BAY CITY ELECTRIC WORKS

KOHLER®

LOFTIN EQUIPMENT CO.

Information Sheet # 54

Bi-Fuel Natural Gas & Diesel Generator Systems

Your Reliable Guide for Generator Maintenance

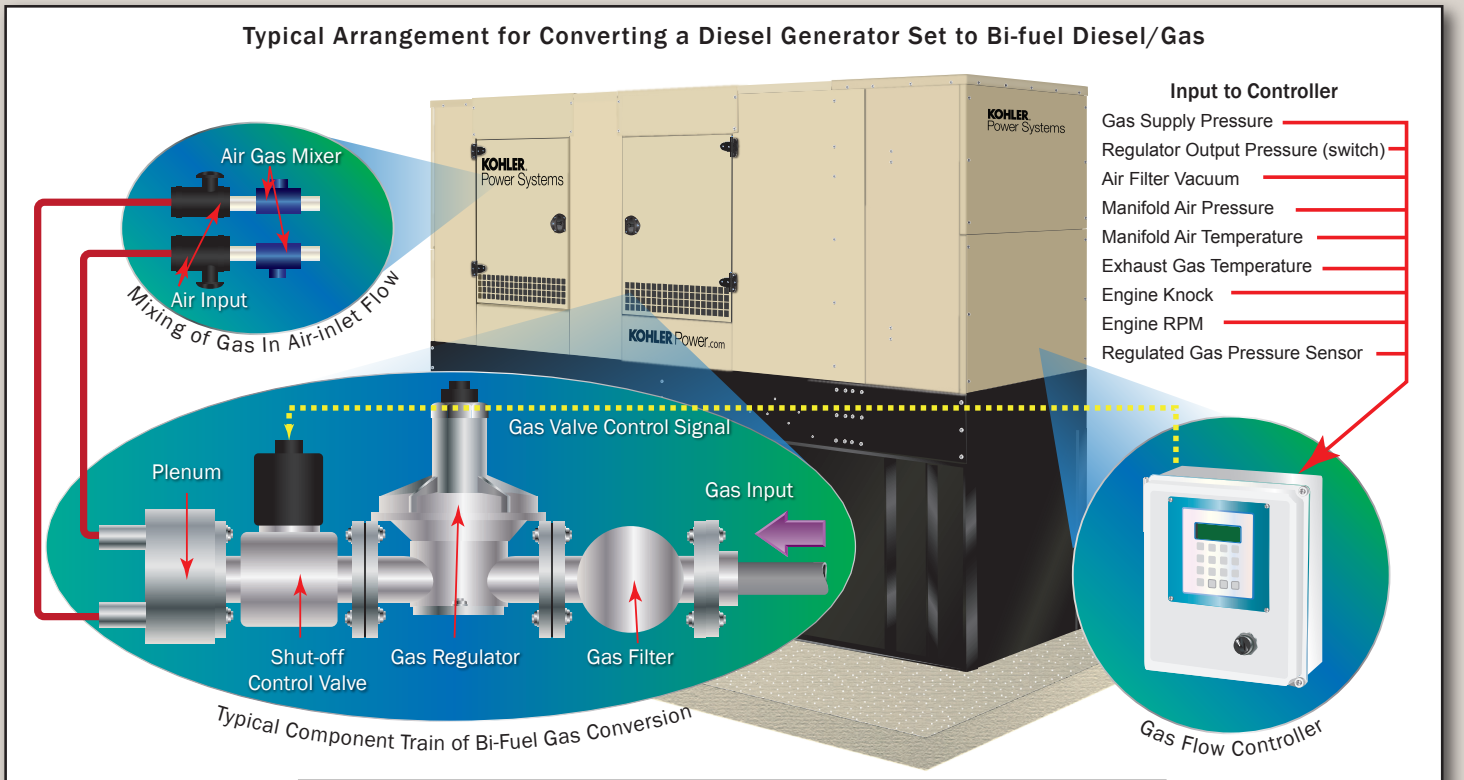
1.0 Introduction:

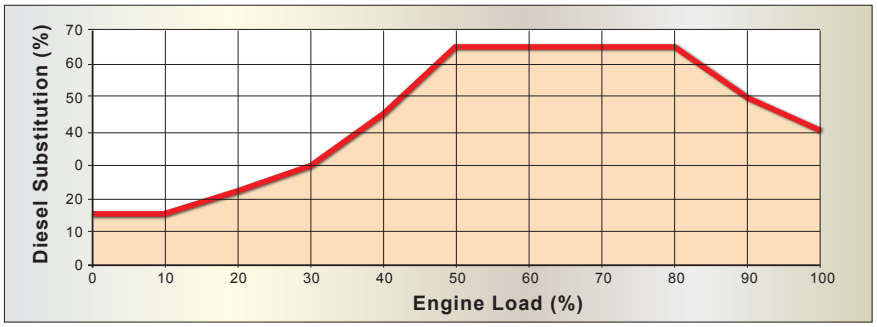
Several generator applications have being adopting bi-fuel technology to address stricter diesel engine emission standards and increased operational costs. New or existing diesel-powered equipment, such as generator sets, can be retrofitted or equipped to take advantage of the lower cost and cleaner exhaust emissions that natural gas provides. The Oil & Gas industry, with the discovery of new gas fields and the utilization of fracking drilling techniques, have provided North American equipment users a ready and abundant source of natural gas fuel at competitive pricing when compared to diesel. The U.S. has some of the largest proven reserves of natural gas.

This Information Sheet discusses the application of Bi-fuel technology to diesel generator systems:

2.0 Application of Natural Gas: Bi-fuel technology conversions use natural gas mixed into the air stream to enable a diesel engine to run on a bi-fuel natural gas/diesel mixture. The fuel mixture varies automatically with no loss in performance. *(Continued over)*

Typical Arrangement for Converting a Diesel Generator Set to Bi-fuel Diesel/Gas





To fulfill our commitment to be the leading supplier in the power generation industry, the Loftin Equipment and Bay City Electric Works teams ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

3.0 Bi-fuel Technology:

Application of current electronic technology has seen bi-fuel technology progress from the traditional large displacement diesel engine applications of the Oil and Gas industry to smaller displacement diesel engines found in many other applications and markets.

Here is how bi-fuel technology works, operating in a closed-loop system: (See diagram on front page.)

- **Blending of the Fuels -** The use of electronics enables the exact blending of the diesel and natural gas fuels in the combustion chamber, with no modification of the diesel's existing internal components or diesel injection system. Before being drawn into the engine's combustion chamber, natural gas is pre-mixed with the inlet air.

  In the usual 4-stroke combustion cycle, diesel is injected into the combustion chamber and compressed to provide the ignition source to burn the air and fuel mixture. However, in a bi-fuel system, the engine only has to inject as little as 30% of the normal diesel level to achieve ignition. The closed-loop system maintains the air-gas mixture is in a lean condition to ensure pre-ignition does not occur.
- **Closed Loop System Working with Engine Governor -** To ensure the ratio of natural gas to diesel fuel is constantly controlled to provide optimum power throughout all changes in engine load, ambient pressure, ambient temperature and humidity, the ignition system operates with the diesel's isochronous diesel governor in a closed-loop control system.

  Sensors for gas supply pressure, regulator output pressure, air filter vacuum, manifold air pressure, manifold air temperature, exhaust gas temperature, and engine knock all feed into a controller. Depending on sensor input from the engine, and variables such as load level, ambient temperature, knock limits, and gas supply pressure input, the controller will determine when to activate or deactivate bi-fuel operation through a gas control valve.
- **Where Gas is Introduced into the System -** The natural gas enters the engine system upstream of the turbocharger and downstream of the engine air-inlet cleaner. Gas enters the system at approximately atmospheric pressure through an air-fuel mixing device for a high level of fuel atomization and minimum air restriction.
- **Gas Substitution -** Gas quality and other conditions, such as load and ambient, can vary substitution rates of gas for diesel fuel. Variations can range from 25% to 70%.

  Programing maintains the engine power within the generator system's continuous power rating. Should there be a failure in any of gas system component, the default position of the controller is 100% diesel. When the load demand exceeds the 100% programmed rate, the system will automatically switch to 100% diesel.

4.0 Effect on Engine Performance:

Current bi-fuel technology ensures the engine power performance is not effected during bi-fuel operation and remains on par with a generator system running on 100% diesel fuel. Heat rejection levels to the exhaust and water jacket systems remain within normal running parameters.

When applied as recommended by the manufacturer, the electronic controller and sensors will ensure the engine responses to load changes are equal or better levels compared with performance on 100% diesel.

Bi-fuel systems are designed to switch fuel modes automatically without any interruption of power output and to maintain the same engine speed droop upon application of load in a pure diesel system. Current electronic and mechanical technologies employed allows the engine to safely run on gas substitution percentages up to 70% of the total fuel requirement, and to produce diesel-like performance in terms of efficiency, stability and load acceptance.

5.0 Advantages of Bi-fuel Operation:

When considering a generator system to operate on a bi-fuel system, the following advantages should be considered:

- **Cost Savings -** Displacing a percentage of diesel fuel with methane-based gas will reduce the fuel costs. This advantage is more obvious in a prime power application. However, even in standby applications there is a cost saving because less fuel has to be stored on site.

  Gas suppliers will offer discounts to users who can tolerate interruption in the utility gas supply. A bi-fuel user can always switch over to 100% diesel if required.
- **Increased Run Time -** Reducing the diesel used can lead to increased run times which can be a major advantage for critical applications during extended power outages.
- **Improved Logistics -** Diesel fuel standby and prime power generator applications include fuel supply in planned maintenance programs. Where access to site is difficult, having an alternative fuel improves supply logistics.
- **Environmental Concerns -** Less above ground storage of diesel fuel will alleviate some environmental concerns.
- **Reduced Flaring -** In the Oil & Gas industry flaring of surplus gas is an emission concern. In cases where this practice is prohibited, using the gas for power is a more acceptable alternative.

6.0 Disadvantages of Bi-fuel Operation:

The main disadvantage of bi-fuel is there are increased components to maintain. Where logistics are concerned, that may mean less is more. The operator of a bi-fuel system has to bring to the site two fuel sources. But many facilities already are connected to gas as a heating fuel. Your authorized generator distributor should be consulted to determine if bi-fuel is the best solution for your generator system.

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