures
- Choke or Valve High Differential Pressures
- Pipeline Coating Breakdown due to High Temperatures
- Gas Well Water Logging Down Hole
- Gas Lift Malfunctions

From field experience and customer interaction, the installation of a comprehensive automation system (and correct diagnosis followed by the appropriate corrective actions) will typically reduce repair and maintenance expense by 10% to 20% per year.

Individual Well Management

Well Management By Exception. Rather than requiring an operator to examine each well's status every day, the concept of management by exception is used to provide information about anomalies through the use of alarm grids color coded for easy recognition of problems. The software alerts the user to any parameter that is out of an ordinary operating range as defined by the user. This allows the user to focus on prioritizing recognized problems, rather than searching for problems that may or may not exist.

Early Detection Of Well Performance Degradation. By monitoring the operating trends of each well in a field, the first indication of a change in the operating conditions of the well visually prompts the user for proactive corrective measures. Further inspection may show an increase in fluid production, excessive line pressure, or a reduction in the flow rate. The information presented from each of these indicators provides the user with a strong start in recognizing problems at an early stage and taking appropriate measures to fix them.

Comparison Of Well Test To Theoretical Limits And Target Values. Users of an automation system have the ability to use information from different parts of the production operation to evaluate the state of the wells and production facilities. The well test information can be compared to the calculated production of each well, and the total from the wells (feeding a particular facility) can be compared to the actual metered sales from that facility.

Notification Of Wells Operating Out Of Parameters Based On Software Calculations. Beyond exception notification from RTU parameters, the automation system provides notification and alarms based on the analytical calculations performed within the software.

Early Detection Of Changing Wells Due To Automation. Alarms can be programmed to alert users that changing well conditions have begun to move the well toward a shut-in condition. The user can even be alerted after hours through call-out programs that can page or call with information about the alarm.

Routine Management And Reporting. These software modules provide historical reports and trends that represent normal operating conditions for a well. Since this data is a part of an integrated database, it can be used for calculating accurate production data. The installation of a comprehensive automation system (and operating by exception) will redirect manpower to better focus on corrective and optimization measures. This prioritizing of operations staff time and

redirection of the existing personnel to work on immediate needs is effectively equal to hiring additional staff.

Typically, effective manpower improves beyond the pre-optimization application to a point where this (effective manpower) can offset new expenses to maintain PLC / RTU equipment and communications equipment.

Efficiency In Field Operations

Reduced Windshield Time. Since data is presented "on-screen" in the production office, and is presented in a way that facilitates easy scanning of a large number of wells, companies that use automation software have found that they can substantially reduce the time necessary for someone to visit and personally inspect each well. Wells still need to be visited, but site visit frequency can be reduced substantially, which frees personnel for priority problem solving or other proactive activities. From past experience, site visits to each well have been reduced from daily to weekly or monthly, depending upon the operating philosophy of individual companies.

Two examples of cost reduction in "reduced windshield time" include 1) more effective meter calibration and 2) more effective field compression and gas dehydration.

More Effective Meter Calibration. The comprehensive automation software has the ability to compare company check meters against sales meters to give an indication of volume discrepancies. Through operating by exception, only those meters with deviations outside pre-set parameters should be field inspected to reduce metering errors. The remaining meters can then be checked as part of a routine or contractual maintenance program.

More Effective Field Compression And Gas Dehydration. Due to the large number of data points which can be scanned by the comprehensive automation software, the operational status of field compressors and gas dehydration stations can be viewed in minutes rather than hours or even days. Through operating by exception, only those compressor or dehydration units requiring immediate attention will be shown as an alarm situation by the monitoring software. This frees up operations personnel to give attention to "true optimization" activities or focusing on the more challenging issues of gas field operations.

Alarm Notification And Management. ***Reduce or eliminate answering services.*** The comprehensive automation software can be integrated with current state-of-the-art call-out systems. These call-out systems take over the role provided by answering services. An answering service typically only helps in calling people when problems are detected by automation systems. Automated installations not only provide detection but also provide more specific information regarding the cause of the problem, enabling field personnel to make improved decisions in case of emergencies. Because of the client/server and dial-in solution, personnel can also take corrective action from their homes. It is also possible for the comprehensive automation software to take corrective actions based on the condition detected.

Reduce or eliminate 24-hour duty. An operator can be paged or called after hours because of an alarm and be given information about the problem. More than that, the operator does not need to leave his home to get detailed information about what is happening at the field. He can use one of the available remote dial-up programs or Windows NT's RAS service to connect to the system remotely and see needed information.

Comprehensive management system to reduce compression costs. For almost all gas fields, compression costs account for a substantial percentage of the field operating costs. Because of the flexibility in configuration and various optimization tools provided by the automation software package, operating companies have used the following solutions to help reduce their compression costs:

By using the information provided by the automation system, scheduling commitments of intermittent flowing wells during peak gas demand can optimize compression, saving considerable expense. The customized startup of wells can also aid in controlling spikes in compression requirements after a shutdown has occurred. In essence, this becomes a reverse peak shaving scheme to gradually load gas compressors during the startup cycle.

The automation software can be used to ensure gas compression capacity at any given time does not cross a certain threshold, thereby benefiting both the operating company and the pipeline company.

Advanced Field Control Reduces Fluid Spills And Loss Prevention. Because the optimization software is an integrated field system, it allows for field-wide control that is typically not present in other SCADA systems. For example, it includes several standard control features for gas fields, such as shutting down wells when a high condensate tank level is detected or controlling injection volumes in conjunction with gas storage based on pressure and volume set points.

As a result of this advanced capability, the operator has a higher level of confidence in detecting leaks and avoiding the costs associated with clean up of condensate or salt water spillage. The operating company also spends less time addressing issues with landowners, landmen, lawyers, and negotiators.

Daily Production Reporting. A comprehensive daily production report (see Figure 1) is provided which illustrates estimated production based on the downtime and the last known good well test of each well, shrinkage analysis obtained by comparing the tested production to sales meter readings, and estimated lost production due to downtime of wells.

The production summary report can be obtained **daily** for different areas of the field or the whole field. Based upon the information presented in the production summary report, field management and personnel can better optimize their resources and prioritize which areas need attention.

Proactive Maintenance Versus Reactive Maintenance. Since the comprehensive automation software helps identify problems before they occur, field personnel can be proactive on field maintenance work. Some examples include:

1. High Gas Pressure Alarms can be an indication of relief equipment failure combined with end device

(shutdown) failure. Should the increase in pressure approach the test limits of the gas system, this can lead to dangerous conditions for operations personnel.

2. Low Gas Pressure Alarms can be an indication of extreme leakage in the gas system or a ruptured line. Again, depending on ignition sources in the immediate area, this can lead to dangerous conditions for personnel.
3. High Gas Temperature Alarms can be an indication of a line heater or glycol dehydration regenerator shutdown failure, which could again lead to dangerous conditions for personnel.
4. Low Gas Temperature Alarms can be an indication of the conditions caused from extreme pressure drop which could form gas hydrates, causing line blockage and operational shutdowns due to freeze-up problems. Thawing gas hydrate plugs can also lead to dangerous conditions for operations personnel.
5. High Level Alarms can be an indication of condensate storage tanks coming close to an overflow condition which could cause environmental problems and unsafe operating areas, plus loss of production.
6. Low Level Alarms can be an indication of inadequate lubrication level in a compressor crankcase, which, if corrected, could conceivably save several thousand dollars in damage.
7. High Gas Differential Pressure Alarms can be an indication of filtering equipment plugging off. This could lead to damage to rotating equipment or carryover to critical process vessels.
8. High Gas Flow Rate Alarms can be an indication of a flow rate increased beyond the process vessel design rate. This could lead to excessive liquid carryover into downstream scrubbers and other process equipment, such as glycol carryover into a sales metering system.
9. Low Gas Flow Rate Alarms can be an indication of line blockage, valve plugging, liquid buildup, etc. In an equipment turndown operation, severely low gas rates can cause malfunctions such as inadequate gas velocities for efficient bubble tray contact in a glycol dehydration tower.
10. Even discrete, on/off actuation can be indicators of problems starting to develop such as a sump pump startup for a normally dry drainage system such as lube oil, glycol, cooling tower water, etc.

Efficiency In Computer Operations And Automation

There are several features that should be used in a comprehensive automation system designed to reduce the on going costs associated with day to day operations in gas fields:

Reduced Installation And On Going Maintenance Costs. Adding wells, facilities, or RTUs to the system is a simple task that can be done by the on-site user of the system. This reduces the amount of time that contractors must be on location during the initial set up of the system and eliminates the need for support when new wells, facilities, and RTUs are added to an existing system.

Reduced System Administration Requirements. Production operators should be provided with a system administration tool that can be used for many system changes and as a trouble-shooting tool. This allows the system administrator to start and stop system processes, monitor performance of the system, and set up the groups and filters that are the basis for managing by exception.

Reduced Support Costs Due To Single System Solution. Since the comprehensive automation software is an integrated software system, a user does not need to move data through several different applications for different tasks. An example of this is the use of well test information when evaluating wells. For example, when exploring the analytical data from one module, the user merely clicks a button inside the program and is presented with the production data from yet another different module.

No Cost Associated With Data Access To Everyone Everywhere. If the system is based on Windows NT client-server technology, it will fit into most corporate networks because NT is accepted as a standard in the computing industry. With the use of WANs or Intranet technology, a company can provide real-time monitoring, analysis, and optimization across the entire enterprise. There is no additional infrastructure cost associated with providing data to any user on the network.

Reduction In Communication Infrastructure Costs. The system should communicate with a large number of different hardware device types in the field. It is not uncommon to have a variety of hardware protocols being used in a field. Since this comprehensive automation system can support multiple protocols on a single frequency, there is no need to have multiple licensed radio frequencies in a field. There is also greater flexibility available to customers since they can choose the best hardware solution for each area of their field and not be constrained by protocol issues.

Reductions In Computing Hardware Costs. Using a system that is a software solution only and does not use a proprietary hardware platform, frees the customer to purchase any hardware that runs Windows NT. The customer can shop around for the best hardware platform based on price, reliability, and availability at the time. Many companies already have a preferred equipment provider and are free to choose the hardware solution from their preferred provider.

Migration From Old Proprietary RTUs And Systems. Obviously, many gas fields already have existing hardware. By communicating with multiple protocols on a single frequency, customers can migrate from a legacy hardware solution to modern PLCs on an incremental basis and not have to replace all current legacy hardware at the same time.

Simplifies disaster recovery. The comprehensive software solution has a number of features built into it to simplify disaster recovery. Some of them are:

- The software system can be implemented in a complete redundant “hot standby” computer hardware

configuration. In the event of a computer failure on the primary machine, the secondary machine takes over in less than one minute. The "hot standby" solution uses industry standard technology and is available at an insignificant cost.

- Hardware configuration parameters for each RTU are stored in the database. In case of a lightening storm or power outage when hardware devices may lose their configuration, the optimization software allows you to simply replace the hardware in the field and download all the stored configuration data back to the RTU. This alone can save hours of reconfiguration time, depending upon the potential level of hardware and configuration losses.

Reduced Data Management Costs. One hidden cost facing gas companies is that of data management. Most gas fields have a significant amount of on-going data management issues. The system helps reduce the data management costs in gas fields in the following manner:

Since the optimization software provides solutions for facility monitoring and analysis, well monitoring, and automated and manual data entry, there is no need to have a large number of different systems in gas fields. The single system approach reduces the amount of effort that companies have to spend doing data migration and management between multiple systems, such as:

- Simple SCADA
- Manual data entry
- Metering comparisons and reporting
- Local databases for production management and reporting
- Databases for regulatory reporting
- Operations management system
- Process management system
- Drilling management system

Because the optimization software is already integrated with reservoir analysis tools such as OFM and DSS, there is no added cost in interfacing this type of software to the reservoir tools used in most oil and gas companies today.

The system integrates seamlessly with SQL databases. It creates a shadow database, which can be any SQL compliant database like MS Access, SQL/Server, or Oracle. The data in the shadow database can be used to seamlessly integrate the comprehensive software system with other production and financial applications. This single system solution improves productivity in gas fields because of the built in integration between the different software modules.

Conclusion

Implementation of optimization software will affect the entire operation of gas fields. Figure 2 shows the relationship between technology, skills, and organization.

The benefits described are always a result of the combination of changes in production operations in all the three areas. It may involve changes in job roles and responsibility for field personnel.

The estimates of savings cited in this paper are based on field experience, customer dialog, and expert input. These benefits and typical improvements do not represent any firm reliable benefits and should be used as a guide to estimate the potential benefits for any particular operating situation.

Figures

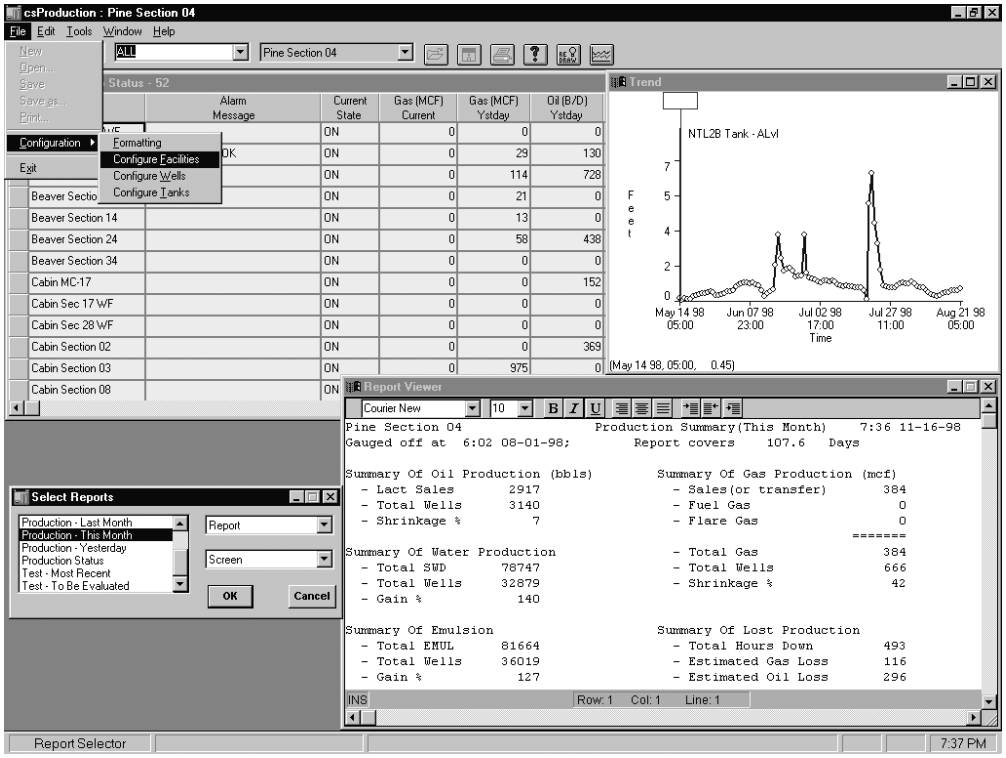

Figure 1

Figure 2