INTRODUCTION

Flow computers, like the computer industry, have been changing rapidly over the past few years. Faster, more powerful microprocessors, higher quality batteries and solar panels, improved electronics and new methods of remote communication now make it possible to automate field production and pipeline systems primarily using low power flow computers as the core hardware.

Low power flow computers were originally designed to replace mechanical charts used in custody transfer gas measurement. They now are being used in whole scale SCADA systems; often performing multi-tube and tube switching operations, flow control, tank monitoring, compressor monitoring, artificial lift and total MMBTU calculation.

Software packages, both man machine interface and central data management and communication programs, have become powerful efficient tools for operating, controlling and managing field production and pipeline systems. These systems are often integrated with sophisticated computer graphics programs to simplify monitoring and control operations throughout the computer networks.

Advances in remote data communication enable companies to gain access to these sites to get current status, collect historical data and perform a host of control functions from the comfort of a field or home office.

GAS MEASUREMENT

The typical low power flow computer usually consists of an enclosure, solar panel, battery, electronic board, temperature probe and absolute and differential pressure transmitter.

Almost all low power flow computers in use today will perform all versions of the AGA calculations for gas flow volumes and NX-19 and AGA 8 methods of calculating compressibility. Most units are able to perform the 1985 version of the AGA 3 calculations and the 1992 version of AGA 3 and the AGA 8, gross and detail method of compressibility. Some units are able to do all of the versions of the equation with a simple selectable menu driven setup.

There are various methods in flow computers for measuring the differential pressure, static pressure and temperature. Typically, these values are measured once per second and the square root of the \((AP) \times (DP)\) is stored each second. This will provide 3,600 integration extension values for each hour which is then averaged. Flow time is monitored to allow for calculating the average integration extension for the hourly record. The complete calculation is performed at the end of the hour or log period whichever is shortest.

In order to maintain adequate information on the flow station, most companies have adopted the minimum standards set forth in API Standard 21.2. This standard sets forth minimum suggested standards for flow computers to be used for custody transfer of natural gas. Among other things, the standard suggests a minimum requirement of 35 days of information to be maintained in the flow computer at all times. The data is stored on an hourly basis at a minimum, but may be stored in shorter intervals. Basic information about the flow station is also required and is often referred to as characteristic data. This information includes the station identifications, calculation setup, pipe size, plate size and any information that could affect how the volume is calculated, such as a fixed composition.

Audit trail capability also plays a key role in a gas measurement system. Most flow computers keep a record in the database of any changes in the setup that can affect volume calculations. A record is made in the database any time a calibration or check is performed on absolute pressure, differential pressure or temperature. These event records also include any changes to the date or time, which could affect the storage of the data. Many other items can be logged in the event records, but may or may not be relevant to volume calculations.

Examples are AP or DP high or low alarms, digital input or output status, low charge, loss of power alarms, etc.

Flow data is stored in the flow computer on location and is often maintained in a host computer application. Host software packages have the capability to archive many years of hourly flow data. Originally, data was stored in flow computers on an hourly basis and this hourly record was referred to as the log period. Low power flow computers have become more powerful and as memory has increased, the time length of the log period has become more flexible. This allows data to be stored in thirty minute, fifteen minute or shorter periods. This typically affects the overall daily storage capacity of flow data.
HOST SOFTWARE

Most systems are built using a computer based host software package. This package is used for complete system management, report generation, communications, and many other monitoring and control functions. These can be as simple as data gathering and printing programs or sophisticated, graphic based SCADA packages.

Typical functions of host software include status and historical data collections, report generation, meter I.D. management, communications, editing errors in flow data, trending and monitoring and control.

The most basic function of host software is to collect data from flow computers in the field and generate reports. The data can be collected in a host PC either at the site or through the use of remote communications. Data is collected locally in the field using handheld or laptop computers. The information is then downloaded by physically connecting to the host computer to the handheld or laptop for data transfer. Many systems now use remote communication systems, such as phone modem, cellular digital packetized data (CDPD), cell phones or spread spectrum radio systems to collect the data into the host software system.

After the data has been collected into the host, reports can be generated to meet various accounting and operational needs. Common reports include volume statements on an hourly, daily or monthly basis. Others are characteristic reports, event reports, calibration reports, alarm reports, and meter station identification lists.

The host software can also facilitate the addition or deletion of meter stations. This is commonly referred to as the meter identification manager, which allows for new installations or removal of meter stations in the system. A list of all meter stations, with basic information such as station number, name, location, field, etc. will maintain an accurate, current record of the stations in the system.

Many companies are now operating their flow computer system with remote communications. The host software operates as the master for these communications. The host computer is attached to a modem or base radio to broadcast requests to the flow computers in the field. Through these requests, data can be collected, current status monitored, alarms, detected, and control parameters changed. This is typically all performed at the host and can be programmed in the host software to automatically take place at predetermined times using a scheduler software type program.

Low power flow computers are also used in SCADA systems and the host software will typically be the central monitoring and control point. Operations such as valve control, tank battery monitoring, compressor monitoring, multi-run tube switching or various other applications can be performed from the host computer. Gas measurement and control systems with quantities in the thousands can all be managed from the central host computer.

In addition to the standard host software, many companies now offer Dynamic Data Exchange (DDE) software, which allows data to transfer directly from the field devices to computer based graphics packages. These graphic software packages are developed to resemble the field locations and allow monitoring and control of various devices from a single computer screen.

REMOTE COMMUNICATIONS

The real value and cost justification in the automation of field sites is the ability to communicate with the field units from a field or home office.

It has become obvious to many companies that locally collecting data is labor intensive and adding remote communications to the gas measurement system has several advantages. One of the most important is the ability to remotely collect data in a short period of time and the capability for operations personnel to have real time information on the status of remote installations. This real time data allows production and field specialist to make quick decisions that could have a large impact on production volumes and gas sales.

A major benefit of Remote Communications with low power flow computers is that the data collected can be used as “Real-time” operational maintenance information. An operator can determine which sites he needs to visit from a quick glance at the morning report of the locations that he is responsible for.

The most basic means of remote communication is via a standard phone line. A modem is installed at the flow computer location and data is monitored and collected from a modem attached to the host computer. The main advantage to using phone lines is they are fairly reliable in populated areas. The disadvantage can be the cost associated with running the line out to the site and the associated monthly fee for using the line. Phone lines also get less reliable the more remote the area.

Radios are commonly used in areas where there are a large number of flow computers in a relatively small area. A radio system consists of a base radio attached to the host computer, a tower for the base antenna, the coaxial antenna cable, and an omni-directional antenna. Another radio is then installed in the remote flow computers with a directional (yagi) antenna on a smaller tower. The base radio typically transmits on a frequency which the remote receives and the base receives on the frequency which the remote transmits. When communicating with a single unit, the base transmits a request for a single meter I.D. and waits for the response from the unit to begin data transfers.

There are mainly two types of radio systems used in gas measurement systems, licensed and unlicensed (spread
RS-232 is a one unit to one unit type of communication and can be converted to RS-485 communications. All of these communications systems can communicate with multiple flow computers with a single modem, radio or cell phone using a RS-485 communication buss. Typical modems use RS-232 communications protocol and can be converted to RS-485 communications. RS-232 is a one unit to one unit type of communication protocol and is usually good for distances up to 50 feet. Spread spectrum radios do not require a license. They are often referred to as “hopping” radios because there is no one frequency, they hop a minimum of three times per second to avoid interference with other systems in the area. Spread spectrum radios run on much lower power (1 watt max) and have a range up to 15 miles line of sight. The main advantages to spread spectrum radios are the low power consumption and freedom of use without an FCC license.

Receivers can be used with both licensed and spread spectrum radios to expand the target area. Some of the newer spread spectrum radios have the capability to act as repeaters and slaves which can create a system that can best be described as a spider web. In this scenario, the more radios in a given area, the better the reception. Cellular phone communications are frequently used in isolated areas where there are single devices. If there are not hard line phone lines or radios to service the area, cell phones are an attractive choice. They work just like a hard line modem, except they operate on a cellular frequency. The advantage of the cell system is cellular coverage is often provided in remote areas. A disadvantage is the power required to keep them up and running. Cellular signals strength can also be weak in remote areas.

CDPD or Cellular Digital Packetized Data is a form of cellular communication that is becoming popular due to the lower cost of equipment and operations. These modems also work off a cellular frequency. There is no wait for dial tone, so the response is almost immediate. CDPD modems originally had fairly high power requirements, which in turn required larger batteries and solar panels at the flow computer site. Newer units have been introduced that draw much less power and provide a better fit for remote powered sites. As with cellular phone communications, it is always best to check with the local cellular provider for coverage before implementing a CDPD or cellular system.

MONITORING AND CONTROL

As companies have increased their reliance on flow computer systems, they have increasingly added to the capabilities of these systems. With the addition of communication systems, came the desire to monitor more than just flow rates at a location. Production companies typically like to monitor casing pressure, tubing pressure, compressor stations and the oil and gas quality have proven to be more accurate if paced proportional to flow, so many companies now send a signal to gas samplers.

These functions and many more have now been added to low power flow computers through the use of digital inputs and outputs, analog inputs and outputs and pulse inputs. Examples of end devices, which can be monitored through the flow computer, include pressure and temperature transmitters, pressure switches, tank level devices and turbine meters.

Flow computers are increasingly being used to control plunger lift operations and custom safety shut down systems. In these systems, casing pressure, tubing pressure, plunger lift arrival sensors and valve control are all monitored and controlled by the flow computer. Logic is introduced to the flow computer via an e-prom upgrade which enables the flow computer to make adjustments based on time or pressure to maximize well production. This provides for a very cost effective approach to total site automation.

Alarm system software packages can be used in combination with flow computers to monitor compressor or tank alarms. This host software can be set up to poll for alarms or the flow computers can be set up to perform cry out. When polling for alarms the host computer periodically calls out to the meters in the field to check and see if an alarm condition is present. If so, it activates a call out list until an acknowledgement is received. These lists can be changed and managed in a software program. Polling for alarms is most commonly used in radios systems.
Flow computers can also be used to “cry out” when an alarm condition is present. The flow computer initiates the call back to the host system, which in turn activates the call out list. The advantage of the “cry out” is that it reports back the instant an alarm condition is detected by the flow computer. Most cry out systems require a modem in the flow computer to operate.

Several parameters can be checked or monitored with alarm systems. A DP low alarm could indicate a well shut in or compressor down. High AP might be a compressor down, blocked line or high line pressure from the purchaser or transporter. Low AP could be a line blow out. All these variables can be set up in the flow computer.

Many low power flow computers also have the capability to trend flow data, pressures, temperatures, etc. Trending is usually set up in the flow computer as a custom application. Trend data is stored in the flow computer and can be collected, stored and viewed through the host software package. Data can be captured anywhere from once a second to once every hour. Trending can give production personnel valuable information on well performance, flow rates, tank levels, etc.

Adding remote communications, controlling valves, monitoring temperature and pressure, trending and setting up alarms all add to the power requirements of the flow computer. A power study should always be conducted to make sure there is enough battery power to run the entire system when conditions for recharging are less than optimal. Many companies use a minimum of 10 days autonomy when calculating power requirements. Autonomy is the number of days the flow computer will continue to run and communicate before the battery falls below a predetermined voltage (11.0 – 11.5 volts). Solar radiation data can change dramatically depending on the area of the country. In areas such as West Texas, where the solar radiation is high throughout the year, a system may only require a 26 amp hour battery and a 10 watt solar panel. In areas of the northeast like New York, where the winters can be overcast for many days in a row, a 42 amp hour battery with a 30 watt solar panel may be required to operate the same system.

CONCLUSION

Low Power Flow Computers originally conceived as chart recorder replacement devices have now become instrumental in the development of powerful measurement, monitoring and control systems. Capabilities should continue to expand with improvements in software, electronics and communications. As companies become more comfortable with the reliability of these systems, they will continue to add to their functions.