FUNDAMENTALS OF ORIFICE RECORDERS

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What is an orifice recorder? The answer usually depends upon who is providing the response. The term orifice meter is used to mean everything from the orifice meter chart recorder to the entire meter station. The American Gas Association defines the "orifice meter" as the complete measuring unit comprised of primary and secondary elements.

The "primary element" consists of an orifice meter tube constructed to meet the minimum recommended specifications of the measurement authority contractually agreed upon by two or more parties. The "secondary element" consists of equipment that will receive values produced at the primary element. The values may be measured and recorded onto circular charts or received by electronic flow computers that calculate a volume onsite, to be retrieved as desired.

This paper addresses the "Orifice Meter Chart Recorder" and endeavors to explain its fundamental workings.

The American Gas Association does not specify a manufacturer or type of recording instrument to be employed. The person selecting the instruments installed at a metering station should answer the following questions about the instruments:

1. Does it have adequate initial accuracy?
2. Will it sustain adequate accuracy under expected operating conditions?
   A. Range of ambient temperatures.
   B. Corrosion.
   C. Accumulation of dirt or foreign material.
   D. Vibration.
3. Will it require excessive maintenance?
4. Are the available facilities adequate for proper maintenance?
5. Is it adequately flexible as to range, damping, etc.?
6. Does it adequately perform all of the required functions?
7. Is it adequately portable?

Installation:

When locating the recorder at a metering station, attention is required for placement and distance from the pressure taps. Pressure values at the recorder must be the exact same pressure values as pressure values at the meter tube pressure taps. That is, the distance between pressure taps and recorder is not limited, if pressures are the same values for the same moment in time. The location of the recorder relating to elevation comparison to meter tube pressure taps is a not a defined requirement, but a requirement of the gas condition.

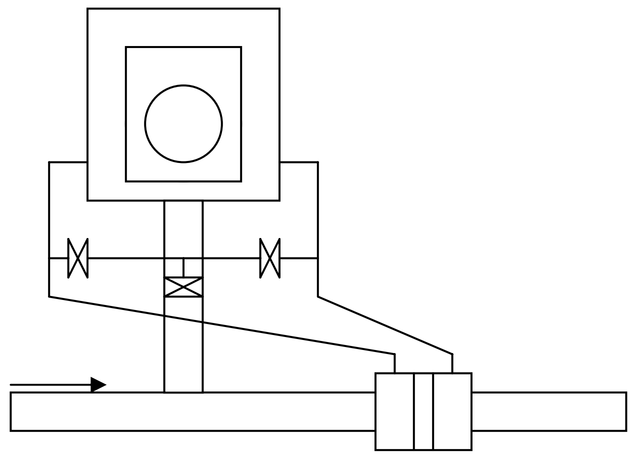

Figure 1. Schematic of the Basic Components of an Orifice Meter Chart Recorder Installation

When the gas is pipeline quality (i.e., separated and dehydrated for removal of free liquids and water vapor), location of the recorder may vary. For example, the orifice recorder may be installed in a walk-in house. The piping of manifold lead lines may be of a configuration not considering drainage of free liquids into meter tube, since pipeline quality gas should not have free liquids that can accumulate in the lead lines.

The orifice meter chart recorder is an instrument that measures the difference in pressure between a point one inch upstream from the face of the orifice plate to a point one inch downstream from the face of the orifice plate. This differential pressure measurement is converted to inches of water column and recorded onto a paper chart.

Differential pressure measurement:

The industry today uses two types of orifice meter chart recorders. One is referred to as a "bellows type" and the other is a "diaphragm type." Both are liquid filled and meet all the conditions required to measure and record the differential pressure across an orifice plate. The differential shaft rotates in the bellows unit as an increase or decrease in differential pressure causes the liquid to travel from one side of the bellows to the other. The differential shaft of a diaphragm unit travels from side to side as the magnitude of the differential pressure changes. A damping valve can control the speed at which liquid travels from side to side. Closing of the valve restricts liquid movement when the flow characteristics are of a varying or fluxing nature and will result in a false recording of differential pressures onto a chart. Generally, this damping of liquid movement will result in a false recording, as the differential pressure variations will record at the highest value and not reflect the low values. This will result in a computed volume greater or less than the chart would normally record.

Today the industry generally uses the bellows-type unit. Located on the downstream or low side of the bellows is a calibration spring that can be of various ranges. The most used range is 0 to 100 inches of water column. As the liquid is pushed from the upstream side of bellows into the low side, a differential range spring, located on the bellows, can be calibrated to restrict the liquid movement. This calibration span is equal to the chart span in inches of water column. If the bellows unit is damaged and loses part of its liquid fill, movement of the bellows is reduced, resulting in a false differential recording on the chart. In addition, if the range spring is damaged, the liquid will not have a restriction in its movement and can result in a greater or false differential recording.

Other conditions that affect or cause false differential recording include free liquid or freezing of liquids in the manifold lead lines. A pressure leak in the manifold lead lines does not allow a static pressure condition and will cause liquid to travel up into the lines. Moreover, a leaking tube connection ferrule will cause a refrigerating condition at the fitting, possibly creating an ice accumulation inside of the lines, resulting in a loss of pressure downstream of the block. This causes the recorded differential pressure to one extreme or the other on the chart, depending on the freeze location. Free liquid and freezing can be minimized by orienting the manifold lead lines to allow drainage of liquid back into the meter tube and by assuring that no pressure leaks are present in the lines at operating condition.

Flowing pressure measurement:

The measurement of flowing pressure is normally by means of a pressure-measuring device (static element) installed in the orifice recorder, such that the flowing pressure and orifice differential pressure are both recorded onto the same chart. The flowing pressure is normally measured in engineering units of pounds force per square inch. Pressure can be measured at either side of the orifice plate but, normally, it is measured on the downstream side. The pressure-measuring device (static element) consists of a hollow tube closed at one end and twisted in the form of a spiral. A pen or pen mechanism is connected to the closed end. An increase in pressure will cause the spiral to unwind and position a pen recording onto a chart equal to a value within its calibration range. The range of an element can vary with flowing pressures. Element range should allow a separation in the recording of differential and flowing pressures.

The degree of chart travel between the two recording pens at zero pressure and degree of travel from zero to 100% of chart range is set to match the same degree of travel as the chart integrator pens. When they are not the same, integration values will not be a product of differential pressure and flowing pressure at the same moment in time.

Located within the orifice chart recorder, the chart is placed on a clock that can be adjusted to make a 360-degree rotation in the time desired. The orifice recorder is a real time instrument that measures the orifice differential pressure continually. Rotation of clock and recording chart reduces ratio of real time to recording time by the rotation speed. That is, a varying pressure recorded onto a one-day rotation chart may allow the accurate tracing of a value by the integrator operator, where a multiple-day chart rotation results in an integrator operator subjective tracing to produce an integrator count for volume calculation.

The accountability of volume computations is greatly affected by damping of the fluid movement in a bellows unit and by chart rotation where the flow rates vary. A valuation of flowing conditions at the metering station and adjustments made to the recorder for accountability in measurement are recommended.

Flowing temperature measurement:

When desired, a third measurement device can be added to chart the flowing temperature. The recording of the flowing temperature should not distort the value of other recordings and be of a range appropriate for the actual flowing temperature. The calibration of recording accuracy is important to recording the flowing temperature onto the chart for volume computation. The degree of travel from 0 to 100 of chart range and degree of travel at zero chart range between the differential pressure pen is set by the manufacturer to agree with the integrator pen movements for correct averaging of temperature to flow values at the same moment in time. If the temperature recording is not correctly calibrated for chart recording, the volume computation may be in error.

The continued accuracy of the orifice meter chart recording depends on proper upkeep of the recorder to maintain it in proper working order. Establishment of a regular schedule of inspections can help ensure proper operation. The inspection schedule may depend on company policy, importance of the station, size (in terms of daily flow volume), type of equipment, etc.

Conclusion:

In closing, it is important to remember that the recorder records historic information from which volumes are computed and money is exchanged between companies. The accountability of measured volumes is only as good as the accuracy of the recordings.