COPING WITH CHANGING FLOW REQUIREMENTS AT EXISTING METER STATIONS

Class # 1050

Barry Lagadinos
Measurement, Instrumentation, and Control Specialist
Atmos Energy Corp.
100 W. Morningside
Fort Worth, Texas USA

Introduction

In the natural gas distribution business, the measuring station is the cash register for buying and selling natural gas. When measuring stations are installed, they should be designed to meet a percentage of the maximum load with a growth factor included in the design of the station for future growth. A perfect measuring station will measure all the gas needs correctly and be the smallest size possible. When sizing a measuring station, it is often assumed that not all equipment it serves will be operating at full capacity 100% of the time. An example of sizing would be a measuring station sized to measure the gas at 70% of the maximum load. When a measuring station is sized, it also needs to be able to measure low flow rates accurately. Accurate metering of both high and low flow rates may not be possible with a single meter application. Flow rates can change permanently or temporarily. Some of these changes in flow rates and methods to deal with them will be covered.

Basics

Natural gas is sold by the standard cubic foot just like gasoline is sold by the gallon. The measurement of a standard cubic foot of natural gas is one cubic foot of gas at a temperature of 60 degrees Fahrenheit, 4 ounces of pressure, and a heating value of 1000 BTU (British Thermal Units). Because natural gas does not come out the ground at these exact conditions, a function of the measuring station is to adjust the actual cubic feet of gas measured to standard cubic feet. If an actual cubic foot of gas went through a measuring station at 80 degrees Fahrenheit, the amount would be slightly larger than a standard cubic foot because the gas would be less dense. If the BTU of the actual cubic foot of gas was 1050, the amount would be slightly smaller than a standard cubic foot of gas. If the pressure of the actual cubic foot of gas was 900 psig, it would be smaller than a standard cubic foot of gas. Most electronic measuring devices in the field are capable of performing the conversion from actual cubic feet to standard cubic feet.

Standards

According to the American Gas Association Magazine, Vol. 93, No. 1, “More than 75 percent of the meters used in the custody transfer of natural gas in the United States are orifice meters”. The primary type of measuring station in gas distribution has been the orifice meter run. An orifice run consists of a metal plate installed in an orifice fitting or between flanges on a straight run of pipe with a precisely bored hole in the middle. One inch on each side of the plate are pressure taps. The taps are used to measure the pressure drop across the plate. A one pound pressure drop across the plate equals 27.7 inches of water column or inches of differential. With the pressure, temperature, inches of differential, pipe diameter, gas composition, and the orifice size, gas volumes can be accurately determined. To make sure that the gas is measured correctly, measuring stations should be built to an industry specification or standard. AGA Report No. 3 is the universal standard for orifice metering. This standard assures that the pressure tap locations, orifice plate dimensions, minimum pipe lengths, etc. meet the same criteria on every station. Beta ratio is the diameter of the orifice plate divided by the orifice fitting or pipe diameter. It is my company’s recommendation that the beta ratio be higher than 0.2 and lower than 0.6 for optimal measurement. By following the Beta Ratio guidelines, it puts a limit on how large or small an orifice diameter can be for each pipe diameter. Measuring stations not built to standards could show different volumes for the same flow due to design of the station. Following the AGA Report No. 3 Standard assures when comparing volumes, you are comparing apples to apples.

Electronic flow measuring devices are now the norm for measuring the variables such as temperature, pressure, differential, etc. and calculating the volumes in standard cubic feet. The differential pressure transmitters come in various ranges from 0 to 700 inches of water column. Optimal measurement is typically between 10% and 90% of transmitter range. When the differential pressure transmitters are over ranged, the measured volume will not increase regardless of how much the flow rate increases, and measurement of the over ranged volume will be lost.

Temporary Changes in Flow Rate

Changes in flow rates can be temporary or permanent. For heating loads, large temporary flow rate changes can be encountered between the morning and evening loads. Automated run switching on orifice runs is one of the tools used for accurate measurement during changes in flow rates. An automated system consists of a primary run and one or more secondary runs with automated valves that may be opened or closed as needed. When the primary run differential pressure approaches the upper limit of the optimal measurement range, equipment on site sends a signal to an automated valve to open on the secondary orifice run. If the orifice size is the same on both runs, the differential pressure should be approximately 25% of original differential pressure on both the primary and secondary run. When the differential pressure drops below an acceptable level on both runs, a signal is sent to close the automated valve on the secondary run. Temporary changes could be seasonal in nature. Heating requirements in summer months could be nonexistent for residential and commercial areas drastically lowering the flow rates. When the flow rate drops off, the differential could get too low for optimal measurement or even show zero differential even though there is flow. The use of summer plates with a smaller orifice size in the lower flow months is a common practice to correct this problem. Another tool to raise the differential pressure is to lower the operating pressure on the orifice run. By lowering the pressure, the velocity of the gas increases causing an increase in differential pressure even though the flow rate has not changed.

SCADA operated or remote telemetry systems that raise or lower the pressure remotely on distribution systems can cause havoc with measurement if not operated correctly. Sending commands to raise the pressure on a system without monitoring measurement could quickly over range all the runs at a measuring station. Also lowering the pressure too quickly could put the station at lower than optimal or zero flow rates. The technician should monitor the measurement on these systems because poor measurement can affect lost and unaccounted for gas and cost the company money.

Permanent Changes in Flow Rates

Sometimes a measuring station becomes inadequate to measure the gas flow because of growth in the customer base, new industrial customers, or residential expansion. When orifice size and operating pressures have been increased to their limits, the only other alternatives is to install a larger station, install larger diameter orifice runs, install an additional orifice run or convert one of the existing orifice runs to an ultrasonic meter run. An ultrasonic meter uses ultrasonic transducers to measure the average velocity of gas along a beam of ultrasound. The advantage of an ultrasonic is there is not a flow restriction in the pipe as there is with an orifice run. Also, an ultrasonic run can measure twice the flow rate as the same size orifice run accurately.

Some of the reasons that flow rates can permanently drop are because of customers down sizing, competition from other gas companies, and alternate fuels. Large volume gas users such as gas fired power plants are shopping for the most competitive rates for natural gas. Often there will be two or more different gas company measuring stations at electric power plants. Whoever has the cheapest rate will flow the most gas. Load requirements can go from millions of cubic feet per day down to the thousands. Large orifice runs will not be able to measure these lower flows. An alternate is to install a low flow positive meter with a restrictor plate to limit the volume of gas it will pass. The low flow meter would measure the low flow until it reached its limit, then the orifice runs would be placed into service to measure the larger volume. When it is more profitable, some asphalt plants use waste oil to heat their product and only use gas to heat the oil. This lower volume would go unmeasured until a low flow meter or smaller meter was installed.

My Company's Approach to Changing Flow Rates

My company is working to educate our engineering department about measuring low flow is just as important as the maximum flow. New technology has resulted in meters like the Coriolis and Dattus meters that can measure large volumes and still be able to measure small volumes similar to a low flow metering run. We have been reviewing flow profiles of large industrial meters and finding that sometimes a large turbine meter that is showing zero flow is really delivering unmeasured gas to the customer. We have been reviewing the hourly volume history on large meters with periods of zero flow to see if the meter is oversized and retrofitting the meter run with a smaller meter that will pickup the low flow. Some meters that show no flow 50% of the time, now show flow nearly 100% of the time.

Conclusion

Because of the changing prices of natural gas, we have seen prices swing from $15.00 a thousand standard cubic feet or MSCF to $3.00 per MSCF. Measuring stations that were installed 20, 30, 50 years ago may not be adequate for today's flow rates. The capture of unmeasured gas from low flow or over ranging could pay for the upgrades to metering stations in a short period of time. Coping with changing flow requirements can be as simple as changing orifice plates or raising and lowering the operating pressure, or it could require upgrading an orifice run with a low flow metering run or installing an ultrasonic meter.