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Natural Gas Marketing

Measurement And Control Systems Optimize Well Performance And Revenue Accounting

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Flow Computers, RTUs

Offer Operators An Accounting Edge

By Ross Linnemann and David Southern

The widespread use of flow computers by both gas gathering and oil and gas production since the early 1990s has made it commonplace for these devices to be used for natural gas measurement for accounting purposes as well as production management purposes.

The technology that is present in today's flow computers easily can perform more than just flow computation. These devices can perform such tasks as logic control, proportional, integral and derivative control, enhanced production methods, alarming call outs, run switching, nomination control, emergency shutdown, communications to other devices, remote I/O and many other functions. These capabilities can be accessed easily, are easy to use, and are either standard features or available at little or no additional cost.

Special customer requirements also can be simply implemented with easy-to-use programming tools. The interface within the SCADA host application of both field information and enterprise information can be considered as part of the overall solution to maximizing the use of these systems as well.

The improved accuracy of these devices and decreasing overall costs associated with their use has improved the speed at which the accounting data can be processed. It also provides a basic simple indication to the producer if he is flowing gas, thus generating revenue.

Considering only this basic function, there are a number of documented cases for flow computers' use to improve productivity, either by more reliable measurement or simply to provide timely information on down wells or problems, thus directing field personnel to focus their efforts on nonproducing assets. These features represent only the tip of the iceberg. Additional features and functions can only further improve the overall performance of the production and measurement site.

Automation Benefits

The information gathered electronically from each well increases the overall flow and improved the flow balance for the field. Other typical benefits of complete automation to oil and gas producers include:

- Short-term gains are being achieved by increasing or decreasing production for the spot market using the flow control capability of the remote terminal units/flow computer.
- The ability to control production from each well and of the overall field assures customers of consistent gas delivery, which has gained companies new customers.
- Field operators now are responsible for 50 percent more sites than before automation, saving the company in contracted services.
- Automated reporting saves operators from unnecessary travel to sites, reducing their "windshield" time and the company's costs for road clearing and maintenance in winter months;
- Production information used by accounting departments increases billing accuracy and reduces the billing cycle by as much as two weeks.
- Engineering departments use production information to analyze well performance for maintenance scheduling and for gas reserve analysis.
- In Kansas, automating the state's well test has improved allowables over manual testing.

In February 1996, when temperatures were below zero for days, a production company in Southwest Kansas was able to deliver 95 percent of its planned production while less-automated producers delivered only 65 percent of planned production. Also, the company could document compliance to contractual agreements with gas distribution customers. This event demonstrated the system's value in minimizing lost revenues and operating costs, and achieving a high level of customer satisfaction.

Other production improvements brought about by using plunger lift applications in the flow computer and having remote access via SCADA include:

- Production increases of 2-30 percent by either actual increases or reduced down time;
- Downhole equipment failures decrease by as much as 44 percent;
- Surface maintenance and repair costs drop by 5-40 percent;
- Reduced driving and vehicle costs of 31-85 percent;
- Overtime and contract labor reductions of as much as 65 percent; and
- Accurate check of the meter audit trail to balance against the custody meter.

Diversity In Capability

Flow computer manufacturers are able to offer expanded units to perform multiple run measurement. This may be for multiple delivery points, injection/withdrawal into gas and liquid storage fields, or possibly run switching for improved range ability and measurement accuracy.

Of course, with these increased features, the unit must have the enhanced features required to manage these runs. The flow computers also are able to accommodate different measurement technologies depending upon the need, such as ultrasonic, corriolis, vortex, annubar or wedge primary elements.

Logic and custom programming used in the flow computers include IEC61131 languages. These programming tools usually are found mostly in the PLC platforms of remote terminal units or programmable logic controllers, but many times also are part of high-end flow computers. Each type has its own advantages and limitations.

One of the earliest forms of logic programming is ladder logic. A ladder diagram is a graphical representation of Boolean equations, combining contacts (input arguments) with coils (output results). It offers electrical flow, large base of users, Boolean equations only, and easy rules.

The function block diagram is a graphical language that allows the programmer to build complex procedures by taking existing functions from the standard library or from the function or function block sections (local library). It offers process flow, good graphical depiction of process, mixed-type equations, large library of blocks, and a common editor with ladder.

Structured text is a high-level structured language designed for automation processes. It is used mainly to implement complex procedures that cannot be easily expressed with graphical languages. It offers structured textual language, high readabili-

FIGURE 1

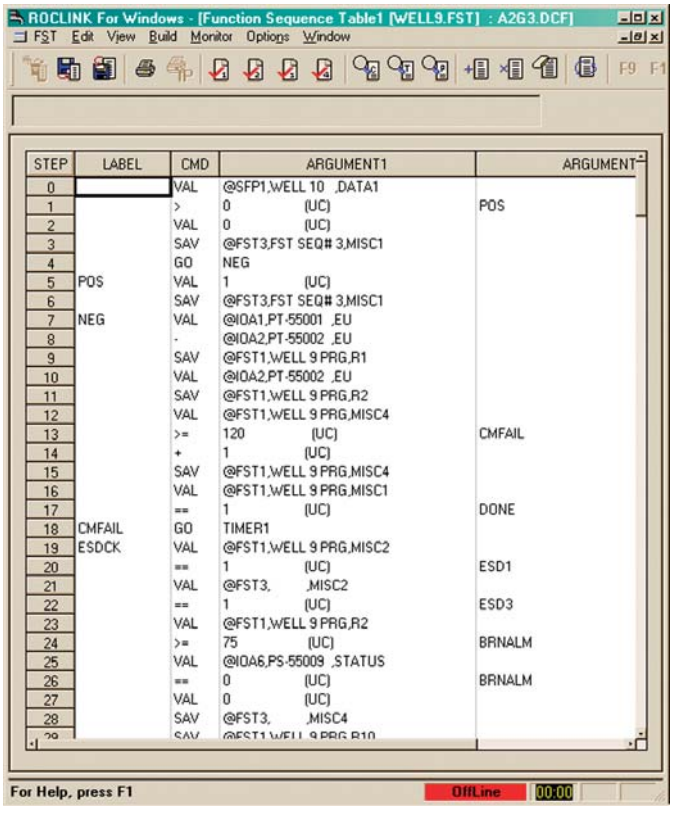
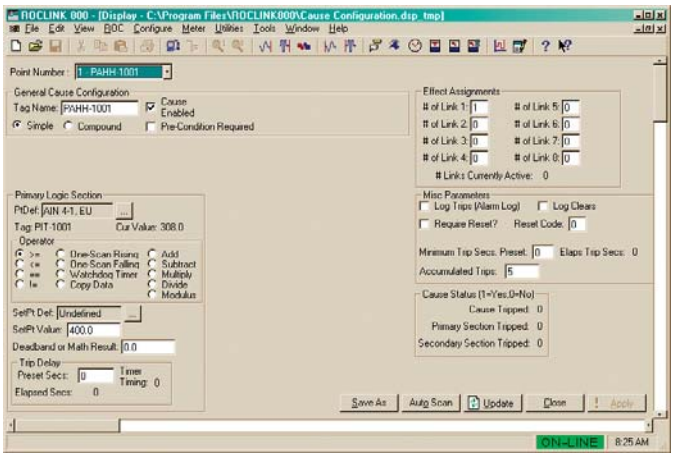


FIGURE 2A



ty of source code, control loops, and complex algorithms.

A sequential function chart is a graphical language used to describe sequential operations. It offers sequential processes, batch or parallel processes, ability to combine with other languages, synchronization mechanisms, and easy dynamic rules.

An instruction list is a low-level language. Its instructions always relate to the current result (or accumulator). The operator indicates the operation that must be made between the current value and the operand. The result of the operation is stored again in the accumulator. It is similar to a machine assembler.

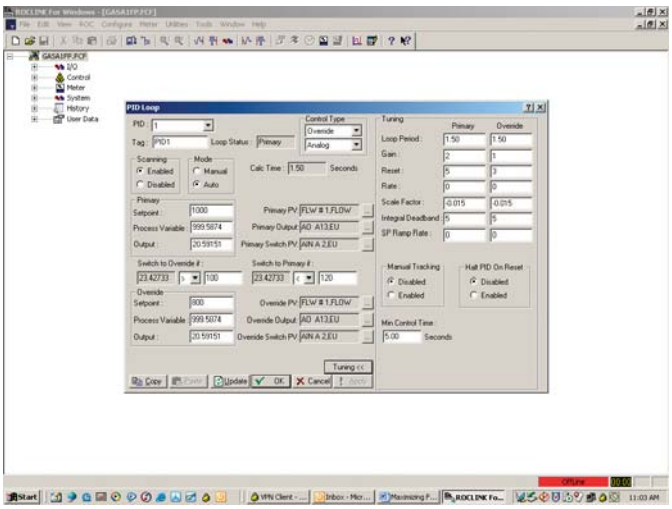
Function Sequence Table

The function sequence table programming tool (Figure 1) is an easy-to-learn, scripted language proprietary to Emerson Process Management's Fisher Floboss and ROC (Remote Operations Controller) brand remote terminal unit and flow computers. This programming tool can be launched in the field with the standard configuration software provided by the manufacturer. It enables the programming fields with easy-to-use dropdown menus, commands and references to process points in the unit. Once the program is written, it is tested for logic errors and then is compiled and downloaded into memory. Many canned applications are available, and on-the-fly development has been implemented in the field on many occasions. Programming capability ranges from single program 300-line applications to six programs with 500 lines each.

Another application, developed by Vinson Process Controls for use with Emerson Process Management's Fisher Floboss or ROC is cause and effect logic (Figure 2A). This easy-to-use menu-driven application allows the user to define causes and effects with mouse clicks, dropdown menus and tags. The application can be expanded and modified while running, with no need to compile or download. Both mathematics and logic functions are supported. Interface to the device input and output variables is by simple dropdown menus. The "what you see is what you get" configuration screen is easy to understand, can easily be set up from a standard cause-and-effect logic diagram and requires no programming language background. The application is self-documenting within the configuration file of the ROC.

The typical flow computer can be configured easily to perform valve control using proportional, integral, and derivative (PID) control (Figure 2B). This application can be configured

FIGURE 2B



to allow assigning process variables, outputs, and gain settings. In the oil and gas production environment, this type of control can be configured for either analog output to a valve current to pressure transducer (I/P) or digital, with a single discrete output for valve opening and one for valve closing. Both methods have their advantages, depending upon power available at the site, air or gas source for valve diaphragms, speed of response, and cost.

A good application of PID control also will have a simple-to-use interface for setting up the parameters, tuning and also interface with other logic applications such as override control. High and low select outputs is another great feature that is available. Another feature that a few devices have is the ability to customize internal screens that are in the unit memory. This allows for graphical feedback of the process information that can be a valuable tool for tuning the loops.

Specific applications and methods useful in improving oil and gas production are available for the RTU or flow computer (Figure 3). These are either implemented in logic applications, may be native to the operational firmware or be high-level programs running in memory of the RTU or flow computer. These applications might be found as a single incidence, or an entire suite of applications may be available. Applications such as plunger lift, pump control, nomination control, emergency shutdown, au-

FIGURE 3

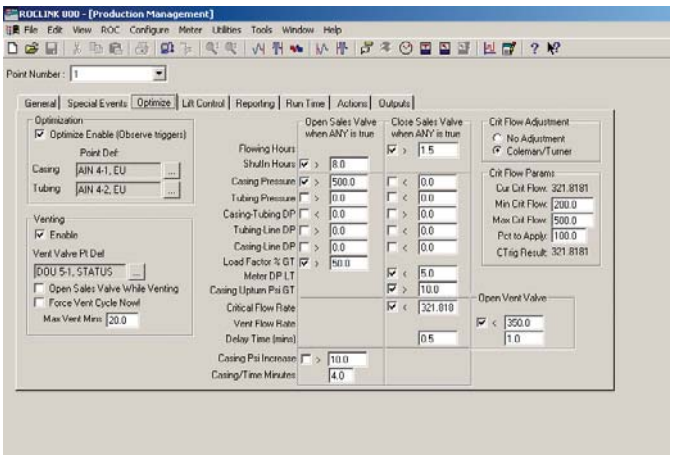
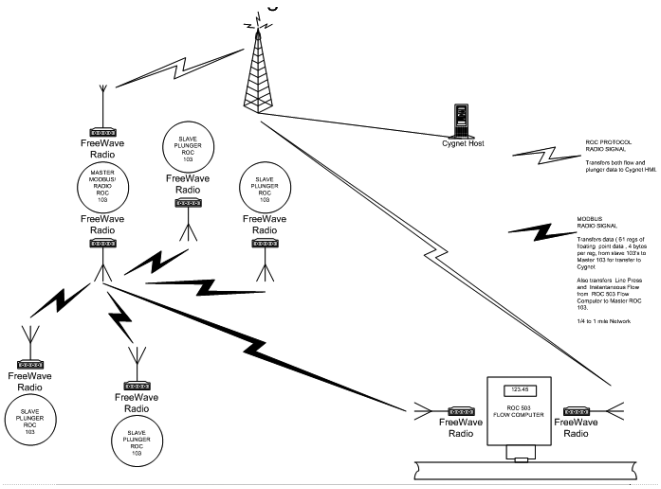


FIGURE 4



(Left) Plunger lift control of a single well at the wellhead often uses transmitters to provide plunger arrival status, tubing pressure and casing pressure. (Right) Data can be wired back to the flow computer/RTU or use wireless technology.

tomatic soaping control, or any custom control that could be developed in logic, are typical for today's flow computers.

Plunger lift systems included in the flow computer/RTU are a cost-effective alternative to both beam lifts and well blowdowns, and they can significantly reduce gas losses, eliminate or reduce the frequency of future well treatments, and improve well productivity (Figure 4). The applications imbedded in the flow computer/RTU allow for several optimization techniques. These methods range from simple time-based inter-mitter methodology, monitoring downhole tubing and casing pressures and tripping open signals, to more sophisticated auto-adjusting techniques based upon a wide variety of process variables. The keys to the method used is the availability of remote adjustment, either by SCADA host or remote access software, and monitoring and reporting of the well performance.

Well Control

The simplest application of plunger lift is to control a single well at the wellhead. Many times this installation has transmitters at the wellhead providing plunger arrival status, tubing pressure and casing pressure. These can either be wired back to the flow computer/RTU or use new wireless technology to transmit this information.

The single plunger lift application operates either an on/off valve for well flow or a throttling valve. The setup for this application provides the user with the ability to preset open and close triggers that will optimize well performance and plunger runs based on logic conditions and time. Some applications also will have some sort of auto-tuning capability that will automatically make adjustments of plunger run times and cycles. Many of these algorithms are proprietary and not widely available across product brands.

When using the optimization methods, the entire application controls the flow, plunger run times, vent cycles, and free flow cycles. It provides an improvement over simple time-based applications.

New Bureau of Land Management and U.S. Forest Service land-use guidelines promote the implementation of the multiple gas well development pad site concept, where an operator will drill, complete and produce multiple directionally drilled gas wells from a common closely spaced pad site. This densely packed site is ideally suited for integrating the production optimization functions into a tightly integrated system.

The pad site automation system can incorporate all of the well site automation functions–including plunger lift, flow measurement and tank management–into a single automation solution, saving purchase and installation costs, and providing enhanced data management, reporting and wellhead operations.

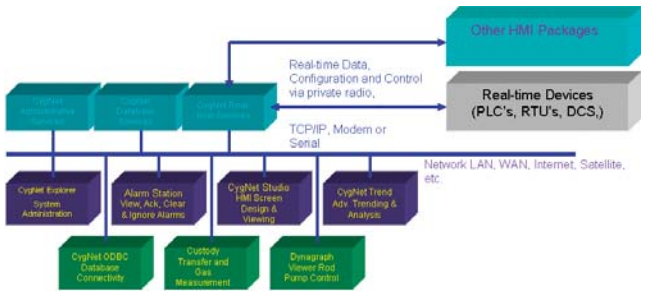
Pad site automation systems can use a single large RTU for total site control or they can incorporate a series of strategically placed remote controllers and a single master controller, all wirelessly communicating with each other, sharing critical operations data for optimum production recovery. The system of controllers will communicate back to the SCADA host by a single system radio or through individual radios.

Some flow computers/RTUs have the ability to interface with surface pumpjacks. This interface can be as basic as simple on/off control based upon timers, optimization considering time and process variables, or they can use the dynamics from strain gauges on the pumpjack to provide feedback on rod loading and downhole conditions. The application typically can be running in the unit, providing read- and write-back to SCADA, and then interface with the pump controls and power.

Nomination control is utilized to maximize the delivery volumes of gas to a given gathering system. Many times, these nominations are daily volumes that can be delivered over the 24-hour period in a steady state condition, or in shorter cycles that may help optimize well production. The systems to provide nomination will require inputs of nomination values and time bases, as well as good PID or on/off control applications to control the flow.

An emergency shutdown system (ESD) can be implemented to automatically shut-in production by use-defined conditions. It also will typically log some sort of tattletale or events to provide an audit trail as to why the shutdown occurred. When these systems are integrated into a SCADA system, the capa-

FIGURE 5A



bility to remotely shut-in also is part of the ESD solution. ESD events can be carefully engineered and monitored by qualified personnel. They also can have outbound alarm notification, using either local call-out or an alarm notification at the SCADA host. Many times, phone dialers at the physical location are used for this purpose, independent of the SCADA system.

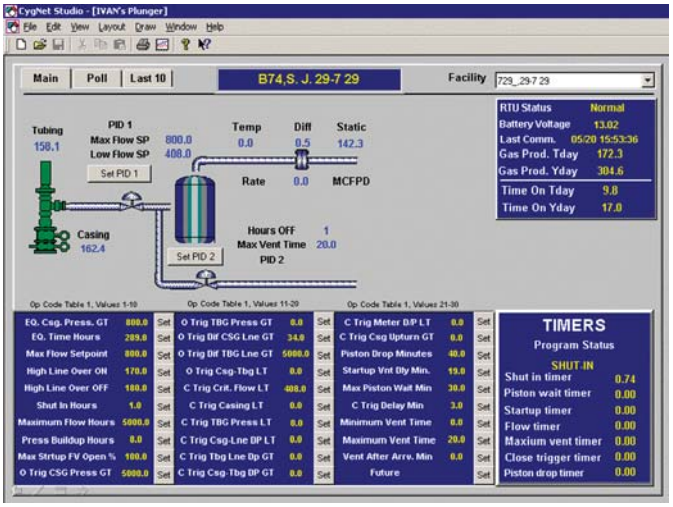
The flow computer or RTU, at the bare minimum, will be able to communicate either wirelessly or be wired to other microprocessor-based devices on location. Many times, this is done using a standard form of Modbus communications, either point to point, or multidropped. Sometimes these applications also must be able to perform in a protocol native to the remote device. Typical applications for this might be to a gas chromatograph for live gas analysis, to a compressor panel for both reading and writing of data, tank level sensors, or to other RTUs or flow computers on the same location.

Additionally, some remote transducers or switches now can be cost-effectively connected wirelessly to the main flow computer/RTU by spread spectrum radio. The Freewave FGRIO remote I/O radio can connect to other slave radios that will interface with discrete inputs, discrete outputs and analog inputs, thus eliminating the need for trenching, long runs of wiring. This will also allow for connecting devices as far as two miles apart.

Once the field devices are chosen for both their basic and advanced capabilities, a host SCADA system needs to be chosen for interface via telemetry to the field devices (Figures 5A and 5B). The system can have different protocols for communicating to multiple brand devices. With today's acquisitions of producing fields, it is commonplace for a company having to manage many different brands of devices. Additionally, the software can be network-centric, meaning that it is designed around the network and is able to truly serve information in a client server environment with minimal load to the network.

Other features, such as alarm notification, can allow the system to notify proper personnel by phone, pager, text message or email. One major producer operating in Oklahoma, New Mexico and Canada using such a system to manage the acquisition, processing, and distribution of real-time data and interact with field devices, user requests, as well as other corporate computers, applications and servers, states, "Today we have 27 servers and over 700 clients running. My goal is to have a majority of our 2,400 employees using the system eventually. Nine-

FIGURE 5B



ty-two percent of our total corporate revenue runs through the system."

Options for serving data to the Internet should be considered when choosing this software. The data would be able to be moved to additional accounting and database systems as well.

The oil and gas producer will most likely benefit from purchasing, managing and controlling his own system of electronic measurement and controls. Simply relying upon furnished data by the gas purchaser with the custody meter is not always the best way to optimize the well performance. With today's sophisticated flow meters and RTUs, it makes good economic sense for the oil and gas producer to implement and control his income producing assets with a real-time SCADA system of telemetry, flow computers, RTUs and control applications. ❐

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