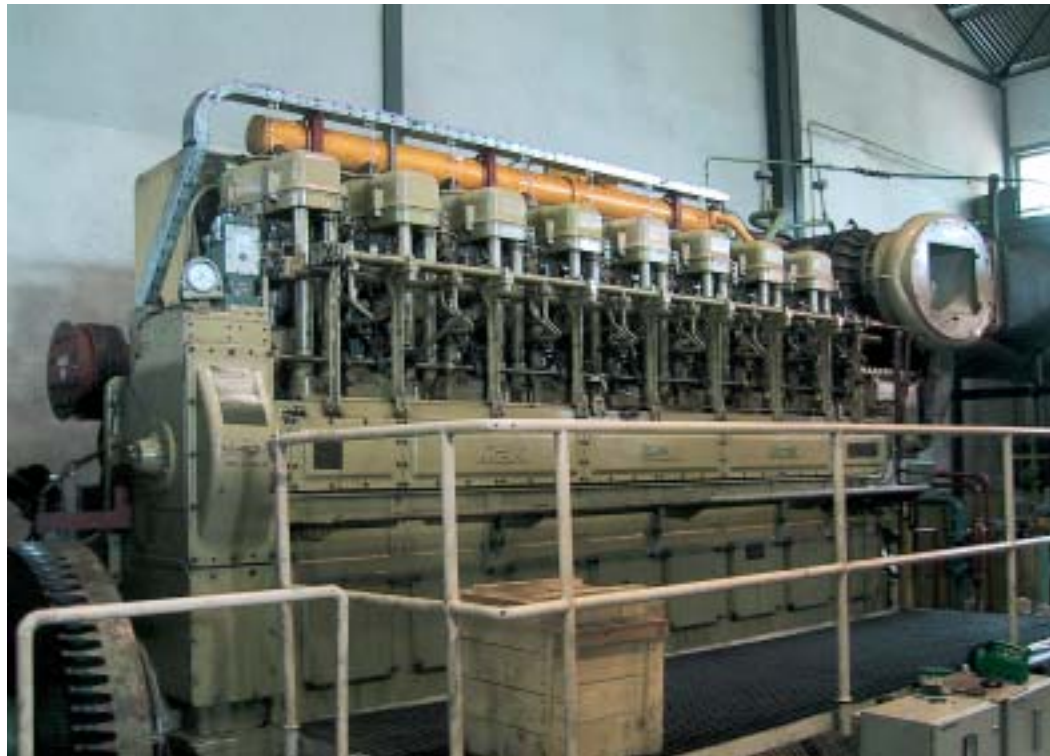




CONVERSION OF DIESEL ENGINES TO DUAL FUEL

General Description



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Clean Energy System ▪ P.O.Box 26, 106 01 Praha 10, Czech Republic
Telephone : +420 272 654 556 ▪ Fax : +420 272 659 740
www.cesys.cz ▪ e-mail: info@cesys.cz

Conversion System

CES converts all brands of diesel engines, any size, at any location, to Natural Gas/Diesel Dual Fuel Operation. The system is applicable both to Low and High Speed engines. Converted engine can be instantly switched from Dual Fuel Mode to Diesel Fuel operation and to continue operation at 100% Diesel Fuel. Dual Fuel Operation of converted engines brings great ecological and economic benefits.

Conversion of Low Speed Engines

Gas admission into each individual cylinder is controlled in timing and duration by opening of GEV valves. Diesel Fuel Consumption is reduced by up to 90 %, engine output remains unchanged, no derating of the converted engine.

Main Features

- Gas injection by Electromagnetic Valves
- Admission Valves with fast response
- Electronic control of gas injection
- Precise timing of gas injection period
- Individual cylinder timing control
- Easy installation

Higher efficiency and steady output and speed are achieved by means of precisely defined injected gas volume, which is in due proportion to the engine output and speed.

Principle of Conversion

Base of modification lies in installation of Gas Electromagnetic Valves (GEV) dosing gas to intake air of each individual cylinder. GEVs are controlled in timing and injection period. Combustion gases are ignited by dosis of diesel fuel, constant under any operating condition. Engines are equipped with automatic control system.

The overall system consists of Electronic Gas Injection Control Unit and Gas Electromagnetic Valves (GEV). Required engine output- and speed- control is done by GEV timing. The Control Unit controls start and duration of gas injection into intake manifold (in front of intake valve). Each GEV is controlled separately. Start and duration of GEV opening can be seen in timing diagram.

Applications

The System has been developed for use in supercharged and naturally aspirated, low/middle/high speed, up to 1000 r.p.m. engines.

The solution keeps the output of the gas engine identical to the output of engine operated with Diesel oil. Applicable to Spark Ignition Engines and Dual Fuel Engines, new engines and engine modifications (generally from 500 kW and above, turbocharged or naturally aspirated, low/ middle/ high speed).

Advantages

Adjustment of beginning and duration of gas admission provides desired gas volume and optimal flushing and cooling of cylinder by flow of filling air. The advantages are lower exhaust temperature and increased engine efficiency. Optimized timing also provides reduced fuel consumption and emission levels. Another essential gain is steady engine operation.

Economic operation

Dual Fuel operation is based on 10 % diesel and 90 % gas volume which reduces significantly fuel costs.

Unchanged power output

Nominal output of converted engine remains unchanged after conversion.

Wider fuel range

Converted engine can be operated with wide range of gases such as natural gas, biogas and other types of gases, diesel fuel.

Minimum engine modification

Conversion and installation of the system requires only few engine modifications.

Possible Diesel Fuel Operation

Converted engine can be operated also with diesel fuel only.

Range of Modifications

- Main parts:
 - safety crankcase covers
 - modification of intake manifold for safety valve installation
 - fuel ignition blocking device
 - engine and generating set signalization – gas pressure governor
- Gas train :
 - automatic closing valves
 - filter
 - ball valve
- Remote controlled start unit
- Case ventilation
- Distribution gas piping
- Air inter-cooler, modification of suction, inlet air
- Temperature control
- Sensors of vital parameters of the engine (connected to control system)



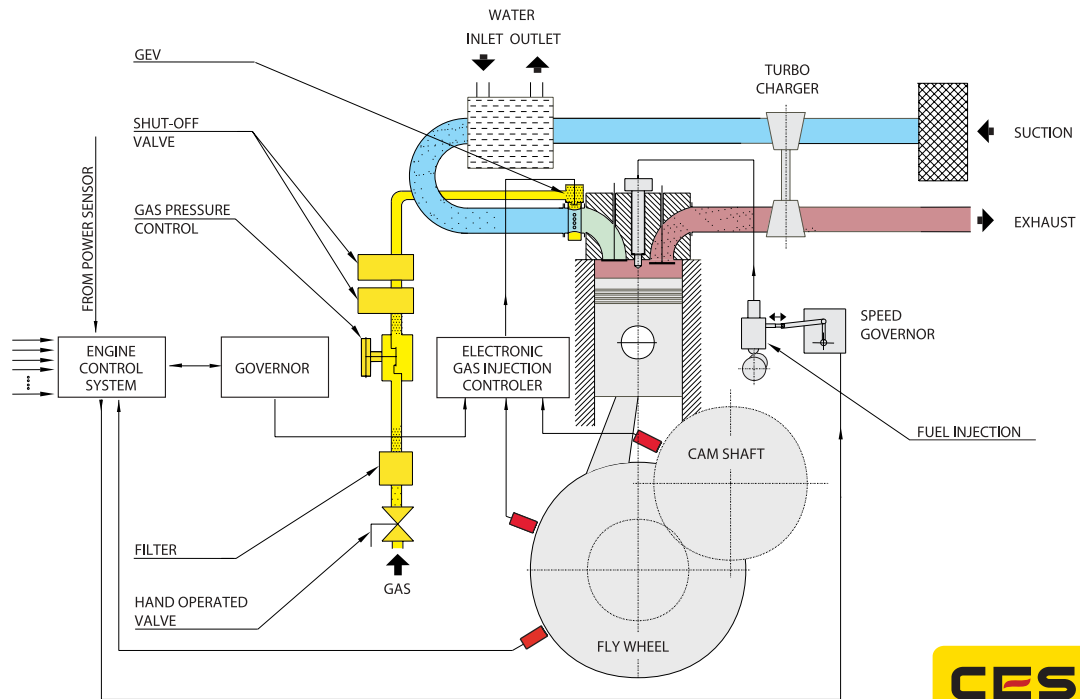
Automatic Control System

- Analog, contact and electric protection of the unit
- Island, parallel and stand-by regimes
- Speed control and voltage regulation in island operation
- Automatic synchronization
- Loading characteristic
- Output
- Power factor adjustment in parallel operation
- Temperature adjustment regulation loop
- Run time, number of starts, emergency stops and output record

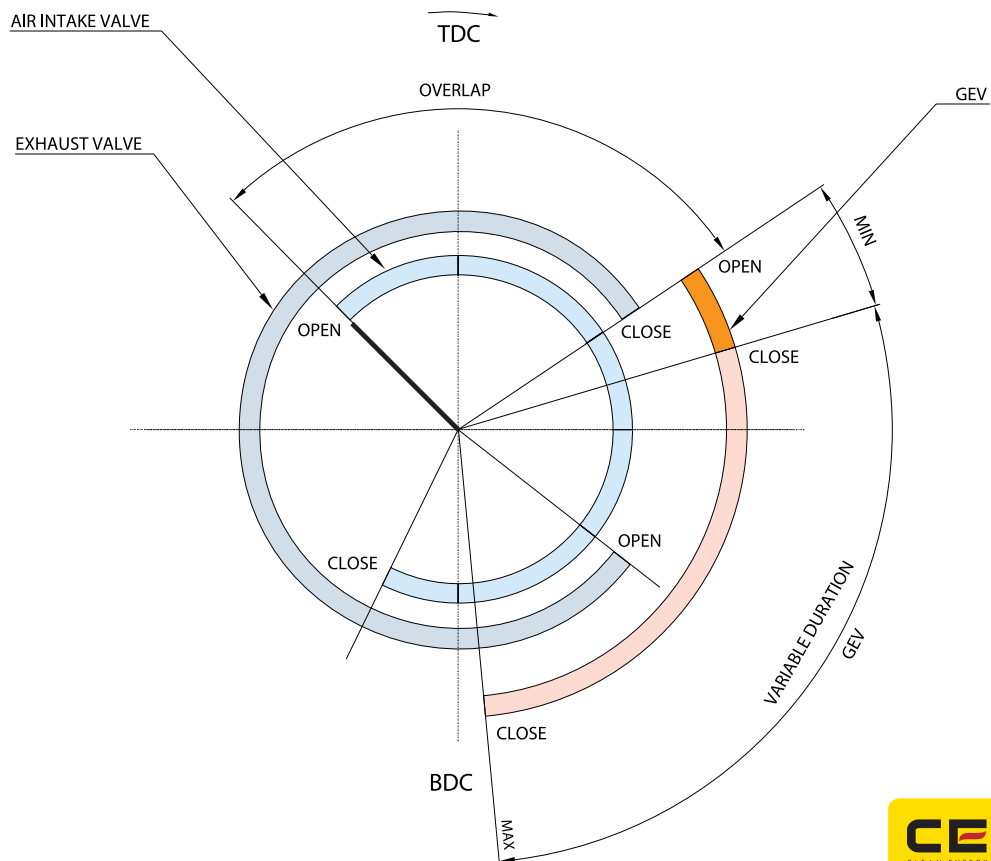
Gas Injection Control System

- Electronic control of gas injection related to crankshaft position
- Adjustable start of gas injection in range 0–180° of crankshaft rotation angle
- Individual GEV timing
- Maximum duration of opening corresponds to 180° of the crankshaft rotation angle

LOW SPEED ENGINE CONTROL DIAGRAM FOR DUAL FUEL OPERATION



TIMING DIAGRAM



Conversion of High Speed Engines

Gas is mixed with air by mixer prior turbocharger. Diesel Fuel Consumption is reduced to 40 %, engine output remains unchanged, no derating of the converted engine.

Main Features

- Gas-air mixture prepared by central mixer
- Admission valves with fast response
- Electronic control of gas volume
- No modification of original diesel injection equipment
- On site inspection not required

Principle of Conversion

Base of modification lies in installation of Central Mixer dosing continuously gas to common air intake pipe. Combustion gas volume is electronically controlled as a function of load (boost air pressure) to reach required dual ratio. Combustion gases are ignited by doses of diesel fuel, adjusted according to operating condition. Engines are equipped with automatic control system. If a knocking occurs, a portion of gas is decreased.

The overall system consists of Electronic Dual Fuel Control Unit, Throttle Body with Actuator and Central Mixer.

Steady output and speed are controlled by original engine speed governor.

Applications

The System has been developed for use in supercharged high speed engines with more than 1000 rpm.

The solution keeps the output of the Dual Fuel operated engine identical to the output of engine operated with Diesel oil.



Advantages

Essential gain is steady engine operation

Economic operation

Dual Fuel operation is based on 40 % diesel and 60 % gas volume, which reduces significantly fuel costs.

Unchanged power output

Nominal engine power output of converted engine remains unchanged after conversion.

Wider fuel range

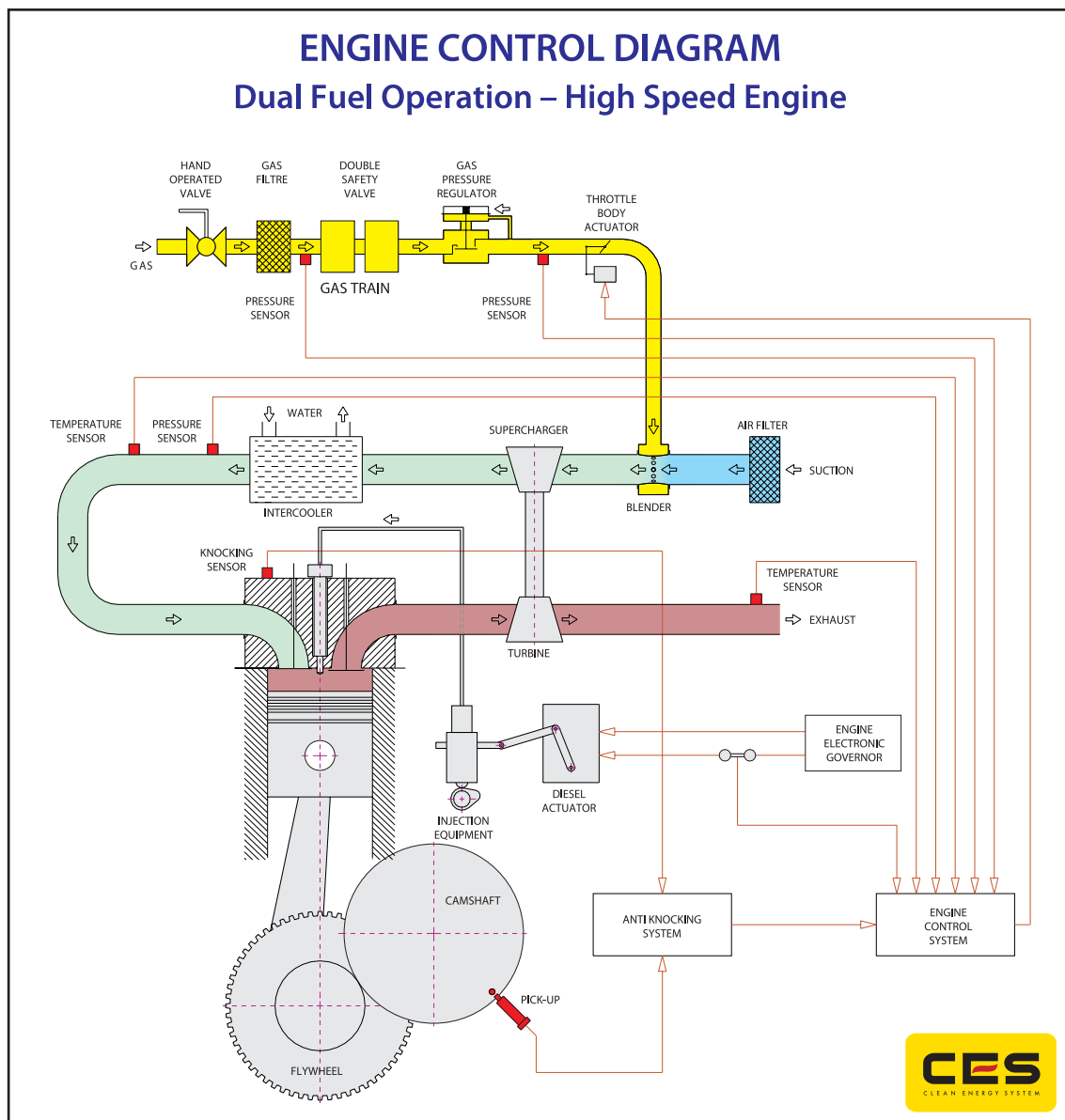
Converted engine can be operated with wide range of gases such as natural gas, biogas and other types of gases, diesel fuel.

Minimum engine modification

Conversion and installation of the system requires only few engine modification.

Possible Diesel Fuel Operation

Possibility to operate the converted engine also with diesel fuel only.



Range of Modifications

- Main parts :
 - Central mixer
 - Throttle body with actuator
 - Gas splitting device for multi cylinder line engine
 - Knocking sensors
 - Case ventilation
 - Engine signalization
- Gas train
 - Gas pressure governor
 - Automatic closing valves
 - Filter
 - Ball valve

Automatic Control System

- Programmable unit designed for Dual Fuel operation
- Boost air pressure and diesel actuator current measuring
- Control of gas safety and throttle valves according to preset characteristics
- Several protections to prevent engine operation under dangerous conditions
- Extension modules contain all necessary inputs and outputs for measuring and controls

Services – General Process

1. Evaluation – Conversion proposal is prepared based on information about the engine such as brand, type, output, RPM, supercharging, valves overlap etc.
2. On-site inspection (if necessary) – Detailed design of diesel-to-Dual Fuel conversion is elaborated based on inspection by our engineers on site.
3. Technical and commercial clarifications – Final detailed technical and commercial conditions of contract.
4. Production of Conversion Kits + Shipment
5. Installation supervision and commissioning – Supervision of conversion works and subsequent commissioning are provided by our engineers under the agreed terms, when necessary. Time of installation depends on engine type, scope of conversion and local facilities/conditions.

