Low Power Flow Computers

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Introduction

Gas measurement has evolved over the last few decades from simple paper chart recorders to sophisticated electronic flow computers. That evolution came about because of technology advances that allow systems to do much more with less power. That power requirement is dictated by the nature of gas exploration and production. Inevitably, natural gas will be found in extremely remote locations. The remoteness of these locations causes many problems that must be overcome by technology. The most elemental of those hurdles is the lack of on site power.

The earliest flow computers utilized a simple battery powered configuration. This required periodic visits by a technician to collect data and change batteries. This is cost prohibitive on several accounts. Of course, the cost of batteries is a factor, but more importantly, the technician's time must be accounted for. Another problem with this system is that it is impossible to know when a battery is about to fail between visits. Many times the battery will have died several days before the technician arrived. The solution to this system became the rechargeable battery.

Rechargeable batteries revolutionized the flow computer industry. The initial cost of rechargeable batteries and a charging system is much higher. However, it is easily surpassed by the recurring costs of a non-rechargeable battery. A much more reliable and useful system was now available. In fact, cost is the single most important factor driving the low power flow computer market. If cost was not an issue, every measurement point would have a climate controlled building with AC power and a high powered computer for measurement. However, the economics of a majority of single measurement points dictate that a low cost solution is necessary.

Flow Computer Basics

Even though economics dictate a low cost solution, the performance of the flow computer cannot be compromised. Especially at custody transfer points, but just as important for basic measurement, the actual algorithms, equations, and methods for gas measurement must be not only correct, but also consistent among different manufacturers. To that end, the API formed a committee and produced a standard that must be followed by all flow computer manufacturers. That standard became API Chapter 21.1.

API Chapter 21.1 provides the algorithms for all aspects of natural gas measurement for custody transfer. This includes calibration algorithms, calculation methods, historical record content, audit trail considerations as well as installation issues. The standard addresses measurement for orifice and turbine measurement. While ultrasonic meters are not specifically addressed in the standard, it has become customary to treat them as turbine meters for measurement purposes.

Calculations

Custody transfer volumetric records can be computed using either on-site or off-site calculations. While most flow computers are capable of on site calculations, almost all custody transfer records are created using the off site calculation method. This is primarily because of the necessity to apply gas quality analysis that is obtained through sampling as well as correct for any upsets in the on site measurement. Each method poses unique challenges.

On Site Calculation

On site calculations, as the name implies, refers to flow computers that are capable of calculating and maintaining full historical data at the measurement site. In addition to performing the calculations, however, the meter must also be capable of making all custody transfer data on-site. This means that all configuration data, orifice diameter, pipe size, gas composition data, etc, must be accessible at the meter site as well as all audit trail information from calibration verification audits, changes to gas quality data.

Unless both parties agree otherwise, all live inputs to the flow equations should be sampled at one second intervals. Likewise, a minimum of the square root extension for orifice measurement and an actual flow accumulation for linear meters must be completed every second. The remainder of the flow equation can be performed on an interval not to exceed one hour. In practice, this equation is completed as quickly as possible, typically once per second.

Off Site Calculations

Off site calculation refers to systems that take basic historical records that contain averages for any live value affecting flow, as well as the flow time for that period and calculates flow after collection. As stated before, while on the surface this method seems less accurate, if done properly, the difference in methods is negligible. In fact, because of the high cost of on-line chromatography, this method is required for most applications. Corrections to on-site calculations are routinely made to compensate for samples of gas taken over time.

Averaging Techniques

Depending on the nature of flow at different sites, different averaging techniques can be employed to apply more weight to flowing conditions. The available techniques are as follows:

1. Flow dependent time-weighted linear averaging

2. Flow dependent time-weighted formulaic averaging

3. Flow-weighted linear averaging

4. Flow-weighted formulaic averaging

Calibration Algorithm

Electronic flow meters utilize various transmitters that convert physical pressures and temperatures into electronic signals. This conversion is done using a series of calibration points obtained interactively through a user interface. These calibration points insure that the flow computer is measuring the process variables accurately. Because the calibration is so critical to proper measurement, additional functionality is required to verify that the process variables are accurate. This verification is done through an As Found / As Left routine.

The As Found / As Left process provides a means of checking that the previous calibration was performed properly. The flow computer will provide a means of checking the calibration by allowing the operator to step through several points along the calibration curve. The operator will apply a known input into the process using highly accurate calibration equipment. The flow computer must not only provide the display of the variables, but it must also allow the operator to enter the value provided by the calibration equipment. The flow computer will then enter an entry in the audit trail indicating both the value entered by the operator as well as the value provided by the flow computer. If the values provided by the flow computer are within a satisfactory percentage, an actual calibration is not necessary. If the values are not within an acceptable percentage, a calibration must be performed.

After a successful calibration, an As Left routine must be performed. The As Left routine is exactly the same as the As Found procedure. The operator must step through the same points to verify that the calibration is accurate.

At the end of the calibration routine, the flow computer will have an audit trail record showing that the process variables are accurate. It will contain a series of audits before the calibration. If the process variable is not accurate, calibration audits will follow. A series of audits will then follow indicating that the process variable is now within specification

Power Saving Functions

Beyond the basic operations of the flow computer, several techniques are used to enhance power savings. Because most of the operations of the flow computer can be completed in a fraction of a second, power can be saved by turning the power to the flow computer off when complete. A flow computer will not be accessed for most of its operation. During that time, the flow computer will wake up sample all inputs, perform a flow calculation, and turn the power off. For most systems, a cycle will take as little as 250 ms. This allows the flow computer to save up to 75%$ of its full power using this technique.

Another source of power savings is the use of low power transmitters. The first transmitters available typically used 4-20ma transmitters. By their very nature, these transmitters use an average 12-13ma continuous current draw. Multiply that by the three transmitters needed for gas measurement, DP, Pressure, Temperature, and the transmitters alone will draw many times more than the flow computer. To address this issue, transmitter manufacturers introduced low power transmitters that provide 1-5v operation. While this signal cannot be run physically as far as 4-20ma transmitters, they work perfectly at the well head. Further advances in transmitters have allowed for Smart Multi-variable Transmitters. This not only combines DP and Pressure measurement into a single transmitter, but also allows for digital communications to the flow computer, further saving power.

Comm Methods

One of the greatest single power draws on a remote flow computer installation is the communications method. Because measurement and control data has become such an important part of any system, moving data from the remote well site back to a central location has become essential. The following is a list of the most common communications methods. Each method poses different challenges as well as different power requirements.

Dial up network: Traditional phone line connections utilizing 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 radios utilizing a technique that does not require a license to operate. 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-timeout-timer. 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 remotest sites in a system.

Direct connect: with RS232, RS423, RS422, RS485, 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 networking systems typically reserved for email and server applications, for data transfer. Since this type of communications systems use the existing networking infrastructure, the cost is low and the data can move much faster than other means. Because the data is on the internet, data traffic and how the data gets to the destination can and does vary, impacting the time that data takes to get there.

Conclusion

Flow computers are continually asked to perform more and more of the tasks of well head measurement and control beyond just basic measurement. These control functions add functionality and value to the flow computer system and help to justify greater cost. As more functions are added to the system, power requirements generally go up proportionally. PID control, gas sampler outputs, tank gauges, third party handoffs, compressor monitoring all add additional burden to the power system. Sizing of a power system becomes one of the most important issues in the planning process.