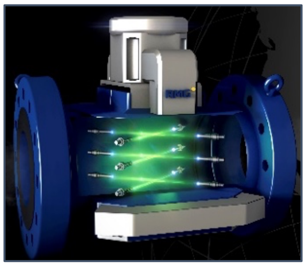
GT400-3P 4-inch Gas Ultrasonic & Orifice Meter Wet & Dry Gas Test Results

Written by John Lansing



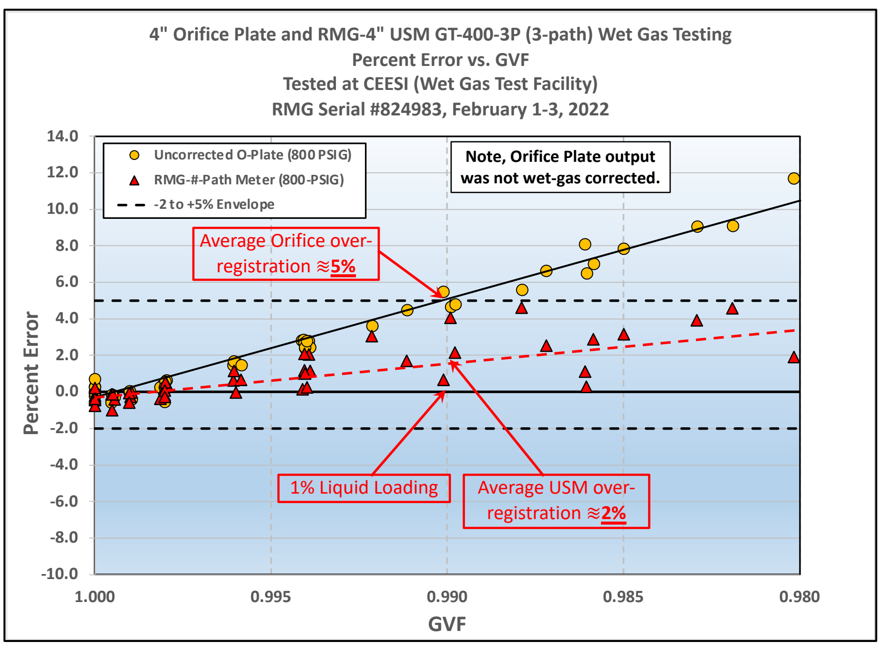
Introduction

The use of multi-path gas ultrasonic meters (USMs) in upstream/midstream applications, where liquids may be present, has generally been considered not a viable application for this technology. Since there are many different USM path configurations in use today, *one should not assume poor wet-gas performance by one meter design translates into the same performance for all others*. To better understand how the **new RMG GT400-3P** (3-path) 4" SCH 80 gas USM responds to liquids, testing was conducted at the CEESI Wet Gas Multiphase Test Facility in February 2022. Data included in this document was collected and processed by the CEESI staff. **During the GT400-3P testing, CEESI also collected data on a 4" orifice meter located downstream of the USM.** This Tech Note compares the results of the **RMG GT400-3P** with the orifice meter. Additionally, dry gas installation effects testing was performed at the TransCanada Calibrations (TCC) facility. All testing was conducted **without using a flow conditioner** to simulate meter performance for low-pressure-loss applications, or where significant contamination and/or debris will likely be present.

Wet Gas Test Details

There were 3 main objectives for testing the GT400-3P in wet gas with no flow conditioner. **First**, quantify the amount of over-registration relative to the downstream orifice meter. **Second**, identify how much liquid the meter can handle before the lower path stops working. **Third**, identify/verify which diagnostics changed, when they begin changing, and the extent of these changes. The test pressure was approximately 800 PSIG, gas temperature was between 80°F and 90°F, and the four gas velocities were approximately 71, 40, 20 and 10 FPS. The Gas Volume Fraction (GVF) varied from 1.000 (which is 100% gas) to about 0.980 GVF (98.0% gas). The liquid was Exxsol D80 which is commonly used to simulate field hydrocarbon condensates.

The graph below shows the effect on each meter's accuracy, from no liquid loading (1.000 GVF) to the maximum of 0.980 GVF. The black solid line represents a linear interpolation of the orifice meter results, and the red dotted line represents the USM's results. Transducer performance was 100% for all tests until the GVF approached 0.980. At this point path 3's performance began to decline (the path closest to the bottom). Pictures below & right show the GT400-3P meter and the 4" orifice meter.



At the highest gas flow rate (~71 FPS), the GT400-3P meter was measuring around 23,000 ACFH. The corresponding maximum liquid flow rate, for a GVF of 0.9771, was 65.9 gallons per minute (GPM), or 89.9 barrels of Exxsol D80 per hour. With a GVF of 0.99 (1% liquids), this graph shows **the orifice over-registering by about 5%** while the GT400-3P over-registered **by about 2%.** At the lower GFV of 0.980 (2% liquids), the orifice is over-reading by about 10% where the GT400-3P is less than 5%. There is some scatter in the USM data for the lower GVFs. This is to be expected as the lower gas velocities are unable to move the liquid in a more stable manner. Meter diagnostics began indicating the presence of liquids around a GVF of 0.994 (about 0.6% liquids). At this liquid loading the USM was over-registering by approximately 1% where the orifice was now approaching 2%.

Dry Gas Installation Effects Test Details

To demonstrate the GT400-3P can be used in applications which dictate no flow conditioning, TCC performed a series of installation effects tests to simulate a variety of "real-world" upstream piping conditions. Tests were conducted with 10 ND of

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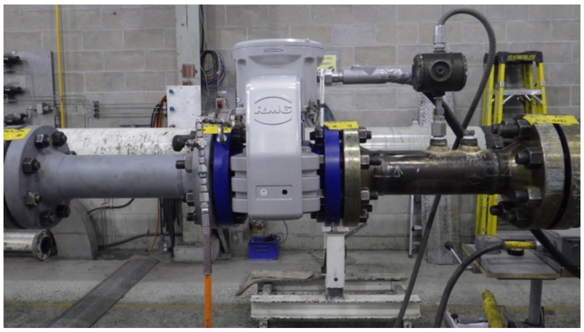
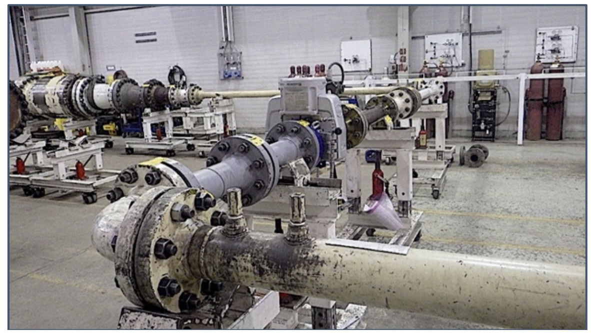
SCH 80 straight piping upstream of the meter **with no flow conditioner** (two 5 ND spools). Baseline testing was conducted to obtain meter performance data over the normal full flow-rate range of operation. Baseline nominal velocities included 100, 70, 40, 25, 10, 5 and 1.5 FPS. Perturbation installation effects included a Single Elbow (SE), Double Elbows in-plane (DEIP) and Double Elbow out-of-plane (DEOOP) for velocities of 100, 40 and 10 PFS. Since most clients would not use a tee upstream for these applications, it was not included in the test protocol. Following are pictures of the RMG GT400-3P during testing at TCC.



Baseline Testing



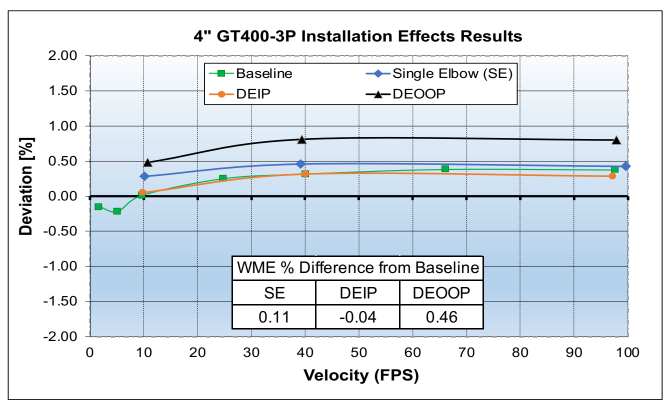
Single Elbow (SE) Testing

Double Elbow In-Plane (DEIP) Testing

Double Elbow Out-of-Plane (DEOOP) Testing

Installation effects testing and calculations followed the OIML R137-1 & 2 guidelines [Ref 1]. A Weighted Mean Error (WME) was determined by TCC from the baseline testing using all gas velocities. TCC also computed the WME for each of the three installation effects tests. The table below summarizes the WME for each of these installation effects and includes the gas velocities and corresponding errors.

Baseline		Single Elbow (SE)		DEIP		DEOOP	
Velocity	Error	Velocity	Error	Velocity	Error	Velocity	Error
97.66	0.38	99.62	0.42	97.21	0.28	97.92	0.80
40.12	0.32	39.21	0.46	40.07	0.32	39.47	0.81
9.67	0.01	10.14	0.28	9.80	0.05	10.77	0.48
WME	0.309	**WME**	0.422	**WME**	0.270	**WME**	0.77



The table above shows the "as-found" WME to be +0.309%. The graph to the right summarizes baseline data, shown by the green line, and includes all test velocities. Also graphed are the results for each of the three tests. The table in this graph indicates the <u>difference</u> for each perturbation test relative to baseline. The Single Elbow (SE) and DEIP WME results were within ±0.11%. The most severe DEOOP test, due to the high level of swirl from the close-coupled elbows, shows +0.46% shift relative to baseline.

Summary

The new **RMG GT400-3P** gas ultrasonic meter was developed for upstream/midstream applications where liquids are often present. All tests were performed **with no flow conditioner**. CEESI Nunn's liquid-loading results showed the effect on accuracy to be **<u>less than half that of the orifice</u>.** All TCC WME perturbation errors were less than 0.5% relative to baseline. Performance of **the uncalibrated GT400-3P meter**, even during the high-level (DEOOP) perturbation test, showed a total uncertainty of less than 1%, and less than 0.5% for the Single Elbow (SE) and Double Elbow in-plane (DEIP) tests. The addition of a CPA 55E at 5 ND would certainly reduce these perturbation effects for clients that desire even lower uncertainty.

References

1. *OIML R 137-1 & 2, Edition 2012(E), Including Amendment 2014*, International Organization of Legal Metrology.