

GTI Bi-Fuel® *for light and heavy duty diesel engines*

ALTRONIC



Operate Your Diesel Engine on Natural Gas

- No engine modifications required
- No power or efficiency losses
- Low cost and easy to install
- Reduces operating costs
- Extends run-time of standby engines
- Lowers emissions
- No high-pressure gas supply
- Allows use of interruptible gas
- State-of-the-art controls and monitoring

The GTI Bi-Fuel® System from Altronic, LLC is an innovative technology that enables operators of light and heavy duty diesel engines to substantially reduce operational costs and lower emissions (with use of DOC) by substituting diesel fuel with lower cost, cleaner-burning natural gas.

Simplicity of Design and Operation

GTI Bi-Fuel Systems follow a design philosophy of simplicity. The system does not interface with the diesel control governor, but instead remains independent. This allows the diesel governor to react to changes in genset load without interference of the gas system. In this manner, the diesel LEADS, and the gas LAGS. This philosophy ensures safe engine operation with no compromise in the operation of either fuel system.

The GTI Bi-Fuel System is comprised of patented technologies that allow engines

to safely operate on gas percentages up to a maximum of 70%* of the total fuel requirement. Engines converted to GTI Bi-Fuel exhibit diesel-like performance in such critical areas as efficiency, stability and load acceptance.

A key feature of the system is its ability to switch fuel modes without interruption in engine power output. The engine can be switched between diesel and gas automatically while maintaining speed and

load. This feature gives the user the flexibility to choose between gas and diesel modes as dictated by fuel pricing, fuel availability or other operational considerations. An equally important feature is the ability to maintain engine power levels while operating in gas mode between the “continuous” and “prime” ratings of the engine. For operations above the programmed power limit, the engine is automatically switched to 100% diesel mode, thus avoiding the necessity to de-rate the engine.

The GTI Bi-Fuel System uses a state-of-the-art electronic control and monitoring system which monitors critical engine and bi-fuel system parameters and activates or deactivates gas mode according to programmed limits. When a monitored parameter exceeds the allowable limit, the controller switches the engine to 100% diesel mode and electronically logs the fault for diagnostic purposes. The control panel is CSA-approved for Class I, Division 2 environments.

Cost Savings

Displacing a percentage of diesel fuel with methane-based gas provides an immediate economic benefit based on the cost difference between the fuels and the amount of run time of the genset. In high usage gensets, the GTI System can pay for itself in a short period of time. Simple

Excel-based spread sheets are available to assist in modeling the economic benefits of converting to GTI Bi-Fuel.

Increased Run Time

Reducing the amount of diesel fuel used extends the run time in proportion to the substitution rate, providing extra hours of operation in critical applications.

Simplified Logistics

The frequency of refueling is reduced, thereby lessening the costs and risks associated with hauling diesel fuel.

Reduced Liquid Fuel Storage

As environmental concerns about liquid fuel storage increases pressure on operators, using the GTI Bi-Fuel System offers some relief by reducing the volume of above-ground diesel fuel storage.

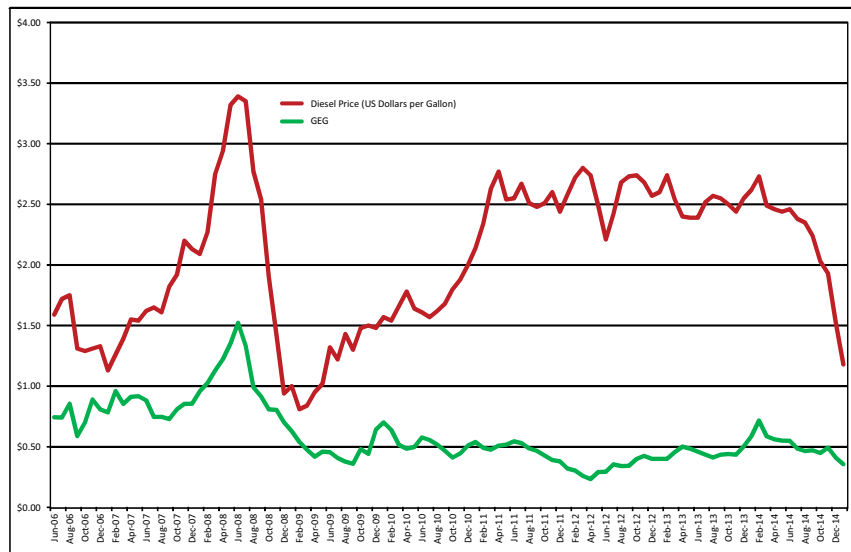
Emissions

Altronic has commissioned independent third party emissions testing of the GTI Bi-Fuel System on industry representative engines by EPA and CARB-certified laboratories to stringent industry testing standards and procedures. Results demonstrate conclusively that, when properly installed and commissioned on engines maintained to OEM standards, operation of the GTI Bi-Fuel System can

result in a reduction of oxides of nitrogen (NOx), particulates (PM), non-methane hydrocarbons (NMHC), and carbon monoxide (CO).**

Flare Gas Reduction

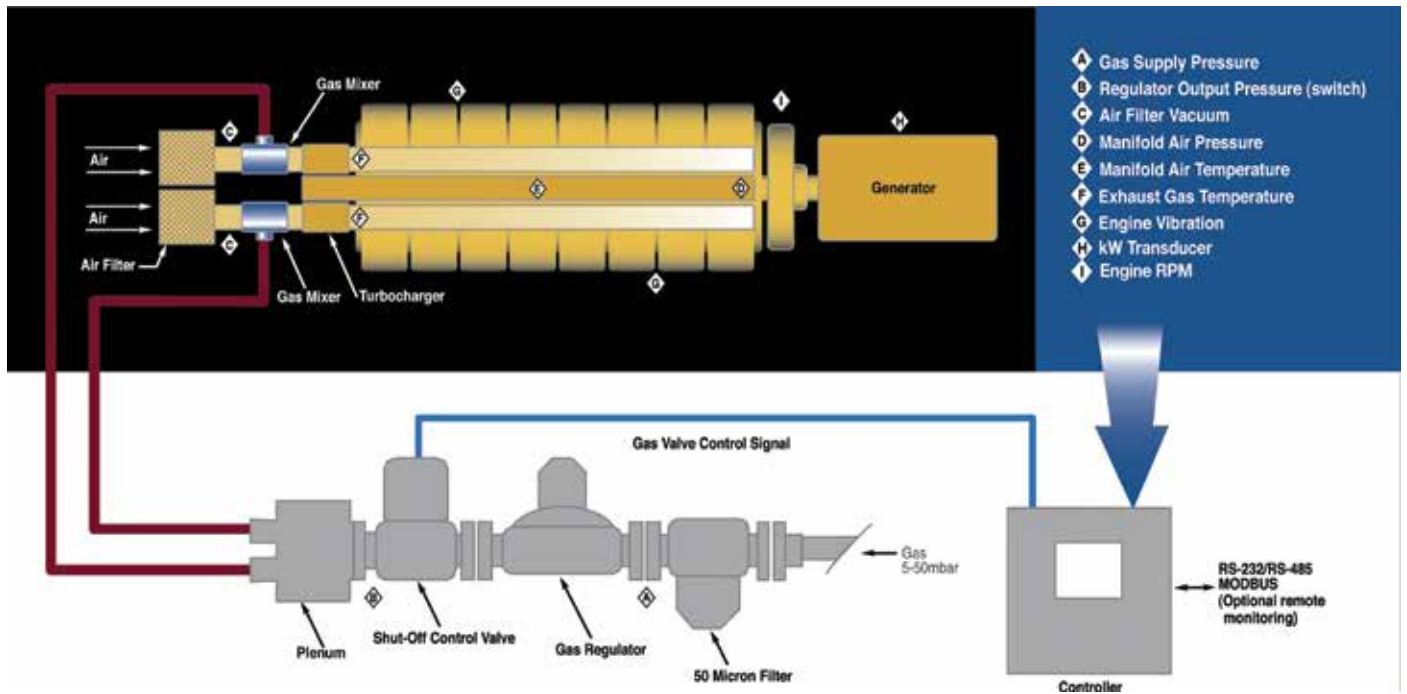
Pressure to reduce the flaring of waste gases into the atmosphere continues to increase worldwide. The GTI-Bi-Fuel System allows these unwanted gases to be used as fuel for the generation of electrical power.



Bi-Fuel® is a registered trademark of ALTRONIC, LLC U.S. PATENTS 6,250,260 and 6,543,395

*Substitution rates can vary from 25% to 70%, subject to gas quality and other application conditions.

**Requires the use of a properly sized diesel oxidation catalyst (DOC). Altronic recommends the use of such DOC on all bi-fuel applications. Contact your local GTI Distributor for details.



Flexible Fuel Rates

Gas suppliers offer discounted rates to customers who can tolerate supply interruptions in times of high demand/ inadequate supply. GTI Bi-Fuel provides for this option since the genset can operate on 100% diesel at any time.

Reduced Capital Costs

Due to the higher power density of diesel engines relative to pure spark-ignited gas engines, the cost per kW produced of a diesel engine can be significantly less compared to the same output gas engine. GTI Bi-Fuel allows the user to enjoy many of the benefits of gas engine operation coupled with the lower capital cost of the initial purchase.

Operation and Performance

Gas is introduced downstream of the engine air cleaner and upstream of the turbocharger. The gas is supplied at approximately atmospheric pressure using a proprietary air-fuel mixer that allows for a high level of gas mixing with the least possible air restriction. The air-gas mixture is compressed in the turbocharger and distributed to each cylinder by the engine air-intake manifold. The lean air-

gas mixture is compressed during the compression stroke of the piston and ignited by reduced diesel spray. Since the air-gas mixture is maintained in a lean condition, pre-ignition does not occur.

Flow of gas to the engine is load dependent and varies with combustion airflow changes. The Bi-Fuel System varies gas flow according to changes in the turbo intake signal. This allows it to respond to engine fuel requirements while maintaining the integrity of the OEM governing system. The standard GTI Bi-Fuel System incorporates a manually-adjustable power valve to control the gas substitution rate. Diesel injection is controlled by the OEM governing system during both gas and diesel modes.

The Bi-Fuel controller monitors various engine and system parameters such as manifold air pressure and temperature, exhaust gas temperature, intake vacuum, gas pressure and engine vibration. This information allows the controller to determine when to activate or deactivate bi-fuel operation depending on engine performance, load level, ambient temperature, knock limits or gas supply pressu-

re levels. The controller can communicate with remote engine monitoring systems via RS-232/RS-485 connection (ASCII or MODBUS protocol).

Engine performance is on par with normal diesel levels. Heat rejection levels to the exhaust and water jacket systems are kept within normal operating parameters. Engine response to load variation is typically equal to, or better than, 100% diesel performance due to the unique design of the Bi-Fuel System and the associated combustion characteristics of the air-gas mixture. Similarly, engine load acceptance (for large block loads) meets or exceeds straight diesel performance.

Factory Trained and Certified Technicians

Altronic requires each GTI Master Distributor to have a factory certified technician on-staff. Altronic provides a rigorous training and on-engine audit program to its distributors to insure quality of installation and commissioning of the GTI Bi-Fuel System to provide proper system performance and engine safety to its customers.

GTI+ BI-FUEL® SYSTEM



The GTI+ Bi-Fuel® System builds on the experience of over 3300 installed GTI Bi-Fuel Systems worldwide. The GTI+ platform offers improved performance through the use of an innovative new mixer design and fully electronic, closed-loop fuel control valve-based gas train. The design increases system responsiveness, reduces the degree of—and eliminates the effect of—any parasitic pressure drop between the gas train outlet and turbocharger inlet.

The GTI+ Bi-Fuel System maintains the basic design philosophy of the original GTI product line: Simplicity in design and operation, while maintaining a true zero-pressure “draw through” configuration that maximizes engine safety.

The GTI+ System is ideal for applications such as drilling rigs, where the optimal substitution rate needs to be mapped across the genset load range. The Altronic AGV5-2L valve combines the function of a closed-loop, electronic zero governor with that of a substitution control valve, providing a fast responding and reliable fuel control system.

Electronic Gas Train

The GTI+ System utilizes a fully electronic, advanced gas train design. At the heart of this system is a specialized version of the Altronic AGV5 fuel valve.

The AGV5 is a microprocessor-based smart valve equipped with a fast-acting voice coil for rapid and accurate response. The AGV5 serves as both the zero governor pressure controller and fuel valve to control the bi-fuel substitution rate across the engine load range. The valve responds in closed-loop control to an electronic pressure signal within the mixer housing, ensuring that the fuel demand at the mixer is satisfied at any given time and eliminating pressure droop associated with pneumatic pressure control systems. This closed-loop control minimizes the effects of pressure drops between the outlet of the gas train and

the mixer inlet. This allows the desired substitution rates to be met while maintaining the fundamental safety characteristics of a zero pressure draw-through design.

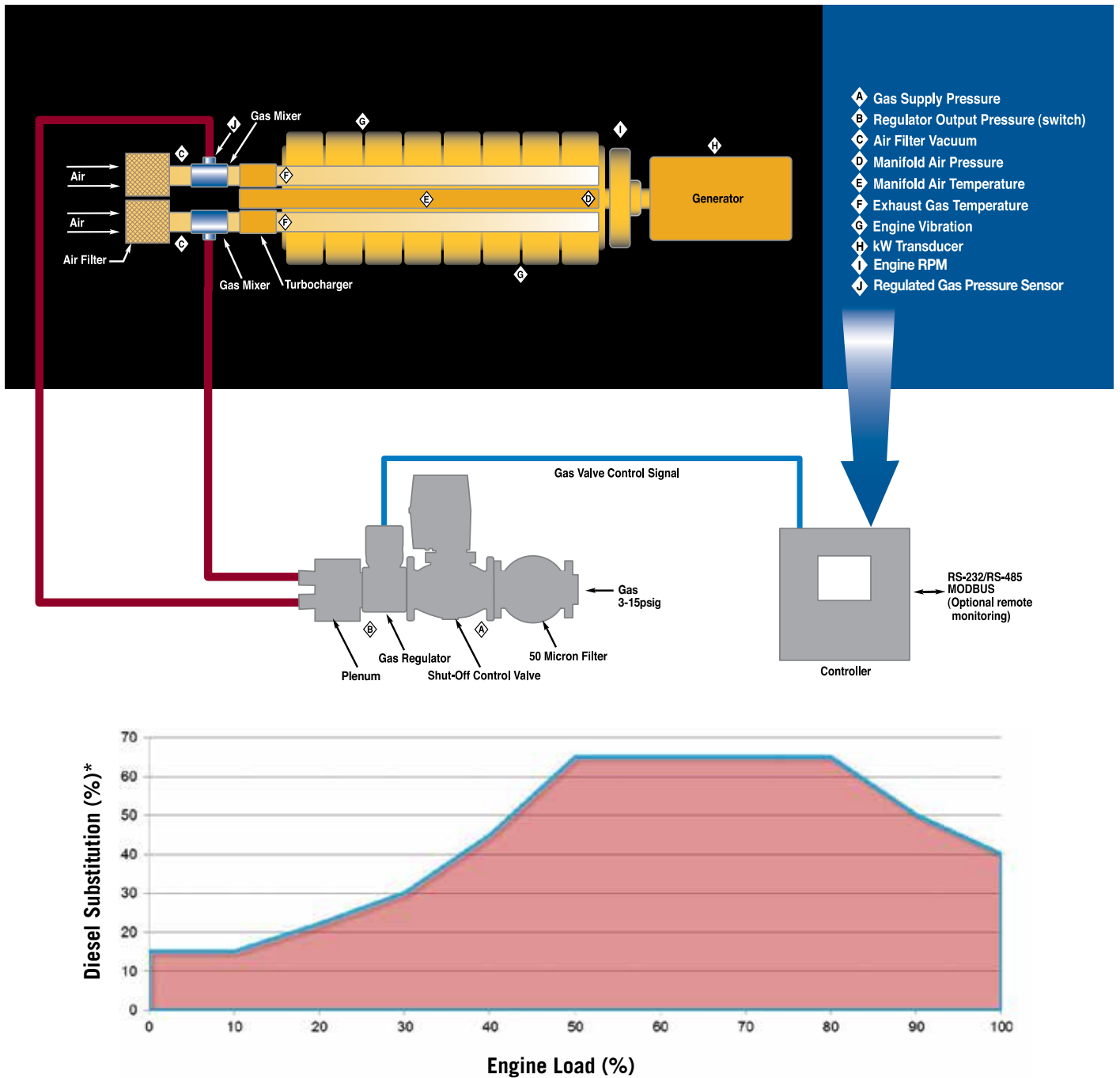


The AGV5 is a proven design that has been used as the fuel control device in hundreds of gas engine applications. Its soft-seat poppet is highly tolerant of gas stream contamination and offers fail safe reliable service.

Since the AGV5 is rated to a higher pressure, the gas train can accept gas supply pressure of up to 50psig, eliminating the need to reduce higher gas supply pressures to lower gas train inlet pressures with an added primary regulator.

The new enhanced gas train also uses a highly-reliable, automatic, fast-acting, industrial shutoff valve to provide dual shutoff capability.

GTI+ Bi-Fuel® System Operation and Performance



DE-3020 Controller Platform

The GTI+ Bi-Fuel System uses an upgraded DE control platform which provides for configurable I/O for increased flexibility in application across the broad expanse of diesel engines in use today.

*Diesel substitution rates can vary based on factors such as gas fuel quality, engine design and condition, engine load profile, ambient temperature, application etc. Altronic makes no guarantee of achievable substitution.

Major System Components and Sub-systems

Air-Fuel Mixer

The GTI Bi-Fuel® System uses a proprietary air-gas mixing device that has been designed for optimum blending of natural gas and engine intake air. Mixing of air and gas is achieved using a sophisticated, fixed-venturi design that avoids the use of an efficiency-robbing throttle plate. The low restriction air-gas mixer ensures that adequate air-flow is maintained to the engine and that operating efficiencies are not compromised by installation of the device. The computer-aided-design mixer is built to aerospace tolerances using CNC machining processes and is assembled using state-of-the-art welding techniques. The finished mixer has no moving parts once installed in the engine air-intake system, and requires no routine maintenance.



constructed of CNC-machined aerospace quality aluminum, and mil-spec anodized for surface hardness and corrosion protection.

Gas Trains

Conditioning and regulating the natural gas prior to admission into the engine is a critical part of the GTI Bi-Fuel System. The system gas train includes a 50-micron fuel filter, an electrically-operated solenoid valve, actuated in the event of an emergency or for system shutdown, and a zero-pressure, demand-type gas pressure regulator—or, for the GTI+ System, a smart, fast-acting fuel



Plenum

The plenum works in conjunction with the DN50, DN65, DN80, or GTI+ gas train and air-gas mixer to control the amount of gas supplied to the engine for a given engine load with very low restriction and pressure drop. The plenum consists of three main parts: inlet plenum plate, plenum barrel (chamber, hardware, and diffuser plate), and outlet plenum plate (1, 2, 4, and 6 outlet JIC hose connections). The plenum is



control valve. This latter component reduces the inlet gas pressure to roughly atmospheric pressure.

With a negative outlet pressure, the design allows the system to use a “demand” control scheme whereby engine intake airflow determines the gas flow of the engine. As engine load changes, corresponding changes in intake air volume automatically draw additional fuel into the mixer.



Engine Control System

The Engine Control System is based on proven Altronic controllers and provides state-of-the-art engine control and safety shutdown monitoring. The controller is designed specifically for the GTI Bi-Fuel System and is straight-forward and simple to operate. It monitors a number of pressure and temperature points and returns the engine to 100% diesel operation should any parameter deviate from its normal range. In addition, a hourmeter function tracks the operating hours in bi-fuel mode. Alarms are annunciated in clear message form and the controller maintains an alarm log of the last 100 events.

Bi-Fuel Pioneers

Altronic began the promotion and sale of the GTI Bi-Fuel System in 2002, long before most genset operators had heard of such application, or before many had enjoyed the benefits that it offers. Since then thousands of systems have been installed throughout the world in a wide range of applications and operating environments. A dedicated network of independent Master Distributors and Dealers, fully supported by Altronic, offers local installation, commissioning and maintenance.

GTI Bi-Fuel Installations



Water Treatment Facility



Peak Shaving/Standby (Propane)



GTI+

Bi-Fuel® Kit Application and Contents

GTI Series	Engine Power Rating	Engine Type	Panel Option	Vibration Sensor(s)	CSA Certified ¹
25 ²	Up to 300 kWe	Single Turbo, Single Cooler	GPN0100-12	Up to 8	No
			GPN1000-12		
50	301-800 kWe	Single Turbo, Single Cooler	GPN1000	Up to 8	Yes
		Up to Six Turbo, Four Cooler	GPN20XX	Standard (2)	
65	801-1500 kWe	Single Turbo, Single Cooler	GPN1000	Up to 8	Yes
		Up to Six Turbo, Four Cooler	GPN20XX	Standard (2)	
80	1501-2500 kWe	Single Turbo, Single Cooler	GPN1000	Up to 8	Yes
		Up to Six Turbo, Four Cooler	GPN20XX	Standard (2)	
GTI+	Up to 4MW+ ³	Up to Six Turbo, Four Cooler	GPN2020	Standard (2)	Yes
			GPN2030		

¹ CSA Certified Class I, Div. 2, Group D System available. Contact a GTI Authorized Distributor for details.

² Series 25 kits require 12Vdc Power; all other Series require 24Vdc power. Not to be used on generator paralleling applications.

³ Contact your GTI Authorized Distributor for larger applications.

For generator paralleling applications up to 300kW use the series 50 gas train.

CARB compliant configuration kits available up to 3MW.



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