BI-FUEL CONVERSION OF DIESEL GENERATING SETS

ComAp

誥鑫企業有限公司
ARITH COMPANY LTD.
地 址： 台北市復興北路427巷30號
電 話： (02)2717-5038
傳 真： (02)2717-5039
e-mail: taipei@arith.com.tw
網 址： http://www.arith.com.tw

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BI-FUEL ENGINE CONVERSION

Conversion of Diesel Engines to Bi-fuel (Diesel and GAS) Operation by

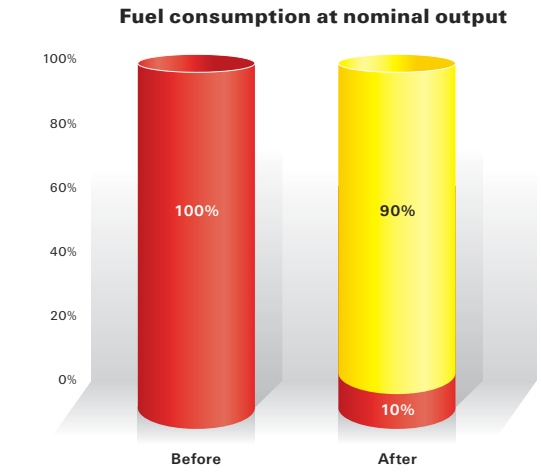
- individual gas-valve technology for slow and middle speed engines
- central gas/air mixer (fumigation) for high speed engines

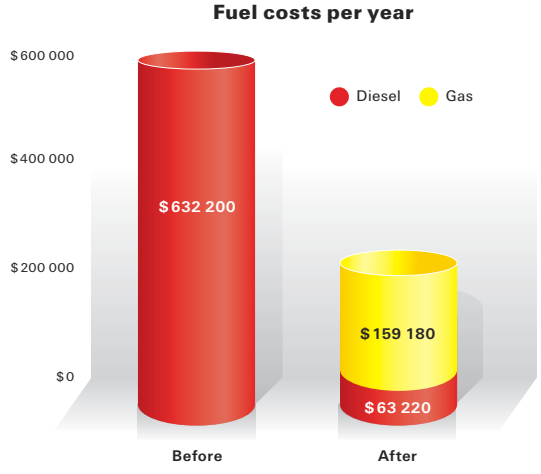
ComAp bi-fuel conversion modifies an original diesel engine so that the engine operates on diesel and gas simultaneously. The gas is used as the main fuel and the diesel is used just for the ignition of the gas/air mixture.

COMMON FEATURES

- Substantial savings on operation costs
- Practically no engine modification required
- Non-derated output power
- Possibility of original diesel operation
- Safe operation
- Lower emissions
- Longer engine life span, longer service and maintenance intervals

ECONOMIZE ON THE COST of your power generation by converting your diesel generating sets to BI-FUEL OPERATION





EXAMPLE Reference gen-set:
CKD/SKODA 1450 kVA; 375 RPM; Czech Republic

- Substitute up to 90 % of your diesel consumption with gas
- Reduce your operational costs substantially

BI-FUEL ENGINE CONVERSION

Frequently Asked Questions (FAQ)

What does bi-fuel operation actually mean?

Bi-fuel operation means the engine uses two fuels (gas and diesel oil) at the same time. Natural gas is intended as the main fuel and diesel oil is used for the ignition of the gas/air mixture inside the cylinder (a portion of diesel oil is injected at the end of the compression stroke, thereby maintaining the original diesel operation principle).

What methods/technologies are employed in the bi-fuel conversion provided by ComAp?

ComAp provides two conversion technologies – one for slow-speed engines (up to 1000 rpm) and the second for high-speed engines (1500 rpm, 1800 rpm). Therefore the choice of the appropriate ComAp solution is determined by the engine speed and consequent suction/exhaust valve overlap (i.e. opening of suction and exhaust valves at the same time). Slow-speed engines normally feature a large valve overlap when the pure air is flushing (cleaning) and cooling the cylinder. After bi-fuel conversion, it is necessary to continue cylinder flushing/cooling by pure air, i.e. gas flow into the cylinder during the valve overlap must be interrupted to avoid the presence of gas in hot exhaust manifold (this would cause a potentially dangerous situation and result in substantial fuel losses). Therefore, each cylinder is equipped with the patented electromagnetic gas valve with variable gas injection timing controlled by a ComAp electronic control system INCON.

In contrast, high-speed engines have only a small valve overlap, so it is possible to install just a central mixer(s) before the turbocharger(s) for the continuous flow of gas/air mixture. Gas injection is controlled by a throttle operated by the ComAp electronic control system InteliGen-BF according to the required engine output and speed.

Is it possible to operate a converted gen-set on diesel oil only?

Yes, the standard operation mode of the converted engine is certainly bi-fuel. However, operation on diesel fuel only (e.g. in case of gas emergency) remains possible and the converted engine operates using diesel fuel with the same parameters as those before conversion was undertaken.

Is it necessary to stop the engine in case of required transition between bi-fuel and pure diesel operation modes?

No, transitions between the two modes (from bi-fuel to diesel and vice versa) can be achieved while the engine is running (i.e. without interruption of the load supply) and is a very smooth process. Note the engine will always start on diesel and the operation mode is switched to bi-fuel upon predefined output level. In case of gas shortage, the transition is immediate at the actual engine load, gas valves are shut off automatically and the engine continues on pure diesel operation. Once the gas supply has returned the engine is switched back to bi-fuel.

What is a de-rating factor (output reduction) for a converted gen-set?

After the conversion, the engine nominal output is not de-rated and all engine parameters (e.g. exhaust temperature, engine temperature etc.) and behavior (e.g. response to a load steps) remains within the limits stated by the engine manufacturer for the original diesel engine (provided these parameters were within limits before the conversion). The de-rating factor according to the ambient conditions remains the same.

How does the conversion affect maintenance costs?

Maintenance costs after conversion will not be increased at all. Substantial parts of the engine remain unchanged, new mechanical parts are of heavy-duty design (e.g. service interval for the electromagnetic gas valves is 6000 running hours), and electronic control systems are fully automatic. Moreover, the gas operation means less carbonization of combustion chambers and turbocharger, so that the interval for de-carbonisation and overhauling of the engine is prolonged.

What warranty does ComAp provide for the conversion?

Standard warranty is 12 months from the date of start-up, but to a maximum 4000 running hours or 18 months since the date of Bill of Lading/Airway Bill, whichever expires earlier. The Warranty covers equipment related to the conversion only.

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SLOW AND MIDDLE SPEED ENGINE CONVERSION

HOW IT WORKS

Gas is supplied to the converted engine by individual electronically controlled gas valves, which are installed on the suction ports of each cylinder. The gas supply for each cylinder is delivered only during the suction stroke and just after the final stage of cylinder scavenging.

Slow and medium speed engines feature an extended period during which the cylinder is flushed with fresh air that flows from the inlet to exhaust, cooling the combustion chamber and ambient parts before pushing out the exhaust gases – a process known as 'cylinder scavenging'. As a result, a significant amount of the inlet air flows directly to the engine outlet, without being used.

Using alternative bi-fuel conversion techniques such as a central gas air mixer, i.e. fumigation, would result in substantial gas losses – potentially creating a dangerous situation due to the presence of un-burnt natural gas in the very hot exhaust manifold.

The gas-valve system ensures the best possible efficiency by using natural gas for normal power generation combined with the beneficial saving of operating with high gas/diesel ratio. ComAp's bi-fuel governor ECON-2S electrically controls both fuels used ensuring a very economical, efficient and precisely controlled safe operation of the converted engine.

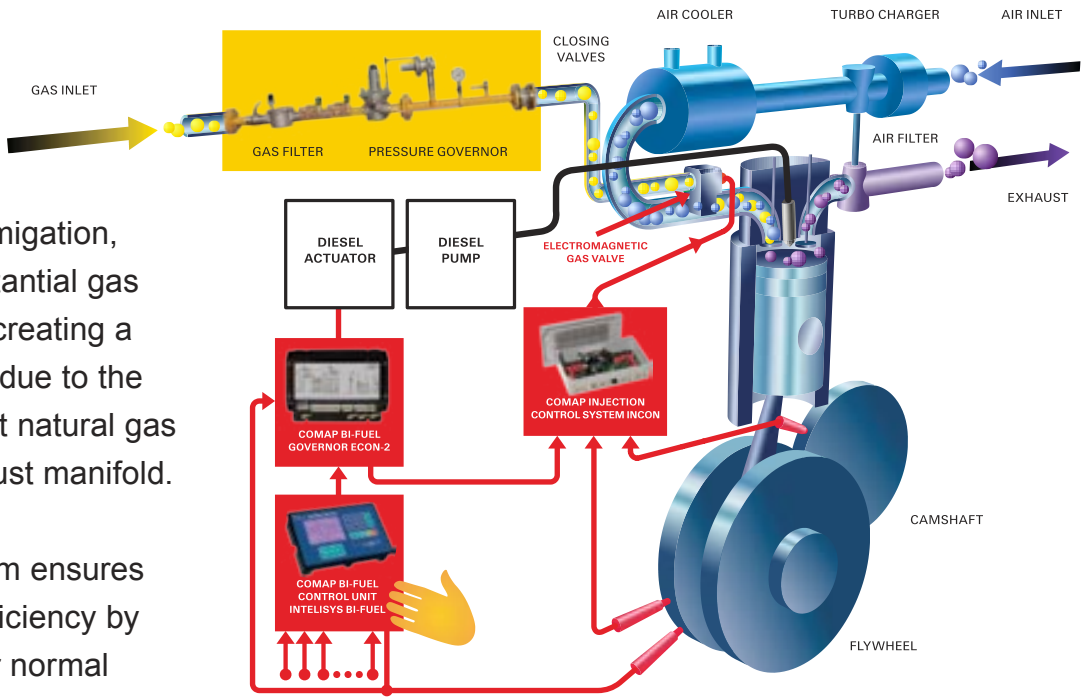
Engine control unit
InteliSys Bi-Fuel

Injection Control System Incon

Electromagnetic gas valve

Bi–fuel governor ECON-2S

SCHEME OF THE CONVERTED ENGINE



SLOW AND MIDDLE SPEED ENGINE CONVERSION

MAIN FEATURES

- Extremely efficient operation – only very small percentage of diesel is necessary
- Cheaper electricity production
- Non-derated output power
- The same response to load steps
- High stability of the engine
- Lower emissions
- Possibility of pure diesel operation maintained
- Prolonged service intervals
- Individual approach
- Turn-key solution

TYPICAL CONVERTIBLE ENGINES

- Slow-speed (up to 750 rpm) turbocharged
- Middle-speed (around 1000 rpm) turbocharged

ELEMENTS OF THE SYSTEM

- Electromagnetic gas valves with gas/air blenders
- ComAp electromagnetic valves control unit INCON
- ComAp Bi-Fuel automatic control unit InteliSys Bi-Fuel
- ComAp bi-fuel governor ECON-2S
- Safety valve(s) for air filling manifold
- Gas train (gas manifold, gas governor, double closing valve, filter, ball valve etc.)

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HIGH SPEED ENGINE CONVERSION

HOW IT WORKS

Gas is mixed with air by a common mixer installed before the turbocharger(s). Gas flow is controlled by a throttle valve, which is electronically operated by the ComAp control system InteliGen-BF according to the required engine output and speed.

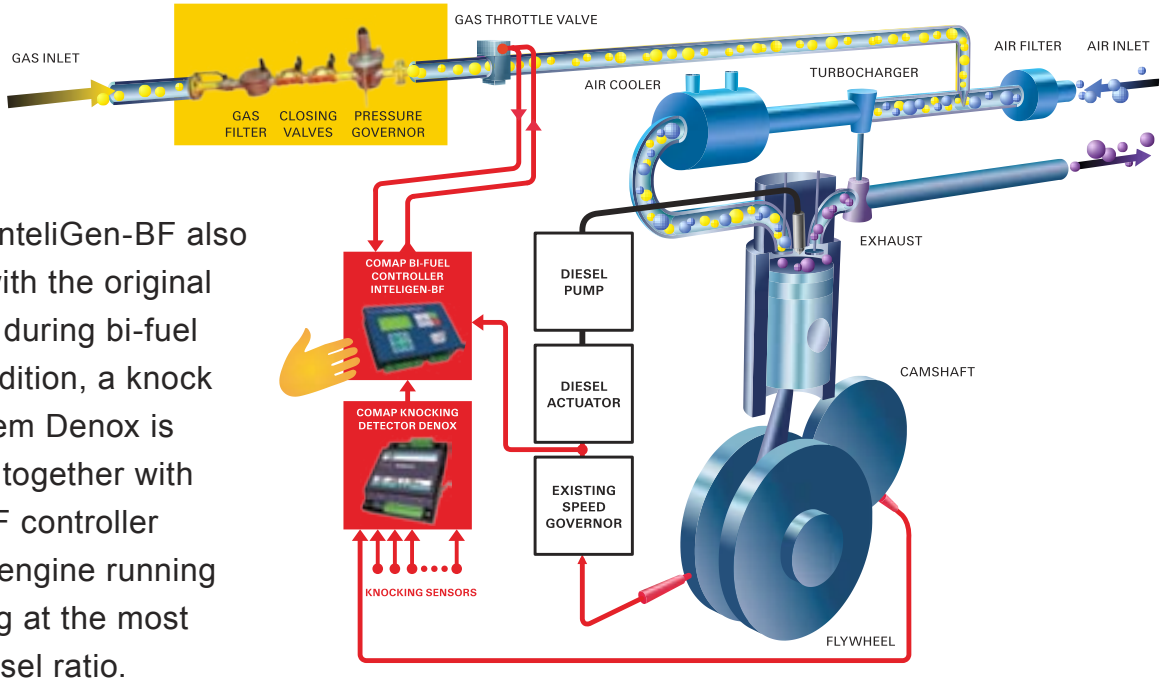
Bi-fuel controller InteliGen-BF

Gas Throttle Valve

Knocking detector DENOX

Gas / Air Blender

SCHEME OF THE CONVERTED ENGINE



The controller, InteliGen-BF also works directly with the original diesel governor during bi-fuel operation. In addition, a knock monitoring system Denox is installed, which together with the InteliGen-BF controller delivers proper engine running without knocking at the most efficient gas/diesel ratio.

HIGH SPEED ENGINE CONVERSION

MAIN FEATURES

- Cheaper electricity production
- Non-derated output power
- The same response to load steps
- The amount of gas is maximum possible at any time
- Lower emissions
- Possibility of pure diesel operation maintained
- Prolonged service intervals

TYPICAL CONVERTIBLE ENGINES

- High-speed (1500 rpm, 1800 rpm)

ELEMENTS OF THE SYSTEM

- Air/gas mixer(s)
- Gas throttle valve with actuator
- ComAp bi-fuel controller/governor InteliGen-BF
- ComAp knocking detector/controller DENOX
- Sensors (vibration, pressure, temperature, etc.)
- Gas train (gas manifold, gas governor, double closing valve, filter, ball valve etc.)

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GALLERY

COMPANY: Master Textile
COUNTRY: Pakistan
CONVERSION: Caterpillar 3512

In May 2003, ComAp's commissioned a pilot conversion project of a high-speed engine at Master Textile, a company based near Lahore in Pakistan. The aim of the conversion was to decrease electricity production costs at the factory – working a three-shift operation, by converting the original generating set which incorporated a Caterpillar 3512 diesel engine to dual-fuel by using the ComAp conversion products.

Original parameters (before conversion)
Fuel: Diesel
Nominal gen-set output:1020 kWe
Real output on site: 800 kWe
Gen-set efficiency: 36,0 %

Parameters after conversion (dual-fuel)
Fuel: Gas + Diesel
Gas / Diesel ratio: 35 / 65 %
Nominal gen-set output: 1020 kWe
Real output on site: 800 kWe
Gen-set efficiency: 36,0 %

Investment payback period:
2 MONTHS

GALLERY

COMPANY: Alkem Nigeria Ltd. / United Spinners Nigeria Ltd.
COUNTRY: Nigeria
CONVERSION: CKD / SKODA 6–38A6S; 2270 kVA; 6 units

In January 2005, ComAp converted to bi-fuel operation 2 diesel generating sets CKD / SKODA with output of 1816 kWe / 2270 kVA operated as prime movers at sister textile factories Alkem and United Spinners in Lagos, Nigeria. Bi-fuel conversion of 4 more identical diesel generating sets in the same powerhouse follows.

The above mentioned slow-speed engine (500 RPM) has been converted by the ComAp gas valve technology, i.e. using electronically controlled electromagnetic gas valves with each cylinder separately.

As a result of the successful installation the constant ignition diesel portion is now approximately only 18% of the original diesel consumption at nominal output.

Original parameters (before conversion)
Fuel: Diesel
Nominal gen-set output: 2270 kVA
Real output on site: 1875 kVA

Parameters after conversion (dual-fuel)
Fuel: Gas + Diesel
Gas / Diesel ratio: 82 / 18 %
Nominal gen-set output: 2270 kVA
Real output on site: 1875 kVA

Investment payback period:
2 MONTHS

MISSION

ComAp's vision is to become a dynamic and significant international company with worldwide presence providing innovative solutions in the Power generation electronics market. Our aim is to provide customers with state-of-art solutions and products with a reputation for excellent reliability and good value.

ComAp's key advantage is our flexibility, experience, knowledge and enthusiasm in all three product lines:

- Electronic products for power generation industry
- Turn key electronic and electric solutions for power generation industry
- Bi-fuel conversion kits

The management task is to keep and strengthen this advantage helping our customers solve their problem and by doing so keep our customers fully satisfied with our service. Within our company we work towards establishing a pleasant and friendly atmosphere designed to support the creativeness, dynamics and courage in finding new opportunities, projects, solutions and technologies. We will always deal honestly and fairly with our partners and personnel.

Libor Mertl

Managing Director

HISTORY

ComAp was founded in 1991 in Prague. Since then ComAp has specialized in engine and gen-set electronics developing several lines of gen-set control systems, anti-knocking detectors, misfiring detectors, gas injection controllers, engine management systems etc.

The first conversions of diesel engines took place in 1995, on slow speed CKD/SKODA engines. Since then ComAp continue to serve customers throughout the world delivering products that offer a proven and reliable solution. Within the last decade ComAp has become recognized as the leader in many of its core areas and is now the world's largest supplier of turn-key bi-fuel solutions and bi-fuel conversion components.

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CERTIFICATION

All ComAp products meet the most rigorous standards during manufacture, with every stage being undertaken in accordance with ISO certification, which was obtained in 1998. Followed by the marine Germanischer Lloyds approval in 2001, ComAp continue to work toward the highest levels of certification with on-going co-operation and support with both national and domestic ISO 9001 partners. Accreditation brings confidence, and every ComAp product is supplied with appropriate warranty and after-sales support for complete peace of mind.

RESEARCH AND DEVELOPMENT

ComAp believe passionately in the importance of continuously developing new technology along with forward thinking software and hardware to maintain the enviable position as worldwide leader in gen-set communication solutions. At the heart of this process is a desire to find better solutions for customers, and draws upon the company's most valuable asset – people. Over 80 % of ComAp employees are graduates with specialist electronic and programming knowledge appropriate to the innovative development of market-orientated engine management systems. This unique know-how is matched by ComAp's significant investment at every stage of the research and development process resulting in the creation of leading-edge modern development facilities.

TRAINING

Complete and full technical training can be provided to suit your needs, and level of understanding either at ComAp facilities or at your own – wherever they are in the world. This is backed by our commitment to offer full service and product installation if necessary. ComAp training is tailor-made to your needs and is designed to ensure you get the most from your ComAp equipment and covers all aspect of operation and equipment use. Further help is provided online at www.comap.cz with ComAp specialists always willing to help whether consultancy or technical support.