Wet Gas Sampling – old challenges and new perspectives

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Outline

• Drivers for wet gas sampling
• Information derived from wet gas sample
• What does rich gas look like? How does it behave?
• Industry standards for natural gas sampling
• How does the industry sample wet gas?
• Old challenges and a new perspective
Gas production is on the rise

• Sources of rich gas:
  – Associated gas from deep water production
  – Rich gas and retrograde condensate reservoir fluids
  – Unconventional gas (shale gas/tight gas)

• Rich gas sources create wet gas conditions

• Wet gas production is not new
  – Widespread attempts to sample it is relatively new development
Shale gas production in 2015 was 37.4 Bcf/d, accounting for 50% of total US natural gas output.

Projected to reach 79 Bcf/d in 2040.
Drivers for wet gas sampling

• Accelerated rate of new production stream
• Measure properties of hydrocarbons produced from challenging sources and location
• Small to mid-size operators use third party gathering entities
  – Drives the need to sample further upstream of gas plant
• Increasing use of complex shared pipeline networks raises potential allocation issues
Information derived from wet gas sample

- Liquid loading for correction of single-phase meters
- Provision of meter configuration parameters
- Validation of wet gas meters
- Determination of overall mixture composition
- PVT studies
- Determination of water present
- Solids determination
What does rich gas “look” like?

<table>
<thead>
<tr>
<th>Component / Quantity</th>
<th>AGA 8 Normal Range (mol% or value)</th>
<th>Processed Pipeline Gas</th>
<th>Ultra Deepwater Associated Gas</th>
<th>Onshore Commingled Gathering Line Gas</th>
<th>Barnett Shale Gas</th>
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<tbody>
<tr>
<td>N2</td>
<td>0-50</td>
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<td>CO2</td>
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<td>C1</td>
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<td>0.9121</td>
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<td>GHV</td>
<td>477-1150 Btu/scf</td>
<td>1018</td>
<td>1516</td>
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</tbody>
</table>
Phase envelopes of dry and wet gas systems

- Path 1-2: Reservoir depletion at constant temperature
- Path 1 – Separator: P-T trajectory in the production process
Industry Standards for gas sampling

- API MPMS Chapter 14 – Natural Gas Fluids Measurement, Section 1 – Collecting & Handling of Natural Gas Samples for Custody Transfer (API 14.1)
- GPA 2166-05 – Obtaining Gas Samples for Analysis by Gas Chromatography
- ISO 10715 – Natural Gas Sampling Guidelines
Industry Standards for gas sampling

- **Equipment recommendations**
  - Membrane filter, probe regulator, pigtail…..etc

- **Spot sampling methods**
  - Purging, evacuated container, helium pop, glycol/water displacement, FPC......etc

- **Best practices**
  - HCDP, line heating
Industry Standards for gas sampling – a commentary

• Applies to transmission quality gas
• Recommendations for equipment, methodologies and best practices for single-phase sampling
• Stresses the need to sample at conditions sufficiently far from a dew point (DP) state
  – Create condition to move away from DP
• DOES NOT APPLY TO WET GAS SAMPLING
• API 14.1, Appendix C – Lessons Learned During Sampling in Saturated and 2-Phase Natural Gas Stream
  – “...none of the current methods are capable of obtaining a representative wet gas sample.”
How does the industry conduct wet gas sampling?

- Use of or modification of equipment and methods per API 14.1 and GPA 2166-05
- Addition of mechanical device to disperse liquid phase
- Bespoke equipment and methodologies
- Potential issues:
  - Lack of traceability
  - No independent performance verification
Is there a problem? How bad is the problem?

• What is the impact of misapplication of industry standards?

• What uncertainty range exists with the current approaches?

• What is the range of business impact?
  – Altered single-phase gas sample can produce errors in gas properties in excess of 10%*

* George, D.L and Kelner, E.: Lesson Learned from API MPMS, Chapter 14.1 Gas Sampling Research Project, ASGMT (20??)
Wet gas sampling - old challenges

• What is a “representative” sample?
  – Representative of what?

• Can a “representative” sample be obtained?
  – Very difficult to impossible

• How does one know a “representative” sample has been obtained?
Factors that affect wet gas sampling

- Dynamic changes in gas velocity changes flow regime
- Liquid distribution along pipe wall changes rapidly downstream of mixer
  - Precludes spot sampling?
- Probe spatial attributes
- Probe design

Wet gas sampling – a new perspective

• What is the information needed from the sample?
  – What is the business and operational impact of the information uncertainty?

• What fluid type is needed to obtain the information?
  – Fluid that recreates the in-situ reservoir composition
  – Gas phase only
  – Liquid phase only

• What analytical procedure is needed to obtain the information needed?
Wet gas sampling to recreate the in-situ reservoir fluid

• Representative in the context of a composite mixture that recreates the reservoir fluid composition
  – From representative sample to representative composite mixture recombined from the sample

• Requires samples of gas and liquid phases at same state of P/T
Representative composite mixture from non-representative samples

- Wet gas stream sampled either spot or composite at flowing conditions ($P_S$ and $T_S$)
  - Equilibrium gas and liquid phases
- Sampling condition is recreated in the laboratory
- Gas and liquid phases are separated at equilibrium condition
- External reservoir fluid property used as boundary condition for recombination
Reservoir fluid property sources

• PVT study on original downhole fluid sample
• Formation pressure surveys
• Others?

• Fluid properties of interest, e.g.,
  – Dew point pressure at $T_{\text{reservoir}}$
  – CGR
  – In-situ fluid density
  – Others?
Information derived from wet gas sample recombined fluid

- Liquid loading for correction of single-phase meters
- Provision of meter configuration parameters
- Validation of wet gas meters
- Determination of overall mixture composition
- PVT studies
- Determination of water present
- Solids determination for flow assurance
CPMA Wet Gas Sampling Ad-hoc WG

• CPMA ad-hoc group on emerging issues / new standards – 1st met on 2016 API Fall meeting
  – Wet gas sampling ad-hoc group (J. Landes, SPL)
  – Vented sources of gas ad-hoc (J. Woodward, SGS)
  – Proving and meter verification for allocation ad-hoc group (C. Woods)
Let’s have a conversation...

Look forward to your questions or comments...

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