Gas Quality Monitoring for Traditional and Renewable Natural Gas

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Fuelling the Future

Gas Supply into Enbridge's Ontario System

- Major pipeline interconnects and TCE mainline transmission pipeline take offs
- Traditional gas producers
  - approx. 65 active points of delivery in southwestern Ontario
- Renewable natural gas (RNG) producers
  - landfill gas and biogas produced by decomposition or digestion of various sources of organic matter is upgraded to in spec RNG
  - receiving RNG from 7 producers, with more projects in the works

Focus is on gas quality monitoring for traditional gas producers and RNG producers.

Gas Quality Specifications

- All gas supplied to Enbridge's Ontario distribution and transmission networks must satisfy applicable gas quality specifications.
  - Gas Quality - Chemical composition and properties of natural gas mixtures

- Purpose of gas quality specifications
  - establish limits on gas components and properties
  - promote safe and reliable operation of distribution, transmission and storage systems
  - ensure existing and new gas supplies are interchangeable with historically supplied natural gas to minimize end-use concerns

Gas Quality Specifications

- Typical generic clause to protect pipeline systems from objectionable material (trace constituents) that makes the gas unmerchantable or causes damage to pipeline infrastructure and end-use equipment.

- *Freedom from Objectionable Matter*
  - *The gas must not contain any contaminants, particles, or other impurities at a concentration that is known as a threat to the integrity of the system, human health, or the environment.*

  - *The gas must be commercially free from bacteria, siloxanes, ammonia, halocarbons, heavy metals, sand, dust, gums, crude oils, lubricating oils, liquids, chemicals, or compounds used in the production, treatment, compression, or dehydration of the gas or any other objectionable substance in sufficient quantity that renders the gas toxic, unmerchantable, or causes damage to or interference with the proper operation of the lines, regulators, meters, or other appliances through which the gas flows.*

Gas Quality Specifications

Typical gas quality specifications applicable to all sources of supply to Enbridge's Ontario system.

Gas Quality Parameter	Limit(s)	Unit	Comment
Gross Heating Value	36.0 - 40.2	MJ/m^3	Interchangeability parameter
Wobbe Number	47.50 - 51.46	MJ/m^3	Interchangeability parameter
Carbon Dioxide (CO_2)	2	mol %	
Oxygen (O_2)	0.4	mol %	
Carbon Monoxide (CO)	0.5	mol %	
Total Inerts	4	mol %	Interchangeability parameter
Moisture (H_2O)	65	mg/m^3	
Hydrogen (H_2)	2	mol %	Subject to engineering assessment
Hydrogen Sulfide (H_2S)	7	mg/m^3	
Mercaptans	5	mg/m^3	
Total Sulphur	100	mg/m^3	
Butanes Plus	1.5	mol %	Interchangeability parameter
Cricondentherm HDP	-8	ºC	Calculated if C6+ > 0.06 mole%

Gas Quality Specifications

Additional gas quality specs for various potential “components of concern” in RNG.

Gas Quality Parameter	Limit(s)	Unit	Comment
Siloxanes	1	mg Si/m^3	Risk to end use equipment (Si buildup from combustion)
Ammonia (NH_3)	3	mg/m^3	Risk to human health and environment Potential odorant masking (change of smell)
Halogenated hydrocarbons Chlorine (Cl) Fluorine (F)	 1 10	 mg/m^3 mg/m^3	Risk to human health, environment and end use equipment
Mercury (Hg) Arsenic (Ar)	80 190	µg/m^3	Risk to human health
Bacteria Total Live Spores	50,000,000 1,000,000 10,000	#/100 ft^3	Risk to system integrity (e.g., micro-organism induced corrosion)

Gas Quality Monitoring and Control

- Means and methods used for monitoring gas quality
  - portable measurements using portable moisture analyzer, Gastec tubes or Draeger chips
  - online analyzers for real time monitoring by Gas Control (mainly RNG)
  - composite and spot sampling by stations techs for traditional producers
  - spot sampling by third party for RNG
  - all sample analysis by third party labs

- Response action matrix for off spec gas quality conditions
  - establishes actions (Warnings or Shut-in) in response to off spec gas conditions
  - applies to portable measurements, online analyzer readings and sample results
  - differs for traditional gas producers and RNG producers

Traditional Gas Producers – Monthly Checks

- Primary gas quality concerns
  - moisture content, H2S content, hydrocarbon liquid dropout (C6+), interchangeability parameters (HV, WN, total inerts, C4+)

- Monthly moisture (H_2O) content checks
  - using portable analyzer, Gastec tubes or Draeger chips
  - response to off spec results
    - if > 65 and ≤ 96.5 mg/m^3, producer informed with 7 days to correct before shut in
    - if > 96.5 and ≤ 130 mg/m^3, producer informed with 3 days to correct before shut in
    - if > 130 mg/m^3, producer informed and shut in until condition is corrected

- Monthly H_2S content checks
  - applies to producers with H_2S stripping equipment or historical H_2S > 1.5 ppm
  - using Gastec tubes or Draeger chips
  - response to off spec results
    - if 4 to 6 ppm, producer informed with 7 days to correct before shut in
    - if > 6 ppm, producer informed and shut in until condition corrected

Traditional Gas Producers – Spot Sampling

- Spot sampling - extended analysis for hydrocarbons, inerts and sulfur species
  - annually for large producers (annual volume > 10,000,000 m^3)
  - every 2 years for medium producers (annual volume is 500,000 to 10,000,000 m^3)
  - every 4 years for small producers (annual volume < 500,000 m^3)
- H_2S –response actions are same as for monthly readings
- Cricondentherm Hydrocarbon Dew Point (CHDP)
  - calculated if C6+ > 0.06 mole % (risk of hydrocarbon liquid dropout?)
  - if > 30 °C, producer advised to correct by given deadline to avoid shut in
  - if ≥ 1 L of pooled liquids in filter, producer shut in
- Other off spec gas quality parameters – response action at Enbridge's discretion
  - risk to our system and end-user equipment?
  - nature and magnitude of off spec condition?
  - is gas supply blended with network gas or not?
  - small, medium or large producer?

RNG Producers

- Source gas for RNG is sampled, analyzed and designated as Category 1 or 2
  - Category 1
    - mainly landfill and wastewater treatment (WWT) biogas
    - increased risk of presence of certain components of concern (siloxanes, heavy metals, halocarbons).
  - Category 2
    - mainly biogas from municipal green bin waste, dairy farm manure
    - lower risk of presence of certain components of concern

- Gas quality of RNG assessed for compliance before permitting initial grid injection
  - confirmed primarily by spot sampling following review of objective evidence from producer

- Primary gas quality concerns
  - CO_2 (reduced from ~40% to <2%), O_2, total inerts, H_2S content, moisture content, HV, trace "components of concern"
  - online analyzers and spot sampling used to monitor/control RNG quality during injection

RNG Producers – Online Gas Quality Monitoring

- Online analyzers
  - injection station includes online analyzers for CO_2, H_2S, O_2 and H_2O.
  - receive shared signals from producer's RNG analyzers for use as primary (CH_4, N_2, H_2) and backup sources (CO_2, H_2S, O_2 and H_2O)
  - provides for continuous, real-time monitoring by Gas Control

- Response actions for off spec analyzer readings
  - if reading ≥ spec limit and < shut-in limit, producer informed with 3 hours to correct before being shut in
  - Producer informed and shut in if:
    - CO_2 ≥ 1.2x spec limit (2.4 mole%)
    - H_2S ≥ 1.5x spec limit (7.5 ppm)
    - O_2 ≥ 1.2x spec limit (0.48 mole %)
    - H_2O ≥ 3x spec limit (195 mg/m^3)
  - if shut-in required, Gas Control activates control valve

RNG Producers – Spot Sampling Protocol

Sampling protocol applied depends on how the source gas was categorized.
Scope and number of sampling events is based on category of source gas and gas quality phase.

Gas Quality Phase	RNG from Category 1 Source Gas		RNG from Category 2 Source Gas	
	Sampling Events	Scope of Analysis	Sampling Events	Scope of Analysis
Commissioning	4	Hydrocarbons to C10 Inerts (N2, O2, H2, CO2, CO) BTEX H2S, mercaptans, total sulphur Siloxanes Ammonia Mercury and Arsenic Cl and Fl halocarbons Bacteria	2	Hydrocarbons to C6 Inerts (N2, O2, H2, CO2, CO). H2S Siloxanes Ammonia Bacteria
Monitoring	Quarterly for 2 years		Quarterly for 1 year	
In-service	Annually		Annually	Same as Category 1

Response to Off Spec RNG Sample Results

- Response actions for off spec sample results
  - applies to components not monitored by online analyzers (mercaptans, total sulfur and other trace “components of concern”)
  - GQ parameter ≥ spec limit and < 1.5 x spec limit (e.g., siloxanes ≥ 1mg/m^3 and < 1.5 mg/m^3)
    - producer informed with 7 days to correct before being shut in
    - follow up with sampling to confirm condition corrected, shut in if not corrected
  - GQ parameter ≥ 1.5x spec limit and < 3x spec limit (e.g., siloxanes ≥ 1.5 mg/m^3 and < 3 mg/m^3)
    - if single component affected, producer informed with 3 days to correct before being shut in
    - if two or more components affected, producer informed and shut in
    - follow up with sampling to confirm condition corrected, shut in if not corrected
  - QG parameter ≥ 3x spec limit (e.g., siloxanes ≥ 3 mg/m^3)
    - producer informed and shut-in
    - follow up with sampling to confirm condition corrected before resuming injection

Discussion

Q & A