



Bi-Fuel System

For Industrial Diesel Engines

(High speed 1200-1800 rpm)

Description

PM Control Systems has developed a Bi-Fuel System for any brand of industrial stationary diesel engine. This system is designed to reduce diesel consumption by substitution of gas and will therefore significantly reduce the operating costs of new and existing applications. Some customers use the Bi-Fuel system as solution for exhaust gas emission reduction.

The new designed control algorithms will help customers to maintain a predefined gas/diesel ratio throughout the entire load and speed range of the engine. This is made possible while maintaining original engine performance and minor mechanical changes. The Bi-Fuel System will give customers the ability to return to full diesel operation at any desired time.

Applications

The new Bi-Fuel System is designed to target the following diesel engine applications:

- Electrical Power Generation.
- Compressor or Pumping Applications.
- Any other stationary application.

The Bi-Fuel System is the latest in the PM Control line of diesel replacement systems for any brand of stationary industrial diesel engine operating at speeds between 1200 and 1800 rpm with a load range of 120-3500kW.

PM-Control offers a sequential gas injection system for large sized medium speed industrial diesel engines.

System overview

The system consists of a Bi-Fuel controller. This controller uses the same hardware as the well known EGS02 lean burn gas engine air to fuel ratio controller.

In order to reduce the diesel consumption, gas has to be admitted to the engine in an accurate and controllable way.

The Bi-Fuel controller works in conjunction with a single point gas injector (Tecjet) or an Gas Control Valve (F-series Integrated Throttle Body) for gas submission. PM-Control Systems will work with you by advising the most suitable solution.

Tecjet (Smart Gas Control Valve)

From engine sizes 600kW and larger, the Bi-Fuel controller works in combination with a Tecjet (single point gas injector) which accurately meters the gas as calculated by the Bi-Fuel controller.

The Tecjet is a smart valve. It receives a gas demand flow from the Bi-Fuel controller (by CAN-communication with 5ms update time).

The Tecjet measures:

- Gas temperature & pressure
- dp Tecjet

With its internal mapping, the Tecjet will determine the position of the valve to meter the desired gas flow.

- Reduces diesel consumption by substitution of gas
- Wide variety of gasses possible like natural gas, bio gas, sewage gas and landfill gas.
- Gas fumigation system
- Minimal mechanical changes by using primarily add on components
- No significant engine modifications
- Full diesel operation remains possible
- Full electronic control
- Flexible programming
- Coloured HMI screen
- Fully wired Control Cabinet build to customer specification.
- System is engineered and supported out of Australia and Singapore.

Tecjets are available in several sizes, allowing a wide range in gas pressures (3kPaG-27kPaG) and gas qualities (natural/sewage/bio/mine/coal seam).

In most cases an additional gas pressure regulator is not required.

L/F-Series ITB (Gas Control Valve)

For engine sizes below 600kW, the Tecjet can still be used, but more cost comparative will be to use either an L- or F-Series ITB (Integrated Throttle Body).

The L- or F-Series ITB operates together with a Zero Pressure Regulator and Mixer unit(s). Required gas pressure for such system is 3-12kPaG).

Control Panel and HMI

The system includes a fully wired control panel with a colored touch screen Human Machine Interface (HMI).

Basic system configuration can be done at the HMI and important system parameters can be monitored and trended.

For example actual diesel/gas ratio can be continuously monitored from the HMI as well as engine parameters and alarms.

Engine Protection

PM Control recognizes that the engine is a costly asset and believes that protection of the engine is equally important.

Therefore the Bi-Fuel system constantly monitors the following parameters:

- Exhaust port temperature
- Intake manifold temperature
- Jacket water temperature
- Engine speed irregularity (misfire).

The Bi-Fuel gas/diesel ratio is adjusted when one of the listed parameters exceeds certain values. The amount of adjustment is freely tunable. If adjustment of the system does not result in the desired result, the system will return to full diesel operation or shutdown the engine.

On top of the above listed standard Protection, PM-Control Systems believes that a detonation detection system is required for Bi-Fuelled engines.

The standard Bi-Fuel system contains a separate knock controller providing protection against knock. This separate knock controller however is fully integrated in the system.

In the event of detonation, the Bi-Fuel controller will instantly reduce the gas admission significantly and then return slowly to the ratio as before the detonation event.

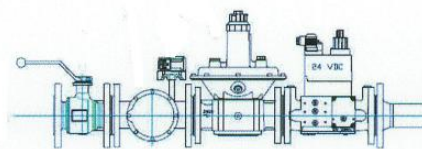
If the detonation continues or repeats within a certain time period, the engine will return to full diesel operation until an operator-maintainer investigates the issue and resets the system.

Gas train:

The system incorporates a gas train complete with a ball valve, double block and bleed plus valve proving system to comply with Australian standards.

On request the gas train can be build to any common industry standard.

A zero pressure regulator will be part of the system in none Tecjet operating systems.



The system has many sensors for control and engine protection. These sensors include but are not limited to speed; manifold pressure, manifold temperature, jacket water temperature, gas system pressure, exhaust gas temperature and multiple knock sensors.

These sensors have been used in many industrial gas engine applications for many years and thus ensuring safety and reliability.



Woodward's PCM128HD Bi-Fuel Controller

Houses many different IO points and having high CPU capabilities to execute bi-fuel algorithm at fast sample times



Woodward's Tecjet.

Single point gas injector, which is a smart gas metering valve. It receives every 5ms an updated gas demand by CAN from the Bi-Fuel Controller.

Proposed for engines >600kW



MAT/ECT-Sensor.

Used to measure the manifold temperature and jacket water temperature

Commissioning

The system has been designed in a way to have as many tunable features as possible, but maintaining simplicity.

The commissioning engineer programs a desired Gas/Diesel ratio (%) in the main 3-dimensional table and the system will control the desired ratio accordingly.

The usage of the programmable 3d-table, creates an optimum Gas/Diesel ratio over the entire load and speed range.

		Engine Load (%)								
		20	30	40	50	60	70	80	90	100
Engine Speed (rpm)	500	0	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0	0
	950	0	0	0	0	0	0	0	0	0
	1000	0	0	10	10	10	20	20	20	20
	1200	0	0	10	20	20	40	40	60	50
	1500	0	0	30	30	30	50	50	70	60
	1600	0	0	30	30	30	50	50	70	60
	1700	0	0	30	30	30	50	50	60	60
	1800	0	0	30	30	30	50	50	60	50

Diesel gas Ratio (%)

In addition to the main 3-dimensional table, the commissioning engineer has additional/optional tools available to change the diesel gas ratio based upon engine parameters like manifold temperature, exhaust port temperature and detonation. Instead of going entirely back to full diesel operation, the ratio can be adjusted accordingly.

Basic tuning of the system can be done through the HMI. However, more advanced setup and configuration needs to be done by means of a laptop connected to the Bi-Fuel controller.

Installation

PM-Control Systems offers a Bi-Fuel kit containing all major hardware components. In general components are add on only and significant engine modifications are not required. Also PM-Control Systems can provide wiring harnesses upon request.

Operation

Typical operation of a generator set would be to start the unit on full diesel and once a programmed timer and minimum jacket water temperature are exceeded, the Bi-Fuel controller will start providing gas to the mixer unit(s) downstream of the air cleaner, but upstream of the turbo.

Since gas starts flowing to the engine, the power will slightly increase. The generator power control and speed control will reduce the diesel actuator to maintain power.

This process continues until the desired Gas/Diesel ratio is achieved by a fully programmable slow ramp rate.

The 3-d Gas/Diesel ratio table is multiplied by some optional correction tables i.e. inlet manifold temperature. This then forms the desired Gas/Diesel ratio.

The diesel actuator and speed control are still operational and will follow the fast system response for sudden load changes. The Gas/Diesel ratio is purposely a much slower process to avoid unstable operation.

During normal stopping of the unit or removal of the Gas/Diesel discrete signal input, the Gas/Diesel ratio will return to 0 via the previous mentioned slow ramp rate.

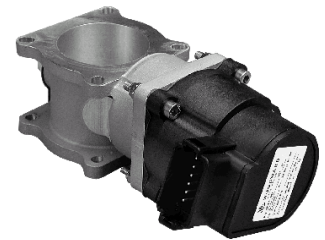
In case of an alarm, the Gas/diesel ratio will return to 0 (full diesel operation) by a fully programmable fast ramp rate. This ramp rate is normally chosen according to the engine's load step and recover capabilities.

Additional features

- Process control:

For applications where the gas supply (flow) is not always sufficient, a process control algorithm has been developed, as optional part of the system, to limit the gas consumption of the Bi-Fuel engine.

The process control will reduce the Desired Gas/Diesel ratio, once the gas supply line pressure reduces to a tunable value. At this pressure the gas substitution becomes a function of the supply line system pressure as well. This will prevent further dropping of the supply line pressure and could prevent the risk of gas starvation of other gas consumers (i.e. gas generator sets or boilers).



Woodward's L-Series ITB.
ITB (Integrated electronic Throttle Body). It's a PWM signal controlled position controller. Proposed for engines <600kW and low cost applications

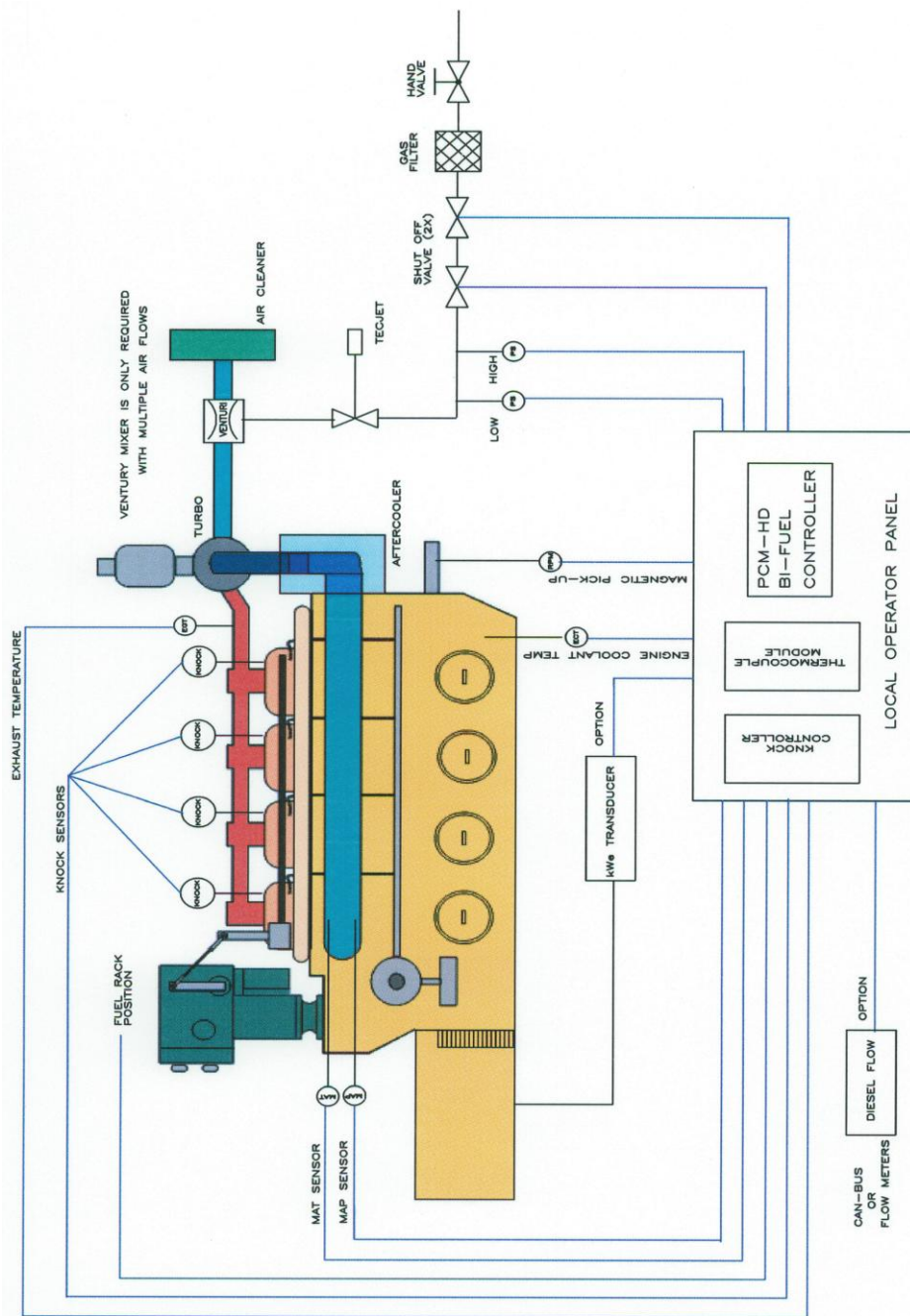


Woodward's Mixers.
Used for none Tecjet equipped systems and used on Tecjet equipped systems with multiple turbo chargers



MAP-Sensors.
Used to determine the Boost pressure of the engine

Overview



Australia office:
PM Control Systems Pty Ltd
 Unit 1, 1 Wirega Avenue, Kingsgrove,
 NSW 2208, Australia
 Tel: +612 9758 2322
 Email: sales@pmcontrol.com.au

China office:
上海鼎茂自动化有限公司
上海代表处
 中国上海浦东东方路710号，
 汤臣金融中心，2218室，
 邮政编码200122
 Tel: +86 21 6165 2260
 Email: sales@pmcontrol.com.cn

Indonesia office:
PT PM Control Systems
 Sentra Bisnis Atha Gading
 Blok A 7C/25 Kelapa Gading
 Jakarta Utara, Indonesia
 Tel: +62 21 4585 7266
 Email: sales@ptpmcontrol.com

For more information, please contact:

PM Control Systems Pte Ltd
 No. 8 Joo Koon Crescent Singapore 629011
 Tel: +65 6779 2822
 Fax: +65 6777 6301
 Web: www.pmcontrol.com.sg
 Email: sales@pmcontrol.com.sg