ABB MEASUREMENT & ANALYTICS | ARTICLE

Application engineered sampling solutions
Gas quality measurement

Accurate, repeatable and reliable measurement of natural gas quality requires extractive analytical measurement in addition to application engineered sample extraction and sample conditioning solutions.

Measurement made easy

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The NGC Liquid Injection System is fully compliant with GPA-2177, and is suitable for use with any liquid stream having a dew point below 100°C, including: NGL's, Y-grade condensates, and BG gasoline.

Accurate, repeatable and reliable measurement of natural gas composition and gas contaminants requires extractive analytical measurement in addition to application engineered sample extraction and sample conditioning systems.

Analyzers for measurement of natural gas composition and gas contaminants operate at low pressure and require the extraction of high pressure natural gas from the pipeline, pressure regulation, transport of the sample to the analyzer, and final sample conditioning for introduction to the analyzer.

This seems simple enough but represents various challenges to assure that the sample introduced to the analyzer is representative of the process and that the analyzer is protected against process upset conditions that can adversely affect or damage the analyzer.

Extracting a flowing representative sample and transporting it and maintaining the sample in its representative state from the sample extraction point to the analyzer module requires application engineering of every measurement application and its unique process and operational conditions.

Analytical measurement of natural gas is further complicated in that natural gas is comprised of a variety of hydrocarbon and non-hydrocarbon molecules and these vary depending on whether it is production gas, the characteristics of the producing region or well, whether the natural gas is treated and/or processed, or whether the lighter hydrocarbon components have been separated from the heavier components and the product is then a Natural Gas Liquid (NGL). There are countless scenarios, requiring that each measurement point be approached as a unique measurement case.

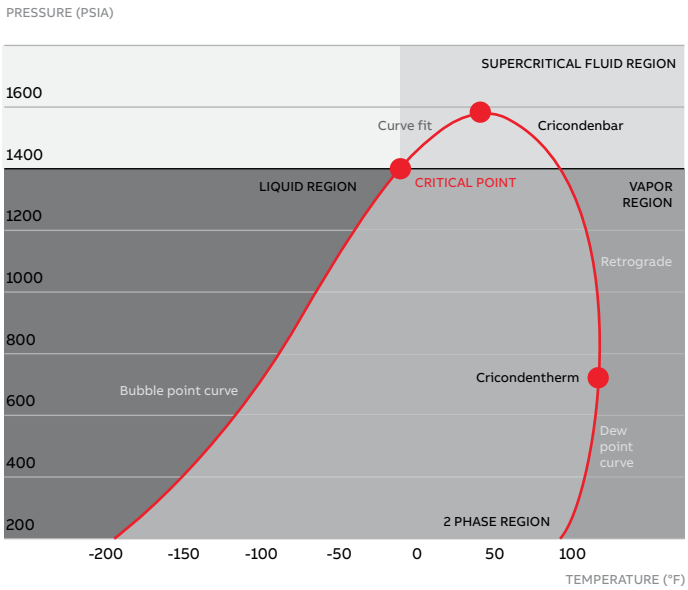
Natural gas & NGL is comprised of a variety of hydrocarbon and non-hydrocarbon molecules:

- Molecules from the produced gas
  - Hydrocarbons C1-C12+, H2O, H2S, CO2, N2, etc.
- Contaminants from gas treatment processes, additives to prevent the formation of hydrates, and scavenger chemical for H2S reduction
  - Methanol, Amine, Glycol, H2S Scavenger
- Atmospheric ingress contamination from leaking seals or maintenance events
  - O2, N2, CO2

Every measurement application need to be reviewed for considerations such as:

- Composition
- Measurements required and ranges
- Process conditions
- Environmental conditions
- Site requirements
- Operational requirements
- Validation requirements
- Each analyzer's sample flow & pressure specification

The first step to an application engineered solution is to obtain a lab analysis of the natural gas composition and the process pressure and temperature conditions in order to design a sample system solution for compliance with API 14.1 recommendations for natural gas sampling. This data is input into a fluid analysis program that outputs a graphical representation of the process under different pressure and temperature conditions, identifying liquid, two-phase and vapor phase regions . Using this graphical representation, an application engineered solution can be designed to maintain the sample in the vapor phase, 30°F to the right of the dewpoint curve as recommended by API 14.1.



The phase diagram and the cricondentherm will depend on the composition of the natural gas and specifically the presence of heavier hydrocarbon molecules with higher boiling points that condense at higher temperature. As can be seen in the table below, methane has a low boiling point of -162°C, and can be maintained in a vapor phase relatively easy for the purpose of sampling. Hexane on the other hand has a boiling point of 68.7°C, so even very small amounts of hexane in a natural gas composition will have a significant effect on the phase diagram and the cricondentherm.

Name	Molecular formula	Molecular mass	Melting point (°C)	Boiling point (°C)	State
Methane	CH_4	16	-182	-162	gas
Ethane	C_2H_6	30	-183	-88.6	gas
Propane	C_3H_8	44	-188	-42.1	gas
Butane	C_4H_{10}	58	-138	-0.5	gas
Pentane	C_5H_{12}	72	-130	36.1	liquid
Hexane	C_6H_{14}	86	-95.3	68.7	liquid
Decane	$C_{10}H_{22}$	142	-30	174	liquid
Hexadecane	$C_{16}H_{34}$	226	18.5	288	liquid

Many of the measurement application requirements in the natural gas industry can be categorized as follows, requiring varying degrees of sample conditioning, filtration and process upset protection.

Treated and processed consumer quality natural gas, custody transfer
- Low hydrocarbon and moisture dewpoint, clean, sweet

Rich production natural gas, untreated, sweet
- High hydrocarbon dewpoint, possibly also moisture dewpoint
- Rejection of free process liquids for sample extraction
- Vaporization and/or multi-stage pressure reduction
- Protection from production and processing contaminants, normal and upset conditions
- Analyzer module temperature conditioning to prevent sample from condensing

Rich production natural gas, untreated, sour
- Same as above, plus material compatibility and safety integrity requirements for H2S

Natural Gas Liquid (NGL)
- Liquid sample extraction with vaporization
  - Vaporizing regulator for light NGL
  - High heat NGL vaporizer for heavier NGL
  - Direct liquid injection to analyzer module for very heavy NGL
- Analyzer module temperature conditioning to prevent sample from condensing inside the analyzer

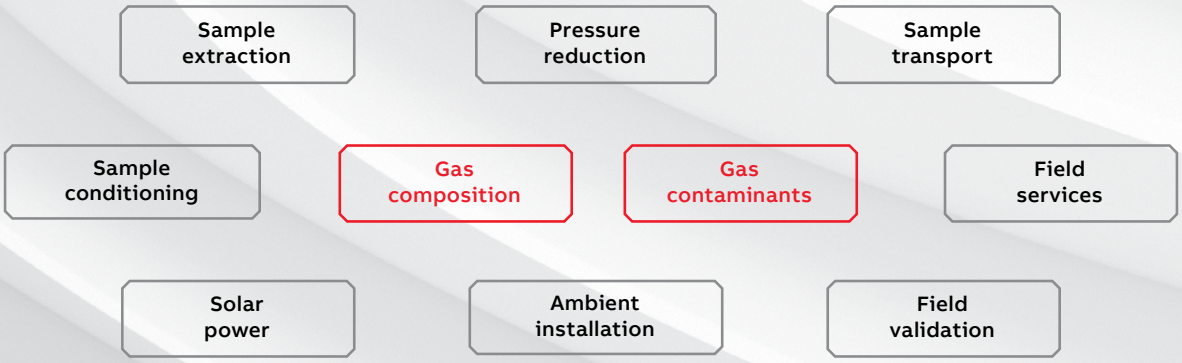
Another consideration is that higher process pressures may place the process extraction condition in the Supercritical region, which in addition to special considerations for seals, requires a greater degree of pressure reduction to reach the sample transport pressure. As a rule of thumb, a consumer quality natural gas will exhibit a temperature reduction of 7°F per 100 psig of pressure reduction. As an example, a reduction from a 630 psig process pressure to a sample transport pressure of 30 psig will exhibit a 42°F decrease in temperature due to the Joule-Thomson effect.

The physical installation of the analytical measurement solution requires assessment of the hazardous area classification and ambient temperature considerations for the analyzer, sample system and any peripheral components, such as calibration, validation and/or carrier gas. Power requirements may also be a consideration for remote sites with limited or no line power available, requiring solar and/or thermoelectric power generation.

In summary, selecting the right analyzer technology and product model for natural gas measurement is only one components of the many considerations required for accurate, repeatable and reliable gas quality measurement, others are:
- Sample extraction
- Sample pressure reduction & regulation
- Sample transport
- Final sample conditioning for analyzer
- Sample filtration & process upset protection of analyzer
- Sample vent
- Hazardous area compliance
- Calibration, validation and/or carrier gas
- Ambient operating & maintenance requirements
- Power
- Remote communications

At ABB, we understand that natural gas measurement is more than just the analyzer. Accurate, repeatable and reliable gas quality measurement requires an analytical measurement solution that is application engineered for the unique conditions of **every** measurement point.

At ABB, we have developed in-house application engineering and system integration expertise to provide gas quality measurement solutions to meet industry needs.



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