Title: Achieving Accuracy in Orifice Meter Installations by W.R. Henry

ACHIEVING ACCURACY IN ORIFICE METER INSTALLATIONS

By
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In order to control as much as possible the accuracy of the measurement in an orifice installation, it is necessary to consider all the following points:

1. Design of the equipment and its limitations.

a. Non-pulsating flow only. Pulsation has a severe detrimental affect on all head type meters so those locations are to be avoided.

b. Single-phase fluids only. The flow pattern is badly affected by the presence of two phases such as excessive amounts of liquids in a gas stream, which would result in significant measurement errors.

c. Orifice measurement is accomplished only with some permanent pressure loss and this can be a serious limitation at low pressures.

d. Limit on rangeability. Since flow varies as the square root of the differential pressure, one orifice bore size is limited to about a 3 to 1 range. This can be overcome by changing plates, multiple parallel meter tubes, multiple stacked transducers or a combination of the three.

e. There are limitations on line size and orifice plate bore size if published data is to be used in the volume calculation. The AGA report No. 3 on The Orifice Metering of Natural Gas lists factors for 2" through 30" nominal line sizes and limits the use of beta ratios from 0.15 to 0.70 for flange taps and 0.20 to 0.67 for pipe taps. Better accuracy can be expected if these values are narrowed to 0.25 to 0.60.

f. The Reynolds number factor and expansion factors are not limitations in high-pressure gas measurement. However, care should be taken to keep the Reynolds number above 8000 in a 2" line ranging up above 500,000 in a 30" line. The expansion factor can cause problems at pressure below 100 pounds when widely varying pressure differentials are experienced.

g. Inlet piping configurations that cause velocity profile distortion must be overcome with proper meter tube lengths and/or the use of straightening vanes.

h. Accurate sensing of temperature, differential a static pressure, as well as specific gravity or density is mandatory if accurate measurement is to be the end result.

2. The primary element must be manufactured to meet specifications.

a. Consideration must be given to the length, roundness, roughness and proper inside diameter of the meter tube.

b. The flatness, roughness, thickness, sharpness and bore tolerances of the orifice plate are of primary importance.

c. The plate holding device must correctly center the orifice plate and have proper size and location of the tap holes.

3. Proper installation of the metering equipment.

a. Careful handling of the equipment to avoid dame during installation.

b. Correct piping configuration adjacent to the meter tube so as to not distort the flow profile.

4. Operation of the meter station.

a. A major source of potential error is the sensing of the differential pressure and other variables. For example, an error of ½" at a differential pressure of 100" represents a 0.3% error in flow, but at 10" a 2.5% flow error. Differential pressures should be kept as high as possible.

b. Similar errors in flow can result from inaccurate sensing of the other variables also: temperature, specific gravity or density. Likewise, care should be taken when sensing the variables that establish the expansion and supercompressibility factors. Significant errors can occur if these factors are established incorrectly.

5. Maintenance of the meter station to obtain long term measurement performance.

a. There must be periodic inspection of the orifice plate and meter tube to observe any changes from their initial condition. Frequency of the inspection will depend on the condition of the fluid being measured and the importance of that particular metering point.

b. Periodic calibration of the secondary elements must be carried out against known standards. Again, the frequency of the calibration will depend on the importance of the measurement at that station.

6. Calculation of the volumes from the recorded data.

a. Care and attention should be given to the selection of the correct equation and factors in computing the flow.

To summarize, good accuracy can only be obtained by controlling the potential sources of error:

1. Proper equipment design
2. Correct manufacture of this equipment to established specifications.
3. Proper installation.
4. Correct operation of the meter station.
5. Maintenance of the meter station.
6. Correct selection of factors to compute the flow.

Appendix C in AGA Committee Report No. 3 is a discussion of the tolerances that might be expected in the computation of flow using an orifice meter. It also gives an example of determining the expected accuracy of a metering installation by use of a root mean square calculation. This says that the calculated tolerance on the basic units of a measuring point expressed in terms of a standard deviation is equal to the square root of the sum of the squares. To cover the entire meter station, the tolerances on each of the secondary elements

should also be included in the calculation.