WHITE PAPER

Natural Gas as a Generator Fuel: Definitions, Limits, & Processes

BY: COREY HONL, P.E., SENIOR DIRECTOR - GLOBAL INDUSTRIAL SOLUTIONS

Do we really know what is in the natural gas pipeline? What exactly is pipeline quality natural gas? Is it even all “natural”? Does natural gas vary from state to state? How do I know if the fuel being provided by the utility is good enough for the generator? These are some of the questions that are commonly phrased during the process of quoting, selling, and commissioning of a natural gas generator. They are all great questions, and some clarity will be provided to help alleviate these concerns.

Pipeline Content & PQNG Definition

Pipeline quality natural gas, or PQNG, will represent a range of values in terms of overall energy content and mixture of hydrocarbon components, of course the bulk of which is going to be methane. There is no single standard that tightly governs what is supplied, however each gas utility will typically supply a commitment on the normal ranges or tolerances on each constituent, as well as the specific gravity and heating value. The typical combustion properties for PQNG are also usually shared, with things like flammability limits, Wobbe Index, and ignition point. Additionally, the gas utility will make a commitment on moisture or water vapor content in the PQNG.

So while the gas quality in all interstate pipelines is going to be slightly different, we can say that typically it is as follows:

- Methane content will be greater than 75%
- It will not be more than 10% ethane or 5% propane
- The balance is higher hydrocarbons, inerts, and other trace components
- High heating values are 950-1150 Btu/scft

This range of constituents is suitable to ensure that consumer and industrial devices like furnaces, boilers, and water heaters all will function well on this fuel. A highly turbocharged natural gas engine however, will need a more stringent definition in order to ensure the best performance and safe operating conditions of the equipment. This is done to ensure good combustion and adequate knock margin on low quality gases.

Similar to the approach on propane, most, if not all gas engine and generator manufacturers will publish acceptable guidelines or definitions. Dissimilar to the industry standard definition of HD-5 for propane, for natural gas such a standard does not exist. For Generac these natural gas specifications are captured in document A0000641394, latest edition, and this would apply for all gaseous products from Generac Power Systems configured for operation on natural gas. An excerpt from this standard is contained below, and of course the gas should be free of solids, water, and liquid hydrocarbons at the delivered temperature and pressure.

Component / Property	Unit	Range
Methane	% Volume	80 Minimum
Ethane	% Volume	0-10
Propane	% Volume	0-5
Butanes	% Volume	0-2
Pentanes and Heavier	% Volume	0-0.5
Nitrogen and Other Inerts	% Volume	0-3
Carbon Dioxide	% Volume	0-3
Total Diluents Gases	% Volume	0-5
Hydrogen Sulfide	g/100scf (mg/m3)	0.25-0.3 (6-7)
Total Sulfur	g/100scf (mg/m3)	5-20 (115-460)
Water Vapor	lb/MMscf (mg/m3)	4-7 (60-110)
High Heating Value	Btu/scf (kJ/m3)	950-1,150 (35,400- 42,800)
Methane Number	MN	80 Minimum

What is Methane Number?

One of the additional specifications that is placed on the generator fuel supply besides the constituents is the Methane Number (MN). This is not the same as the methane concentration, content or volume/molar/mass percentage, and that is a common misunderstanding in the industry. MN in fact is a way of documenting a fuel's resistance to knock or detonation in the engine under normal operating conditions. This is very similar to how Octane Number is used to rate gasoline, and the Cetane Number is used with diesel fuels.

A fuel with a low MN will ignite very easily and lead to detonation if it is treated like a high MN fuel (high compression ratio, advanced ignition timing, & no power derate). Generally high calorific value fuels, such as HD-5 propane or those containing high amounts of butanes and pentanes, will be high Btu/scft (MJ/Nm3) and therefore low MN. Fuels with a high MN are very resistant to knock and would be considered low energy or lower Btu/scft. Examples of these fuels would be field gases with high inert content, and biogases like from anaerobic digestion or landfill decomposition. Most fuels that we could consider PQNG or acceptable for generator applications will have a MN between 80-100.

MN itself can either be calculated or estimated based on running it through a specially equipped test engine. It is most common that the calculation process is followed and there are a half dozen or so industry methods or processes that have been developed to estimate the MN. These have been developed and/or adjusted both by engine manufacturers, standards organizations, and industry associations. Most recently ASTM released their standard D8221, Standard Practice for Determining the Calculated Methane Number of Gaseous Fuels Used in Internal Combustion Engines for industry usage. Contact your designated technical support resource at Generac on this topic for assistance is needed.

Once the fuel constituents are known, they are fed into the MN calculation tool to determine the MN of the fuel. Gas engine and generator manufacturers will typically supply MN-based power derate curves if they have developed that specific engine to be more fuel flexible than just PQNG. For Generac an example would be our MGG Derate Calculator as found here: https://www.generacmobileproducts.com/specialpages/calculators/mgg-derate-calculator. Such derating tables are commonly built into product specification sheets and operating manuals, and are the result of laboratory development with blended fuels to simulate the lower MN conditions. This is precisely why there are typically 25-30% power derates when comparing the same turbocharged gas engine on natural gas vs. propane.

What should I do about my project?

It is always a good practice to work with your customer (or dealer or engineering firm) to contact the gas utility to get an indication of the available gas quality in your area. Generally, the utilities have measurement stations in sporadic locations throughout their network which contain gas chromatographs to analyze the gas composition. This process is highly regulated and governed by ASTM D1945, Standard Test Method for Analysis of Natural Gas by Gas Chromatography, so there should be high confidence in the results. Reports from this process contain a complete breakdown of constituents that will allow a detailed comparison to manufacturer's specifications and if necessary, calculation of the MN. Additionally, it is sometimes desired to get a gas sample directly at the generator location to know 100% for sure what is the gas type entering the equipment. There are independent labs that have analytical capabilities to run a thorough analysis on the sample, and some also supply sampling equipment, which is very specialized.

Renewable Natural Gas

One other topic that is increasing in market activity is the usage of Renewable Natural Gas (RNG). RNG, sometimes also called biomethane, is simply a byproduct of taking biogases from municipal or agricultural digesters, or even landfills, and stripping the non-methane components from that gas. The methane part of the biogas is then further cleaned to ensure it fits the local definition of PQNG, and then it is injected to the local pipeline network. RNG in this approach would be a suitable generator fuel and meet manufacturers guidelines.

RNG would be indistinguishable from the rest of the PQNG already in the pipeline, however there is a credit possibility some users can take for burning this gas. Federal and state policies have pushed the RNG market with certain incentives around this fuel, as well as some state-specific programs in California and Oregon. For more information on RNG and related programs, you can refer to the EPA's website here: https://www.epa.gov/renewable-fuel-standard-program.

Summary

Natural gas is fast gaining acceptance as a resilient and maintenance-free fuel for the standby power industry, and almost all long-term projections on national supply and price stability are favorable. Market data continues to show a growing penetration of natural gas generators over liquid fuels for mission critical emergency standby applications, and one of the reasons natural gas is a great fuel for generators is its consistency in the interstate pipeline network. Saying that, however, there are applications where the gas quality does not fit the definition of PQNG, and the sales engineer needs to know if and how to apply the gas quality change against the manufacturer's standards and power derate tables. On a global basis, gas quality has greater variability, thereby necessitating solid technical and practical understanding of these concepts to ensure successful application of the gas generator, and reliable operation of the equipment for the customer.

GENERAC®
INDUSTRIAL POWER

Generac Power Systems, Inc.
S45 W29290 Hwy. 59
Waukesha, WI 53189
201903791 04/2021

ASKGNRC@generac.com
1-888-GENERAC
(1-888-436-3722)

GeneracIP.com