Technical Library

As A Service to the HydroCarbon Measurement Industry, CRT-SERVICES Curates this collection of Digital resources.

WWW.CRT-SERVICES.COM
WWW.CRTSUPPLY.COM

11133 Interstate 45 S Suite O
Conroe, Texas 77302
(713) 242-1190

REAL-TIME ELECTRONIC GAS MEASUREMENT

King Poon
Thermo Fisher Scientific
1410 Gillingham Lane
Sugar Land, TX 77478

Introduction

With natural gas production in the United States being more than 60 billion cubic feet (BCF) per day, accurate gas measurement is paramount and the delivery of this measurement data must be on time (i.e. accurate real-time data). Production, engineering, gas nomination, billing and various administrative functions are just a few of the departments now requiring real-time information to process the massive amount of data. Instead of charts, electronic flow computers are now used by the natural gas industry to automate the data collection and control process. Host computer systems periodically collect data from the flow computers and send control commands, gas analysis data and configuration information to the flow computers as part of daily operations. The success of real-time measurement requires the coordination of many functions, including measurement and control, communications, data collection, archiving, post processing, reporting, and the sharing of this information. Breakdowns, in any of these functions, affect the integrity of the entire system and prevent the data from being distributed to the end users in a cost efficient manner.

Electronic Flow Computer

Electronic flow computers are used to interface between the field instrumentation and the system's host computer. An electronic flow computer provides the benefits of a local interface, remote host interface, meter run gas flow equations, basic control algorithms, as well as gas measurement data.

An electronic flow computer interfaces to the primary devices such as orifice meters, turbine meters, positive displacement meters, ultrasonic meters, as well as pressure and temperature sensors to collect data and perform calculations according to the API and AGA standards. Inputs are taken from field instrumentation in a variety of ways. Typically, these inputs use analog inputs through a 4-20 mA current loop or voltage signal. Increasingly, smart transmitters are being used that require a digital serial interface such as RS485, fieldbus or HART protocol. This digital link provides not only primary sensor information but diagnostic and setup information such as span and offset can be accessed through this communication link as well.

API 21.1 – Flow Measurement Using Electronic Metering Systems states that all live inputs to the gas flow equations (such as differential pressure, pressure and temperature) must be sampled at a minimum interval of once a second. It also states that the square root extension for orifice measurement and the actual flow accumulation for linear meters must be calculated every second. The remainder of the flow equation can then be performed either using on-site or off-site calculation methods.

Data Log

One of the advantages of electronic flow computers is the ability to log events that occur in the field in real time. For example, if an operator changes an orifice plate size but incorrectly inputs the new value of the plate into the flow computer, the event log will provide a means to identify when this error occurred and enable off-site corrections to properly adjust the flow calculation accordingly. Usually there are three types of data logs: historical log, event log and alarm log.

Historical log: After the flow computer performs calculations based on the instantaneous data, the following hourly and daily average values will be stored in the historical log:

- Date and time stamp
- Static pressure
- Temperature
- Differential pressure (in the case of an orifice meter)
- Actual volume (in the case of a turbine meter)
- Flow time (the amount of time the flow meter flowed above the low flow cut off value)
- Square root extension (orifice meter)
- Accumulated corrected periodic volume
- Accumulated periodic energy
- Gas quality data such as gravity, btu, CO_2, N_2, …

Event log: The event log is used to log all the changes to flow related parameters (such as changes to orifice plate size, contract hour, low flow cut off values, manual override of live inputs, etc.), calibration records and as-found-as-left records. This log includes the time and date of the event, the types of event, values of the variable before the event and values of the variable after the event.

Alarm log: The alarm log is used to log all the alarm conditions that have occurred in the field. This log includes the time and date of when the alarm occurred, the type of alarm, values of the variables associated with the alarm, the time and date when the alarm is acknowledged, the time and date when the alarm is cleared and the values of the variables when the alarm clears.

Alarm Call Out

In order to react to critical alarms in real time, the operator must be informed about these alarms and be promptly provided with information about the current field conditions. With flow computers being widely distributed over a field, one way to quickly retrieve this information is to have a host computer constantly poll the flow computers and have an operator watching for the alarm conditions around the clock. There are several disadvantages to this method: cost increases due to larger power requirements at each remote site in order to support the communication system, long loop times to poll the entire system and in general, the system will not have frequent alarms. A better method of handling real-time alarm conditions is to utilize alarm call out functions. The alarm call out can be implemented in two ways:

Pager Method: Alarm “triggers” can be set in the flow computer so that when an alarm condition occurs, the flow computer can initiate a call to the operator using text messages through a pager system in order to inform them about the alarm. The operator can then collect more information and react to the alarm conditions accordingly.

Host Method: When an alarm condition occurs, the flow computer can initiate a call to the host so the host can collect the alarm information directly from the flow computer. The information is then processed and the host system can start calling a pre-set list of operators to inform them about the problem using pager systems or generated voice messages to let the operator know what is wrong in the field.

Host Computer

The host computer system is the central nervous system of the real-time gas measurement system. Its responsibilities include monitoring and controlling the entire system and providing the necessary Human Machine Interface (HMI) for the users. The host also distributes the data to all the users in a timely manner. Some of the questions that we need to ask about a real-time gas measurement system are:

- How fast do we need to scan the whole system?
- Are there some points that need to be scanned faster than the others? For example, hourly log data does not need to be gathered more than once an hour. However, some of the instantaneous data from Plunger Lift Control applications may need to be gathered more often.
- How fast can the system execute control commands?
- What types of data need to be time stamped?
- Do we need to send a large amount of data back and forth?
- How does the computer system distribute data? Web? Email? Reports or files through Local Area Network or Wide Area Network?
- Do we need to poll all the data (polled data) or report by exception? In order to use report by exception, values need to be entered (or downloaded via the host computer) so that when the live input variables or calculated values change by more than a preset value, the new value will be reported to the host computer when the flow computer is polled. Notice that both the flow computer and the host system have to support the report by exception function and the method of report by exception, usually, supports only a single host.

These questions will help us to further define our system time constraint and performance requirements.

Communication System

Data must move between flow computers and the host system through the communication system. The following communication devices are typical examples of equipment used in real-time gas measurement systems:

Dial-up network: Traditional phone line connections utilize a local utility. Modems need a certain amount of time to dial the phone numbers and make the connections. The two modems need time to exchange information so that they can negotiate all of the communication setup parameters. Connection time has to be taken into consideration when using dial-up network modems.

Leased line: Dedicated phone line connection utilizing a local utility. Since this system is dedicated, there is no connection time required but data throughput can be limited.

Licensed radio: Data radio using a fixed dedicated frequency and usually has more power than any other radios. Radio licenses are usually difficult to get.

Spread spectrum radio: Data radio utilizing a technique that does not require a license to operate. There are many other advantages to this type of radio: Inherent interference rejection capacity and resistance to multi-path fading secure communication, easy implementation of repeaters, low cost and easy connection to existing high speed communication network. However, the slave radios need to synchronize with the master radio during power up. If power cycling is used in a gas measurement system, the power up synchronization time needs to be added to the overall wake up time.

Satellite: Data transfer using satellite through a third party provider. Since messages are being sent to a hub, before they reach the final destination, the message may be broken up into multiple pieces. The whole system (host computer and gas flow measurement device) needs to be flexible enough to set up timing parameters such as in-between-byte-timeouttimer. These systems can have typical turnaround times of 20 seconds per poll so data throughput can suffer. The advantage of these systems is that data can be collected from some of the most remote sites in a system.

Direct connect with RS232/RS485 or fiber optics: Usually there is not a timing problem with direct connect. These systems are limited to a fixed distance from the host system.

Digital cell phone: Use of existing digital cellular phone infrastructure for data transfer. In addition to dialing of the phone number and training times, digital cell phone technologies can suffer from the same problems as satellite systems (time delays).

WAN/LAN: Utilizing an existing networking system typically reserved for email and server applications for data transfer. Since these types of communications systems use the existing networking infrastructure, the cost is low and the data can move much faster than other means. Notice that once the data is on the data highway, data traffic and how the data gets to the destination can vary, impacting the time that data takes to get there. In addition, data security must be carefully planned.

Each of the above systems has distinct advantages and disadvantages. In reality, an effective real-time gas measurement communication system will use a combination of many different communications techniques. A typical gas collection system might use a dial-up modem to connect to a radio system that will provide access to a field of remote devices. A detailed analysis of the available communications systems that are already in place, custom tailored for the specific needs of each application, is ultimately required.

Data Distribution

After the host computer collects the data, the need to effectively distribute this data arises. This implies that the distribution method and format of the data has to be flexible enough so that the data can be used easily and quickly. An operator should be able to sit in front of a monitor and see what is changing in the field so that decisions can be made accordingly. Engineers can get updated information into spreadsheets or other common forms so that it can be fed into user programs in order to be provided with an updated status of the field. Reports can be sent out through email or put into shared folders on the network, at predefined intervals, so that data can be accessed in a timely fashion. Web access to the data is important as well. If an operator is at the office or miles away, the system can still be navigated to obtain the information that is required.

Conclusion

Microprocessor based gas flow computers, together with sophisticated host systems in concert with flexible communication systems, give the industrial user a variety of tools to support better measurement and control functions in real time. An efficient gas measurement system with timely data handling and distribution is critical to a successful business in today’s fast changing yet demanding energy industry.