Wet Gas Sampling

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Abstract

The API Wet Gas Sampling Committee, under the API Committee on Production Measurement & Allocation (CPMA), conducted a study to identify potential sources of errors in the sampling of natural gas flow streams containing small amounts of free hydrocarbon liquid (wet gas). The objectives of the study were to quantify measurement uncertainty associated with using dry gas sampling methods to sample wet gas streams, and to provide recommendations for future wet gas sampling test programs.

A binary mixture of methane and n-heptane was used as a testing media. The testing was conducted in a closed-loop test facility at an elevated pressure of 700 psig and ambient temperatures in a 3-in. pipe. The dry gas sampling method per API *Manual of Petroleum Measurement Standards* (*MPMS*) Chapter 14.1 (*Collecting and Handling of Natural Gas Samples for Custody Transfer*), Section 12.7 purging—fill and empty (PFE) was used to collect the wet gas samples.

NOTE API *MPMS* Ch. 14.1 scope is limited to gas sampling at or above the natural gas hydrocarbon dew point. Furthermore, API *MPMS* Ch. 14.1 states the sampling of multiphase flow streams (free liquid and gas) should be explicitly avoided.

The wet gas samples were analyzed using gas chromatograph (GC) methods and compared to measured reference gas flow rate and liquid flow rate streams. This report summarizes the wet gas testing methodology, test setup, test results, conclusions, lessons learned, and recommendations.

Contents

Page

1 Introduction 1

2 Wet Gas Physical and Technical Challenges 1

3 Executive Summary 2

4 Acronyms 3

5 Wet Gas Sampling and Testing Methodology Considerations 3

5.1 Liquid Dropout Testing Approach 3
5.2 Liquid Injection Test Approach 4

6 Test Objectives and Approach 4

7 Test Facility and Testing Configuration 6

7.1 Test Setup 8
7.2 Test Procedure 9
7.3 Sampling Procedure 10
7.4 Test Matrix 11

8 Results 15

9 Uncertainty Analysis 18

9.1 Mass Flow Rate Uncertainty Methodology 20
9.2 Compositional Uncertainty 20
9.3 Discussion 24

10 Conclusions 24

11 Lessons Learned 25

12 Recommendations 25

Annex A (informative) Background Paper for CPMA Wet Gas Technical Report 27

Annex B (informative) Flow Visualization Spool 31

Annex C (informative) Addressing the Challenges of Wet Gas Sampling and Analysis in the Context of Upstream Production Measurement and Allocation—A White Paper 33

Figures

1 Closed-loop Liquid-injection Testing Configuration P&ID Drawing 5

2 SwRI Multiphase Flow Facility 6

3 Model of Test Section Layout 7

4 Test Section Photograph—View from Upstream of Wet Gas Sample Location 7

5 Test Section Photograph—View from Upstream of Wet Gas Sample Location 8

6 Close-coupled Sampling Setup 10

7 Wet Gas Operating Conditions Superimposed on Flow Pattern Map 12

8 Free Liquids Missed by the Wet Gas Sampling Method vs Lockhart-Martinelli Number 16

9 Free Liquids Missed by the Wet Gas Sampling Method vs % GVF 16

10 Wet Gas Sampling Molecular Weight Percent Error vs Lockhart-Martinelli Number 17

11 Molecular Weight Random Error Percentage vs Lockhart-Martinelli Number **18**
12 Equations/Methodology to Determine Wet Gas Composition **21**
13 Equations/Methodology to Determine Wet Gas Composition **21**
14 Equations/Methodology to Determine Wet Gas Composition **21**
15 Equations/Methodology to Determine Wet Gas Composition **22**
A.1 Measurement Triangle **27**
B.1 Lateral Flow Image **31**

Tables

1 Gas Sampling Procedure **11**
2 Wet Gas Sampling Test Matrix **12**
3 Test Matrix for Saturated Gas **13**
4 Test Matrix for Wet Gas XLM = 0.010 ..... **13**
5 Test Matrix for Wet Gas XLM = 0.015 ..... **14**
6 Test Matrix for Wet Gas XLM = 0.02 ..... **14**
7 Test Matrix for Wet Gas XLM = 0.025 ..... **15**
8 Comparison of SwRI Stated Uncertainties to API Wet Gas Sampling Committee Calculated Uncertainties for Orifice Plate Gas Flow Rates **19**
9 Comparison of SwRI Stated Uncertainties to API Wet Gas Sampling Committee Calculated Uncertainties for Coriolis Liquid Flow Rates **19**
10 Orifice Plate Uncertainty Budget **19**
11 Coriolis Meter Uncertainty Budget **20**
12 Reference Metering Uncertainty Estimation **22**
13 Saturated Gas Composition (from Gas Analysis) and Uncertainty **22**
14 Saturated Liquid Composition (from PVT Package) and Uncertainty **23**
15 Reference Wet Gas Composition and Uncertainty **23**
16 Wet Gas Composition and Uncertainty **23**
17 Average Wet Gas Uncertainty **23**
18 Average Wet Gas Uncertainty **24**
B.1 Reference Instrumentation **32**

Disclaimer

The dry gas sampling method per API *MPMS* Ch. 14.1, Section 12.7 PFE was used to gather the wet gas samples in this study. API *MPMS* Ch. 14.1 scope is limited to gas sampling at or above the natural gas hydrocarbon dew point. Furthermore, API *MPMS* Ch. 14.1 states, “The sampling of multiphase flow streams (free liquid and gas) should be explicitly avoided.”

Wet Gas Sampling

1 Introduction

Current API/GPA[1] standards only address dry gas sampling, such as encountered with pipeline quality gas. Dry gas can be defined as gas at or above the saturation temperature at the operating pressure in the pipe with no free hydrocarbon liquids present. Dry gas sampling techniques can produce large bias errors when free liquids are brought into the sampling vessel. Captured wet gas samples may not represent the true ratio of the gas and the liquid components in the flow stream.

In two-phase flow, the gas and the liquid components are not homogenous; they flow at different velocities and in different quadrants of the pipe. The phase distribution in the pipe is a function of the fluid's two-phase flow regime that depends on complicated wet gas parameters, including the gas–liquid density ratio, superficial gas and liquid velocities, pipe diameter, interfacial tension, and other two-phase flow parameters. Upstream and downstream fittings and pipe elevation changes can create liquid "hold-up" areas where liquid velocities slow and occupy a larger percentage of the pipe. The objective of the study is to characterize the uncertainties of using dry gas sampling techniques to collect samples from a wet gas stream.

2 Wet Gas Physical and Technical Challenges

Extracting the correct liquid-to-gas ratio is crucial to obtaining a sample that represents a two-phase source. In a two-phase natural gas stream, the liquid phase contains high concentrations of the heaviest hydrocarbon components, the heaviest components have the highest heating value per unit volume, and a small volume of liquid expands to a large volume of gas. Uncertainty in the quantity of liquid included in a two-phase sample magnifies uncertainty in the composite fluid composition, which is the basis for determining heating value. Too much liquid in the sample and the heating value will be too high; too little liquid in the sample and the heating value will be too low.

The ratio of the gas mass flow rate to the liquid mass flow rate directly impacts the fluid's overall composition, which in turn affects the BTU content traveling down the pipe. Extracting a wet gas sample from a single, discreet location in the pipe may not represent the true ratio between the gas and the liquid bulk mass flow rates. Liquids may not flow uniformly from the sampling probe's tip through the connecting tubing leading to the sampling vessel. Depending on the sampling fluid velocity in the connecting tubing, liquids can cling to the connecting tubing walls or collect in the connecting fittings. Depending on heat losses between the connecting tubing and the ambient air, the saturated gas flowing through the connecting tubing can further condense depositing additional liquids in the connecting tubing walls and fittings. Depending on the pressure drop from the sampling probe's tip to the sampling vessel, liquids clinging to the connecting tubing walls may flash or further condense and change the sample vessel's composition.

Existing analytical methods of a captured wet gas sample require the entire sample be raised to an elevated temperature that vaporizes all the sample's components. Since the components in the captured sample are not known a priori, one must guess the required elevated temperature to vaporize all the components. Additionally, sampling bottle seals are often not rated to the temperature required for complete vaporization.

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[1] GPA Midstream Association (GPA), 6060 American Plaza, Suite 700, Tulsa, OK 74135, www.gpamidstream.org.