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WHITE PAPER

Understanding Bi-Fuel As A Reliable Fuel For Backup Power

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INTRODUCTION

Designing a standby power system requires the right generator for the load requirements as well as the most reliable fuel source. The Authority Having Jurisdiction (AHJ) ultimately determines fuel reliability in any application.

Diesel fuel has been a traditional fuel choice because its high thermal efficiency typically results in a lower cost per kilowatt in most applications. On-site fuel storage also ensures reliability. However, issues of fuel storage, contamination and breakdown can affect system reliability. Gaseous fuels are being considered more often now because they avoid the fuel storage issues of diesel. The gaseous fuel infrastructure in most areas is generally reliable in an emergency, as well.

Bi-fuel generators simultaneously burn both diesel and natural gas, effectively capitalizing on the benefits of both diesel fuel and gaseous fuel with minimizing drawbacks.

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DETERMINING RELIABILITY

In case of the utility failure, a standby generator system is designed to ensure the uninterrupted flow of power. A key to ensuring reliability in backup power solutions is determining the most reliable fuel supply. Reliability, however, can mean different things to different people. For example, some markets define reliability by the amount of run time required for the application. In other cases, reliability means storing fuel on site. Ultimately, the final arbiter of reliability in a generator application is the AHJ (Authorities Having Jurisdiction). The AHJ is an organization, office, or individual responsible for enforcing codes, standards or regulations. The AHJ varies from place to place, and could include one or more departments of local or federal government. You must consult them as to whether the generator's fuel supply is considered a reliable one.

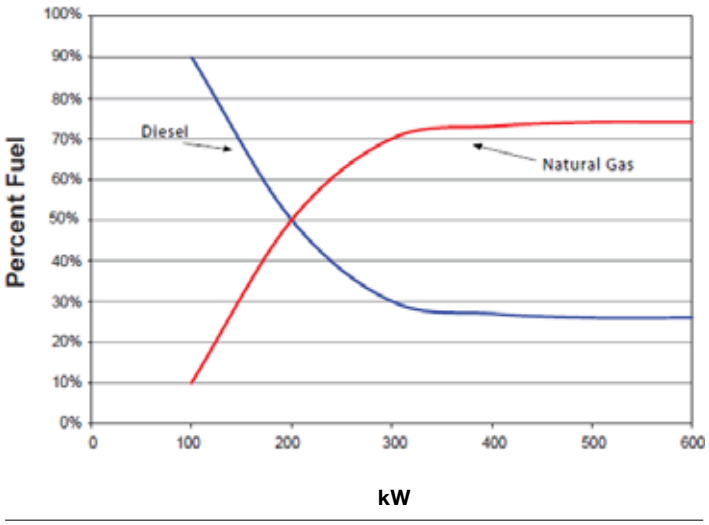

Figure 1. BiFuel % Diesel and Natural Gas

A THIRD OPTION

One way to alleviate challenges of diesel and gaseous fuel while building upon their strengths is to specify a system that burns both fuels at the same time within a single engine. This is the case with bi-fuel technology.

Bi-fuel generators combine the power density and capital cost benefits of diesel engines with the extended run time of natural gas. A bi-fuel engine is a compression-ignited engine modified for simultaneous combustion of both diesel fuel and natural gas. Diesel fuel, which ignites at 500° - 750° F (260° - 399° C), is injected into the combustion chamber as a pilot fuel. The ignition of the diesel fuel in turn ignites the natural gas, which has a much higher ignition temperature of 1150° - 1200° F (621° - 649° C). Bi-fuel generators start up using 100% diesel fuel. After certain criteria are met – such as acceptance of the electrical load – the generator's controller introduces natural gas to the fuel mixture. The controller slowly reduces diesel fuel injection while adding natural gas, until the unit is running more on natural gas than on diesel fuel. Under typical conditions, bi-fuel generators will operate on a ratio of 25% diesel and 75% natural gas, with no reduction in power. An example for a 600 kW generator is illustrated in Figure 1.

If the load increases, more diesel fuel will be added to increase engine RPMs and the natural gas will back off. Natural gas will once again be increased when the load stabilizes.

In most bi-fuel engine designs, the diesel fuel is introduced using existing injectors, while the natural gas is added through one of three proven techniques:

• **Low pressure injection.** Natural gas is injected via port injectors, so that it mixes with the air just before it enters the cylinder. This is done at moderate pressure—usually 50 psi or less. This approach requires installing individual natural gas fuel injectors onto the engine. Additionally, because many diesel engines use turbochargers to feed air into the engine, a gas compressor is required so that the natural gas injection pressure is higher than the boost pressure from the turbocharger. These extra components typically result in significantly higher costs.

• **High pressure injection.** The natural gas is delivered directly to the combustion chamber at the end of the compression stroke. This requires very high injection pressure—usually about 3000 psi. Because it requires a sophisticated—and costly—fuel delivery system, it is more commonly used in very large applications, such as municipal prime power.

• **Combustion air gas integration.** Sometimes referred to as fumigation, natural gas is introduced into the engine's air intake, right before the turbocharger, at a very low pressure—usually 5 psi or less. The turbocharger then ensures that there is a good air-to-gas mixture going into the combustion chamber. No engine modifications are required, so system costs are minimized. Additionally, advanced microprocessor, sensor and actuator technologies economically provide precise and responsive system control. This approach has seen the broadest application in the standby power market.

BENEFITS OF THE BI-FUEL GENERATOR

Bi-fuel generators capitalize on the reliability benefits of both diesel and gaseous fuel while minimizing their respective drawbacks. For one, the lower capital cost of a compression-ignited engine is retained while capitalizing on many of the advantages of gaseous fuel, such as an improved emissions profile.

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Run times are extended while on-site fuel storage requirements are decreased. This is because natural gas, not diesel, is the predominant fuel in a bi-fuel system. Assuming a typical fuel ratio of 75% natural gas to 25% diesel, you can spec a bi-fuel unit with a diesel tank sized for 24-hour continuous operation at full load and expect a running time of about seven days. This can be very important, since refueling may be difficult during emergencies that cripple municipal infrastructure. It can also allow for smaller diesel tanks, because natural gas is the predominate fuel. With smaller fuel tanks, the risk of fuel contamination and the cost of fuel maintenance is significantly reduced.

Additionally, fuel redundancy is built into the system. If the natural gas supply is interrupted for maintenance, the controls automatically revert to 100% diesel without interruption.

Maintenance costs are reduced, as well. Testing has shown that bi-fuel engine oil remains cleaner compared to an engine running on straight diesel, thanks to the clean burning characteristics of natural gas. More importantly, though, the cost of diesel fuel maintenance is reduced because less fuel is stored on site

SUMMARY

When designing a standby generator system, there are several options (diesel, gaseous and bi-fuel) when it comes to fuel. It is important to understand the reliability issues of all of these options before consulting with the AHJ to determine which fuel choice will best meet their definition of reliability while simultaneously meeting the needs of the customer

BIOGRAPHY

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Experience – Muhammad Armaghan is a Product Manager at Generac Power Systems. He is responsible for the Industrial Generator product line. Armaghan has experience working in industrial power generation markets and has supervised several multimillion-dollar projects throughout Unites States. These include power plants, healthcare facilities, data centers and municipal projects. Armaghan has also worked closely with consulting and specifying engineers, as well as general and electrical contractors and end users.