ORIFICE METER MAINTENANCE AND OPERATION

Class # 1270
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Introduction

The natural gas industry has seen many changes lately. The world population is increasing and with this the energy demands in the world are also increasing. Producers and pipeline companies have seen tremendous growth and reorganization through these increased demands for energy. The advances in technology in the last decade have literally put a computer and cellular phone at everyone's fingertips and increased the need for electricity, thus the need for natural gas to generate this electricity. With this increased demand for natural gas, the logistics involved in acquiring it, and the profit differential between demand and logistics, the need for proper maintenance is more important than ever.

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The Purpose

Natural gas is a commodity just like wheat and oil bought and sold each day. The individual or company who buys or sells this commodity wants to buy or sell just that and no more or no less. With this in mind, the need for assuring accuracy in the measurement of natural gas becomes apparent. Proper maintenance and operation of natural gas measurement equipment is performed to assure that the guidelines for natural gas measurement and the contractual agreement between the parties buying, selling, or transporting the natural gas are being met.

The Orifice Meter

The instrument used to measure this commodity is called the orifice meter. Its ability to measure accurately the production, transportation and distribution of natural gas has made the orifice meter a widely accepted method. This instrument consists of two parts, the primary element and the secondary element. The following is a description of the 3 kinds of meter tubes used in the industry.

- The Orifice Flange Union is by far the most basic and economical design that consists simply of two flanges with machined taps. The paddle type orifice plate is then simply placed between gaskets and bolted in between the flanges. Jack-screws allow the operator to spread the flanges to inspect the orifice plate. The orifice flange union is a simple, yet labor intensive, means of accurately measuring gas flow. Before the orifice plate can be inspected, the meter run needs to be isolated and bled to atmospheric pressure. The use of orifice flange unions has sharply declined due to strict EPA restrictions on emissions, higher operating costs, tightening standards and the introduction of new, low cost orifice fitting designs.

- The Single Chamber Orifice fitting shares a number of components with the dual chamber orifice fitting but also needs to be isolated and depressurized prior to inspecting the orifice plate. Unlike the orifice flange union however, the single chamber orifice fitting utilizes a plate carrier, seal ring, and top clamping bar seal to quickly and easily remove the orifice plate for inspection without breaking apart the flanges. Once the system has reached atmospheric pressure, simply loosen the clamping bar screws and gently tap the sealing bar to break the seal between the sealing bar o-ring and the body. Slide the clamping bar out of the body, lift out the plate carrier assembly, remove the sealing bar o-ring, and remove the orifice plate and seal ring from the plate carrier assembly.

- The Dual Chamber Orifice fitting is the most commonly sought orifice fitting because it permits the inspection of and replacement of orifice plates without interrupting the process flow. The dual

chamber orifice fitting makes use of a gate valve to effectively isolate the two chambers that are integral to the plate carrier removal and insertion process. Under normal operating conditions, the orifice plate is located in the lower body of the dual chamber orifice fitting. To remove the orifice plate, bring the complete meter tube to operating pressure and verify the bleed valve is in the closed position by turning it clockwise. Open the equalizer valve by turning it counter-clockwise and allowing ten seconds for the two chambers to equalize pressure; failure to properly complete this step may result in severe injury. The equalized pressure will now allow the gate valve to freely rotate to the open position. Turn the lower gear shaft until the plate carrier has advances upwards from the lower body and engages the gears of the upper body gear shaft. Rotate the upper body shaft until the orifice plate carrier assembly stops and bumps against the bottom of the sealing bar. Isolate and depressurize the upper chamber by rotating the gate valve to the closed position, closing the equalizer valve, and opening the bleed valve. Upon completion depressurization, the plate carrier may be removed in much the same way as a single chamber fitting.

Primary Element

The primary element or meter tube consists of a specified length of pipe upstream of an orifice and a specified length of pipe downstream. The orifice plate is centered in the meter tube by a flange or orifice fitting. The upstream side of the meter tube conditions the flow of natural gas before it enters the upstream side of the orifice plate. This conditioning can be obtained with length of pipe or a flow conditioner. The flow across the orifice plate creates a differential pressure which is measured and recorded at the flange or orifice fitting through pressure taps on the upstream and downstream side of the orifice plate. The meter tube and orifice plate are constructed according to guidelines developed by the American Gas Association (AGA) and American Petroleum Institute (API).

The upstream side of the meter tube conditions the flow of natural gas before entering the orifice plate. There are items to keep in mind when designing and or maintaining the meter tube. The meter tube when installed would have been designed for a certain volume of clean and dry natural gas, unknown to the designer that days, weeks or even years later that volume will be increasing or decreasing, and clean and dry gas could be hard to obtain. Increasing volumes could be from new production being turned into the same system or gas from another system being put into this system. Increasing volumes bring intrusions into the pipeline allowing debris and dirt to be introduced into the previously clean pipeline. This dirt and debris can disrupt and even obstruct gas flow by collecting against the flow conditioner and orifice plate. Also, with well stream production, fluids from malfunctioning production equipment, injection pumps, and gas treating facilities will migrate along the pipeline until reaching the orifice plate where a damming effect can occur at the orifice plate. Another item to consider in meter tube design is the addition of compression. Compression will be introduced as wells decline and no longer have the ability to flow freely into the pipeline and will be placed directly upstream of the meter tube. Compression when not correctly installed can cause pulsation in the gas flow. Along with the pressure, heat and vibration can cause damage over time to the meter run. Meter runs should be built with the expected use in mind not only from an accuracy point of view but safety as well. All of these examples can create inaccuracies in natural gas measurement and if not corrected can multiply into significant dollar amounts.

The AGA and the API developed the guidelines for the manufacture of the meter tube by obtaining flow characteristics in the perfect environment. All of the above items discussed can cause changes in the flow characteristics of the meter tube resulting in a distorted output being recorded and used in gas volume calculations.

Secondary Element

The secondary element is the device which records the outputs of the primary element. These process values are differential pressure, static pressure, and temperature and these values are used in calculating the volume of gas. These devices also have guidelines developed by the AGA and API to insure accurate measurements. The recording device can be mechanical or electronic.

The mechanical recording device or dry flow bellows type meter records the data it retrieves on a circular chart. The meter uses an oil filled bellows with a range limiting spring to measure differential pressure across the orifice plate; a bourdon tube is used to record the static pressure and temperature. The bellows, range spring and bourdon tubes are susceptible to corrosion and fatigue and may cause errors in measurement. Scheduled testing and calibration determined by contract, company, or necessity is conducted to insure accuracy.

The electronic recording device or electronic flow meter records the same data as the dry flow but with greater resolution. The EFM takes readings every second and these readings are averaged and recorded in memory for use in onboard calculation of volumes corrected for gas composition. These devices are very powerful and can control flow, record input from external devices for monitoring gas quality and have the ability to produce real time data to a communications link for monitoring. Like the dry flow recorder this device requires contract and company defined testing and calibration to insure accuracy of recording outputs from the primary element correctly.

Measurement Station Inspection

The measurement station consists of the primary and secondary element and inspection and test of each element is necessary to maintain accuracy.

The measurement technician must make many observations during a measurement station inspection. They are possibly the only person that visit this site and with electronic measurement and telemetry it may be several months between visits. Problems should be corrected if possible or noted on the meter test report and/or reported as necessary. Items to be observed should include the following:

1. What are the differential, static, and temperature readings?
    a) Are the readings above 10% and below 80% of the range of the device?
    b) If not, why?
    c) Does there need to be a plate change?
2. Are the pens marking?
3. Are the charts turning and if so are they on the correct day and time?
4. Does the station have gas passing through it and if so, how much?
5. Are there any gas leaks at the station or around the station?
6. Have there been any modifications? (i.e. compression, dehydration, control valves, load fluctuation)

The orifice plate should be inspected each time the measurement station is inspected. Like the meter tube, the orifice plate should also be clean and free of liquids, dirt, and debris and should also be flat and free of nicks. The seal ring should be pliable and free of cracks. An orifice plate that does not meet the requirements established by the AGA and API should be replaced at the earliest possible time. The measurement technician should assure that the orifice plate was inserted correctly before and after inspection. The condition of the orifice plate will also give the measurement technician an idea of the condition of the meter tube. The orifice plate should be measured to determine size. Do not rely on what is stamped on the orifice plate or the tech eye judging the bore size. Mic the plate in an X pattern to verify the plate size. An extra few minutes can save costly errors that can be overlooked by a hurried tech. The conditions of the orifice plate “As Found” and “As Left” should be documented in the meter inspection report.

The meter tube should not be damaged internally, and should be clean and free of dirt, oil, water, and any other debris. The flow conditioner should be clean and undamaged. The meter tube should also be in good physical condition and not damaged externally. An annual inspection of the meter tube is suggested although it is difficult to perform due to time and resources required to internally inspect meter tubes.

A test of the recording devices should be performed during a measurement station inspection. It is of utmost importance that a test of the equipment be performed before any adjustments are made. For example, if upon blowing down the meter a high differential zero is noted, the differential should be tested

with this high zero present to assure that the error is recorded for the full scale of the differential range. With this error reported on the meter inspection report, a volume adjustment may be made by the integration office. Electronic flow computers have the ability to log these test points in an event file, these test points may then be taken from this file and used by editing software to make the volume adjustments.

This test should begin by making note of the flowing or static conditions of measurement station (i.e., Differential pressure, Static pressure, and Temperature). With all of this information noted the meter test begins with a differential zero test under pressure. This is accomplished by equalizing the pressure across the bellows unit, transmitter, or transducer and isolating this pressure by closing the tap valves at the orifice fitting. The differential should indicate zero. This is a very important test in that it simulates flowing conditions ceasing. An indication other than zero indicates a problem and needs to be corrected.

The recorder will then be blown down and a static pressure zero should be checked. The static pressure may zero on pounds per square inch gauge (psig) or pounds per square inch atmosphere (psia), which is determined by the gas purchase contract and should be determined prior to testing. Atmospheric pressure will vary in different parts of the country.

The differential pressure, static pressure, and temperature should be tested through their full range. The errors should be logged in the inspection report and in the case of an electronic flow computer they should be logged in an event file “As Found”. After correction of any errors, the recorder should be retested again to assure accuracy and all points logged “As Left”.

The technician should be sure that the orifice meter is back in service, chart hub is tight, and pens are inking before leaving the location.

A quick check of the volume should also be made to assure that the orifice meter is back in service and measuring correctly. This is done by calculating the 3 process values along with the orifice plate diameter and the line size to calculate the volume.

Measurement Station Test Report

The test report is the official documentation of the measurement station. All the information obtained during the test should be recorded on this report. All parties present during the test should sign and obtain a copy of the test report. A copy of the test report will also go to the integration office and any corrections that need to be made will be made according to this test report. Take the time to write out or print out a measurement station test report on location. It does not take but a few minutes and it is easier to remember all of the information obtained during a test while you are still on location. Whether you’re doing contract work or an employee, it is your job to ensure accuracy with the equipment in the field and part of that is documenting it correctly and clearly. Take time to do your job and do it right the first time.

Conclusion

Maintenance and operations of orifice meters is a combination of maintaining the meter tube and recording devices in accordance with guidelines developed by the AGA and API. Through education and good working relationships between the producer and the purchaser, accuracy in measurement can be obtained and profits realized by both parties. As in any industry or situation in life, communication is key.