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Canadian Gas Association

Standing Committee on Operations
Biomethane Task Force

Biomethane Guidelines (Draft) for the Introduction of Biomethane into Existing Natural Gas Distribution & Transmission Systems

Winter 2011

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Legal Notice

Acknowledgements

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Executive Summary

The purpose of this Guidance Document is to establish a common framework for the introduction of biomethane into existing natural gas distribution and transmission networks. There is a shared and important need to understand the quality and potential impacts of introduced gases to these pipeline networks. ***However, this Document does not provide specific "cleanup standards" or conditions for introduction of biomethane to the pipeline network.*** Rather, it may serve as an industry-wide reference covering basic biomethane quality parameters, characteristics, and analytical techniques that may be used in contracts or new tariff gas quality specifications.

This document provides Biomethane Quality Guidelines

Specifications and recommendations for specific equipment, processes and techniques needed to clean and purify biogas to become biomethane will **not** be discussed within this Guidance Document. The natural gas industry's responsibility is assumed to begin at the reception point of biomethane, at an injection/mixing point for a transmission or distribution system.

Introduction

Operators of distribution and transmission pipeline systems are now frequently approached to purchase and/or take delivery of biomethane. Many wish to take advantage of this opportunity to transport and/or distribute a "green product" or renewable energy product but are somewhat reluctant due to limited experience with it. Currently, gas quality specifications only exist for geologically formed natural gas. There is very limited industry experience with biomethane or renewable natural gas (RNG) and many questions about its application.

Biogas must be cleaned sufficiently to biomethane for consideration for introduction to the natural gas pipeline network. Based on the biomass source material, produced raw biogas contains constituents and compounds that pose hazards to the pipeline network, human health and the environment. In addition, insufficiently cleaned biogas may contain trace or residual compounds that compromise the integrity and operation of gas utilization equipment.

The quality of geologically-derived natural gas is specified in gas transportation tariffs agreed upon by the supplier and the local distribution or transportation system contracting for the gas. These specifications can vary by region and by individual tariff. Biomethane is not sufficiently characterized by these existing tariff provisions.

Biomethane quality is very important to natural gas companies and to acceptance to the pipeline network. In order to accept biomethane as a viable renewable energy product, a Guidance Document covering quality and common practices is necessary. This Guidance Document can then be used as a reference for producers, suppliers and receivers of this renewable natural gas product.

This Document intends to create common understanding of biomethane between all stakeholders: natural gas companies, farmers, landfill and wastewater treatment owners/operators, developers and providers of biogas cleanup technologies.

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Scope & Mandate

The mandate of the CGA Biomethane Task Force was to identify, understand and evaluate the impacts of biomethane on transmission & distribution systems as well as end-use equipment, and, from that knowledge, develop a Canadian natural gas delivery industry guideline for pipeline grade biomethane suitable for mixing with existing and future natural gas supplies.

The boundaries of Guidance Document work executed by the Task Force are from the point of biomethane injection into any given transmission or distribution system to the point of end use. Additionally, the Task Force was asked to include the known impacts (safety and operational) of gas quality variations and appropriate test methodologies required to ensure biomethane is acceptable to all CGA members and Canadian stakeholders, i.e. in compliance with the operational aspects of CSA Z662 and CSA B149. The scope does not consider the possibility of injecting raw (un-cleaned) biogas or semi-processed biogas/not fully upgraded gas into natural gas delivery or transportation systems. This Guidance Document also does not address the design, construction, maintenance and/or operation of a biogas to biomethane plant.

Background

Biomethane is a *cleaned biogas product* produced from the anaerobic digestion of a wide variety of biomass materials. Interest in biomethane as an interchangeable product for natural gas has been noted throughout North America due to environmental, political, and economic drivers. Sources of this increasingly popular fuel include landfill waste, wastewater treatment digestion, agricultural waste, food-processing waste, and animal/bird farming by-products (manure digestion). Historically, raw or partially-cleaned biogas has been used primarily for on-site electrical power generation or other site specific energy needs.

Biogas is produced from the breakdown of organic material (landfill, wastewater, animal waste, and biomass) and contains a mixture of methane, carbon dioxide, and trace contaminates. The raw gas mixture is known as biogas. This gas mixture can be "cleaned up" or processed to produce *biomethane*.

The application of biogas as an energy source began in India in the 1800s and has proved popular around the world at different scales and application. Over 5 million plants are claimed to be in operation in China as a source of cooking fuel. During the energy crisis of the late 1970s and early 1980s significant effort was put into research of industrial scale production of biogas. The momentum for this work was generally lost as oil prices came down. Work did continue in Denmark and several large digesters were built in the late 1980s and 1990s. Germany used the Danish experience and established a biogas program for the generation of electricity in 2000. By 2008, this German program has resulted in the construction of over 3000 plants. Sweden implemented the application of biogas in 2002 with upgrading of the biogas to biomethane for natural gas grid injection, primarily for vehicle fuel use. By 2008, biomethane was being used to operate 130,000 vehicles. As of 2010, Germany leads in the production of biomethane, generated from energy crops exclusively, in Europe with the gas being injected into the natural gas distribution system.

Raw biogas that is produced from an anaerobic digester contains up to 68% methane gas. The bulk of the remaining 30% or more is carbon dioxide, and small percentages of sulfur compounds or trace amounts of other constituents. The gas also contains significant amounts of water*. Biogas would not be acceptable for injection into a pipeline system due to concerns with low heating content, system integrity risks (corrosion and freezing) and potential risks to human health.* Cleaning of the biogas in a properly

designed and operated treatment plant can produce a biomethane with a methane content of 96% or higher and removal of the contaminants of concern.

There are a small number of biomethane upgrading facilities operating in the United States that inject gas into the distribution system (less than forty). There are two known biomethane upgrading facilities operating in Canada and injecting gas into the local distribution system as of fall 2010. One is located in Quebec using a landfill as the gas source with the second in Abbotsford, BC with a digester as the biogas source.

The paper "Renewable Natural Gas in Canada" produced by the Alberta Research Council with sponsorship of the CGA evaluated potential means of production of gas from various biomass waste streams and estimated the total potential gas volumes available. These estimates indicate that the biomass volumes available could produce gas equivalent to 1.3 times the amount of natural gas used by Canadian residential and commercial consumers and equal to about 20% of the total current natural gas production. While these volumes will not be reached due to location of the biomass and economics, it does provide an indication of the potential magnitude of the energy source.

The use of biogas for electrical generation is an inefficient application of the gas as only about 35% of the available energy is recovered due to the efficiency of the internal combustion engine powering the generator. If waste heat from the engine can be used the overall plant efficiency can be increased. However, German experience has shown that installations that can usefully apply the available heat in all seasons are rare. The introduction of biomethane into a natural gas transmission or distribution system would permit the available energy of this gas to be better utilized.

Biomethane Quality Guidelines

The Biomethane Guidelines below were created from a compilation of existing Canadian natural gas quality specifications, recommended component limits cited in European standards and in the United States, and practices recommended by this Task Force. The Guidelines compiled below are supported by references. However it is important to consider the particular situation in which the biomethane will be injected, as specifics between systems may vary and other considerations may dominate in a decision for biomethane introduction to the pipeline network. These Guidelines are not prescriptive and final decision for biomethane introduction should be carefully considered by the gas utility.

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Physical Properties	Reference	Symbol	Upper Content Limit	Units	Comments	Test Methods
Heating Value	Published Canadian Tariffs	-	*36 to 41.3*	*MJ/M3*		ASTM D1945 or GPA 2261
Wobbe Index	Published Canadian Tariffs	-	*47.23 to 51.16*	-		
Carbon Dioxide	Published Canadian Tariffs	CO_2	*2*	*mol%*		*ASTM D1945/1946*
Oxygen	Published Canadian Tariffs	O_2	*0.4*	*mol%*		ASTM D1945/1946
Inerts	Published Canadian Tariffs	-	*4*	*mol%*	N, O_2, CO_2 + others	ASTM D1945/1946
Hydrogen Sulphide	Published Canadian Tariffs & CSA Z662	H_2S	*6 or 7 to 23*	*mg/M3*	7 is Distribution (Z662), 23 is Transmission (Tariffs)	ASTM D4084
Sulphur (in total)	Published Canadian Tariffs	S	*115*	*mg/M3*		ASTM D3246
Mercaptans or Methyl Mercaptan	Published Canadian Tariffs	-	*6 to 8*	*mg/M3*		
Water Content	Published Canadian Tariffs	H_2O	*35 to 65*	*mg/M3*		ASTM D1142 or ASTM D5454
Hydrocarbon Dew Point	Published Canadian Tariffs	HCDP	*-10*	°C		
Gas Interchangeability	Published Canadian Tariffs & CGA NGI Report (2009)	-	*IC & YT Indexes*		Weaver Incomplete Combustion & AGA Yellow Tipping indices	
Temperature Steel	Published Canadian Tariffs	-	*Max 49 to 50*	°C	(Temperature of the injection gas)	
Temperature Plastic	CSA Z662	-	*Max 30*	°C	(Temperature of the injection gas)	
Particulates	Published Canadian Tariffs	-	*Free of…*			
Biologicals/Bacteria	Published Canadian Tariffs	-	*Free of…*		0.3 micron filter separator recommended	
Hydrogen	TBD	H_2	*TBD*		TBD relative to individual pipe material considerations concerning Hydrogen embrittlement and stress cracking. Hydrogen permiability regarding threaded and gasketed joints and non-metalic pipe systems needs to be well understood.	
Ammonia	MarcoGaz compilation of European specifications (TBC)	NH_3	*3*	*mg/M3*		*ASTM D1945/1946*
Halocarbons and Organochlorinated Compounds	MarcoGaz (France) compilation of European specifications & AFSSET Reports. Vinyl Chloride based on NIOSH & OSHA	-	*10*	*mg/M3*	Limit of 1 mg/M3 for vinyl chlorides within the 10 mg/M3 total	EPA TO-15
Heavy Metals	Laboratory Detection limits for mercury & arsenic	-	*Mercury 0.05 Arsenic 30*	*micro-grams /M3*	For copper, zinc & other metals; comparison to existing metals in current Natural Gas stream, i.e. metals from biomethane do not substantialy contribute to background levels.	
Siloxanes	Based on end use requirements. Twice the lab detection limit of 0.5.	-	*1*	*ppm*		
Volatile and Semi-Volatile Compounds	-	-			Monitor & establish presence in NG stream; must know what's in both Natural Gas & Biomethane streams	EPA Method 8270
Other Considerations: This is not a complete listing of potential trace constituents. Refer to published reports concerning trace constituents that may be present in various biogas sources. (see GTI Reports: Pipeline Quality Biogas: Guidance Document for Dairy Waste, Wastewater Treatment Sludge and Landfill Conversion, Pipeline Quality Biomethane: North American Guidance Document for Introduction of Dairy Waste Derived Biomethane into Existing Natural Gas Networks).						
Footnotes: There may be circumstances, based on the judgement of the gas system operator, where specific component limits may differ from the information above.						

The Biomethane Guidelines provided here are not a "black and white" set of parameters for the introduction of biomethane into natural gas delivery systems throughout Canada, but rather a flexible set of considerations that a specific gas system operator can use to determine specific limits suitable for specific biomethane contracts. Biogas sources and potential trace constituents should be considered.