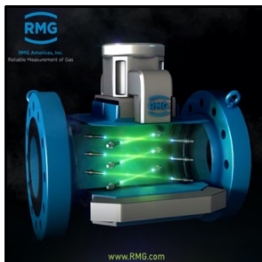


Benefits of Using Flow Conditioning with Gas Ultrasonic Meters

Written by John Lansing



Introduction

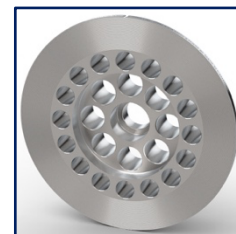
AGA Report No. 9 (AGA 9) [Ref. #1] requires flow calibration for all fiscal applications to reduce the meter’s overall uncertainty. AGA 9 also discusses uncertainty requirements, due to field installation effects, a USM manufacturer must meet once the meter is installed. All USM manufacturers provide piping recommendations to comply with the AGA 9 field uncertainty budget of $\pm 0.3\%$. Traditionally gas ultrasonic meters are flow calibrated with upstream piping spools that include a flow conditioner (FC). The initial reason for calibrating the USM is to reduce the meter’s uncertainty. But a second, and perhaps more important benefit, is to obtain baseline meter diagnostics information. Meter diagnostics, which are discussed in AGA 9, are used to help validate it is still operating accurately once installed in the field. For example, upstream field piping can create significant flow disturbances that may not be accounted for during calibration. Therefore, installing a flow conditioner with the meter significantly reduces, or eliminates, these field distortions. This makes comparing the flow calibration diagnostics to the field installed diagnostics much easier and more meaningful.

Meter Path Design Discussion

There are many different USM path configurations in use today. Each manufacturer strives to provide the lowest possible uncertainty in order to comply with industry standards or regulations, and to also have a perceived competitive advantage. In some world areas, the use of a flow conditioner is deemed unnecessary for a variety of reasons such as cost, and pressure drop. Thus, most USM manufacturers have piping recommendations that do not utilize a flow conditioner. Although USM designs can meet today’s AGA 9, Measurement Canada (MC) PS-G-06 [Ref. #2] and ISO 17089 [Ref. #3] performance requirements, the use of a flow conditioner will reduce virtually any meter’s field installed uncertainty. But perhaps the biggest benefit of using a flow conditioner is to provide a more stable and repeatable velocity profile once the meter is installed in the field. Without a stable and repeatable profile, it may not be possible to validate the meter’s installed accuracy.

Test Details

In June 2020, CPA conducted a series of tests at the TransCanada Calibration (TCC) facility in order to validate that a shorter upstream piping package, when used with the CPA 55E (shown on the right), would meet MC’s $\pm 0.3\%$ uncertainty budget. The piping package tested included 3D + CPA 55E + 3D spool pieces. Typical OIML R-137 [Ref. #4] upstream piping configurations were used to demonstrate this packages’ performance. TCC used an RMG GT400 6-path meter for these tests. This “metering package” easily met all of the MC’s requirements. Results were summarized in **Tech Note 3** [Ref. #5]. Meter diagnostic data was collected from the USM for all of the installation effects tests. Perhaps the most difficult test included two out-of-plane (right-turn) elbows with a ½ moon plate between the elbows. This test created very significant swirl and asymmetry flow profile distortions that simulate what can occur in the field. Data collected was labeled using abbreviations like RT DBOOP FC HMP (double elbows out-of-plane, right turn, FC, ½-moon plate) to identify the “installation effect” type. Diagnostic data was also collected with the same upstream piping (3D + 3D), but **with no CPA 55E**.



Diagnostic Data Results

Following are graphs collected during the RT DBOOP FC HMP test, using RMGView software, for three of the most important meter velocity and swirl diagnostics. These graphs were collected during testing at 40 feet per second (FPS) and represent diagnostic information for Individual Path Velocity (Fig. 1), Swirl by Plane (Fig. 2) and Cross Flow Velocity by Plane (Fig. 3).

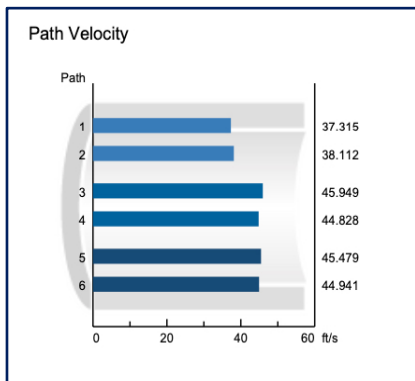


Figure 1 – Path Velocity

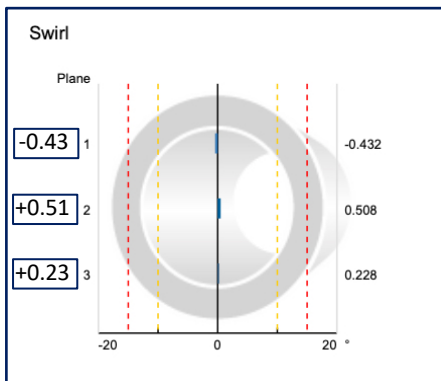


Figure 2 – Swirl by Plane

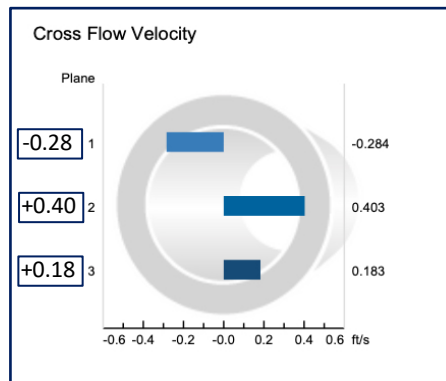


Figure 3 – Cross Flow Velocity by Plane

Benefits of Using Flow Conditioning with Gas Ultrasonic Meters

Written by John Lansing

There are several important diagnostic details shown in these three graphs. First, Figure 1 shows some asymmetry is still present from top to bottom, but the individual path velocities for each plane were very close. This is further supported by Figure 3 which shows extremely little Cross Flow Velocity by Plane. The bar graphs make it look significant due to the graph's "auto-ranging" feature. However, upon further inspection, it is evident that the amount of Cross Flow Velocity is negligible. Figure 2 shows virtually no Swirl for each of the 3 planes. This data demonstrates just how good the CPA 55E swirl reduction capabilities are. The following diagnostic graphs were obtained from the same upstream piping configuration (RT DBOOP HMP) at 40 FPS, but **without the CPA 55E**. Essentially this means there was 6 nominal diameters (ND) upstream of the meter.

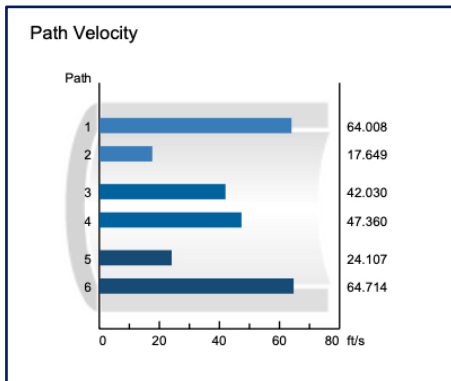


Figure 4 – Path Velocity

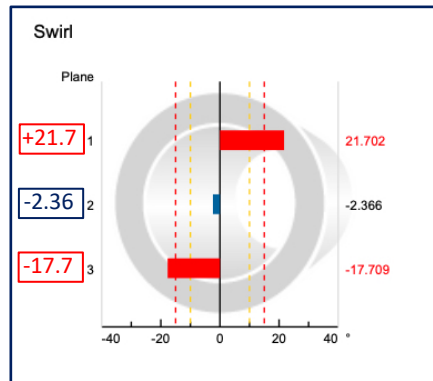


Figure 5 – Swirl by Plane

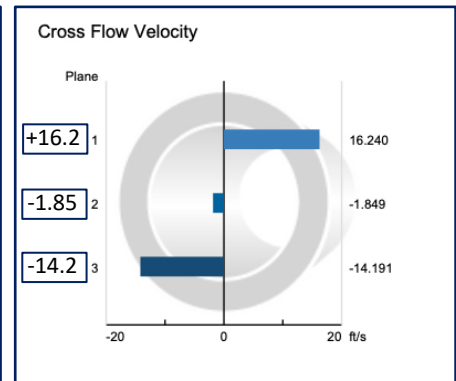


Figure 6 – Cross Flow Velocity by Plane

Figure 4 shows a tremendous difference in Path Velocities by Plane, especially Paths 1 vs. 2 and Paths 5 vs. 6 where the level of swirl is very high. By comparing Figure 4's profile with that of Figure 1, a significant difference is apparent. Figure 6 shows the excessive level of Cross Flow Velocity by Plane, in particular Planes 1 & 3. The Cross Flow Velocities in Figure 3 were well under 0.5 FPS, whereas the values in Figure 6 show velocities in excess of 14 FPS. When comparing Figure 5 with Figure 2 it's clear there's a tremendous amount of residual Swirl Angle by Plane that was not present with the CPA 55E. In Figure 5, both Planes 1 & 3 have active Warning and Alarm limits. The Swirl Alarm limit has been exceeded so the meter is now reporting this graph in Red as opposed to the blue as shown in Figure 2.

Summary

Today's gas ultrasonic meter can handle a significant amount of flow profile distortions and still remain within the uncertainty guidelines of the various Industry documents. This has been demonstrated by many published papers over the past several years. **However, proving the USM is still accurate once installed in the field, and that it continues to remain accurate over time, is just as important as the initial flow calibration.**

The reason clients collect diagnostic log files at the time of flow calibration is to use them to help validate the meter's accuracy has not changed significantly once installed in the field. If a meter is installed without a flow conditioner, flow profile information, as shown in Figures 4-6, are nowhere representative of those shown in Figures 1-3. Thus, it would be very difficult to validate this meter's accuracy has not been affected by comparing the meter's diagnostics with and without the CPA 55E.

RMG Tech Notes

This is the 7th Tech Note in our series. Previous Tech Notes are posted on our website at our [website](#), or we can email them to you. If you have any questions, please contact us at SalesUSA@RMG.com.

References

1. *AGA Report No. 9, Measurement of Gas by Multipath Ultrasonic Meters, Third Edition, July 2017*, American Gas Association, Washington, DC.
2. *Measurement Canada PS-G-06-Provisional specifications for the approval, verification, reverification, installation and use of ultrasonic meters, Revision 4, dated 2017-11-15.*
3. *ISO 17089-1:2019, Measurement of fluid flow in closed conduits – Ultrasonic meter for gas, August 2019, Second Edition*, Geneva, Switzerland.
4. *OIML R 137-1 & 2, Edition 2012(E), Including Amendment 2014*, International Organization of Legal Metrology.
5. *Tech Note 3: Shorter Upstream USM / CPA Piping Lengths Significantly Reduces Cost*, John Lansing, November 2020, [Link to Tech Note 3](#).