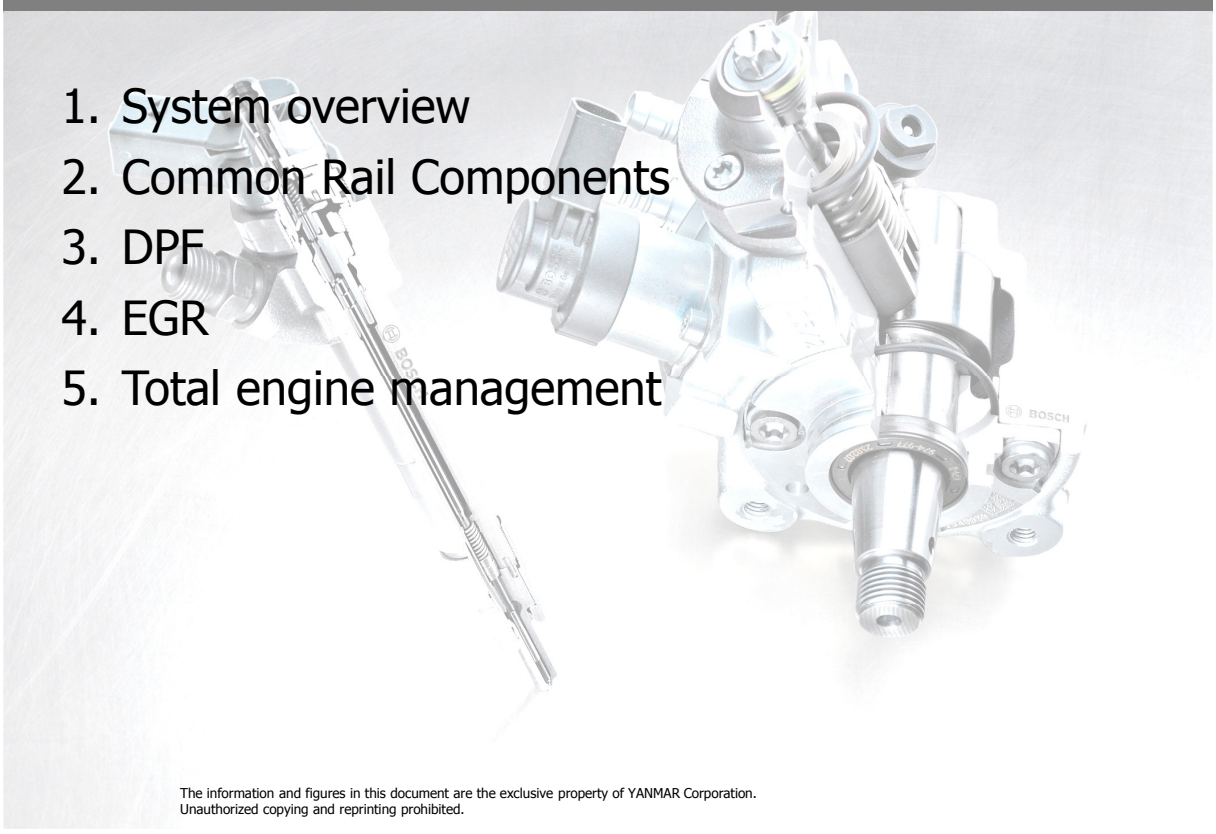
Common Rail System

1 April 2013

Vico de Bres
Customer Service Department
Yanmar Europe B.V.

YANMAR

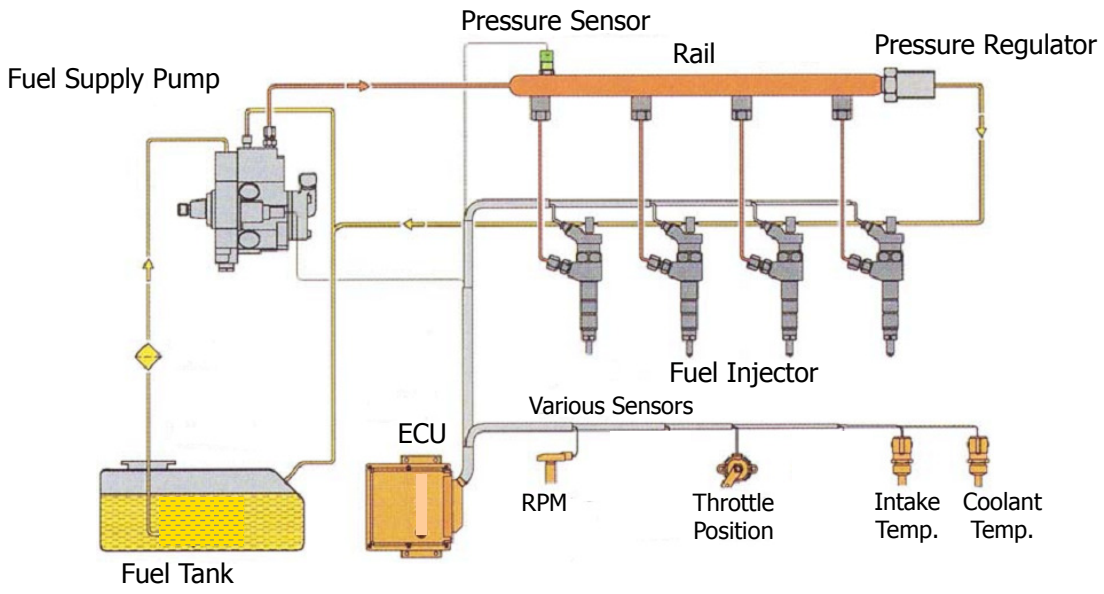
Content



1. System overview
2. Common Rail Components
3. DPF
4. EGR
5. Total engine management

System overview

Common Rail overview



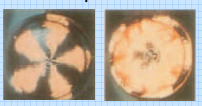
Possible for extreme high pressure injection few times in 1/1000 sec.

Features and advantages

- Feature -

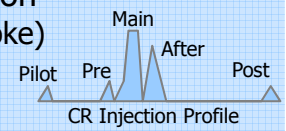
- Extra High Pressure (160MPa)

Combustion Comparison



90MPa 160MPa

- Multiple Injection (3 to 5/stroke)



CR Injection Profile

- Injection Timing Control
- Independent Cylinder Control
- Advanced Electronic Control

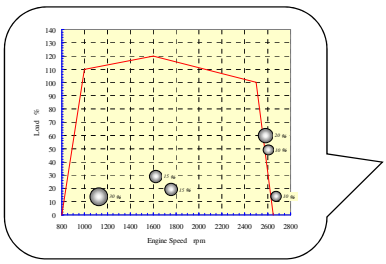
- Advantage -

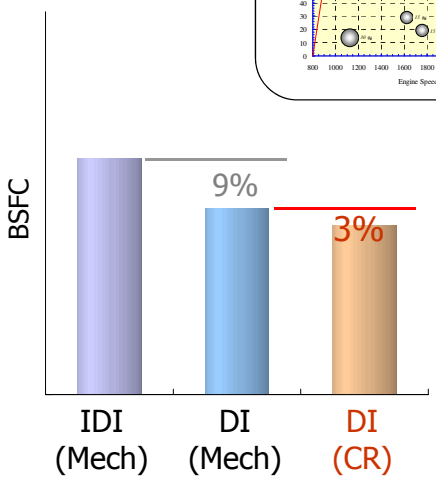
- Cleaner Exh. Gas Emission
  (NOx & PM Reduction together by Combination with EGR)
- Lower Noise
- Lower Fuel Consumption
- Better After Treatment Control
- Minimize Unbalance between each Cylinders
- Diagnosis, Fail Safe

Fuel consumption

Lower Fuel Consumption

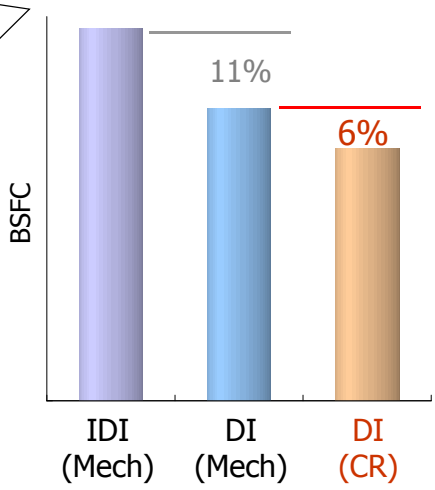
Rated Fuel Consumption





Estimation Vale of 3L-Class NA Engine (Engine Only – No DPF)

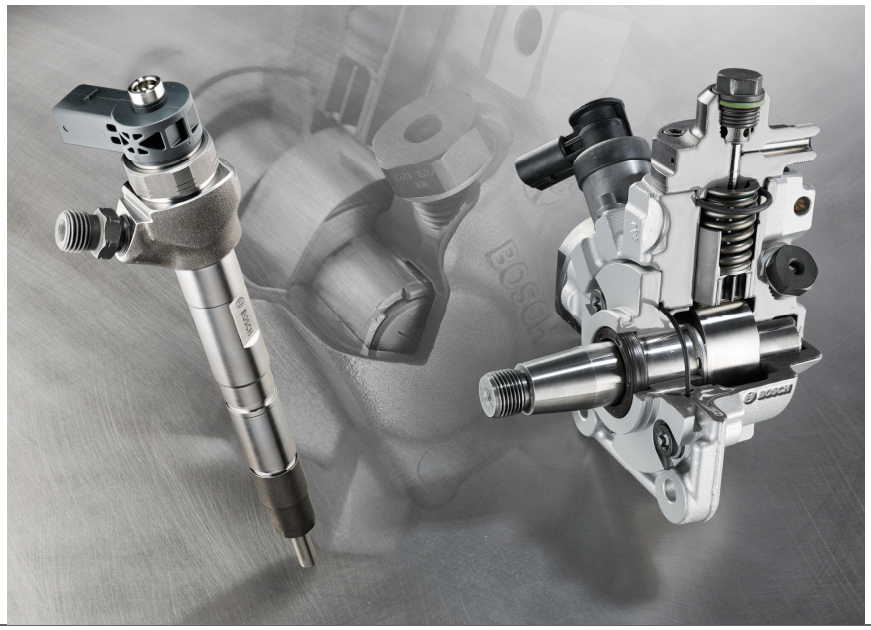
Excavator Pattern Fuel Consumption



Note: In case these emission level are same

Common Rail Components

Title



Common Rail Fuel System Components

1. **Fuel Tank**

2. **Primary Fuel Filter/Water Separator**

3. **Fuel Pump(s)**
   Low Pressure Feed Pump – High Pressure Supply Pump

4. **Fuel Rail**

6. **Fuel Rail Pressure Sensor and Control Valve**

7. **Injectors**

Common Rail Fuel System Components

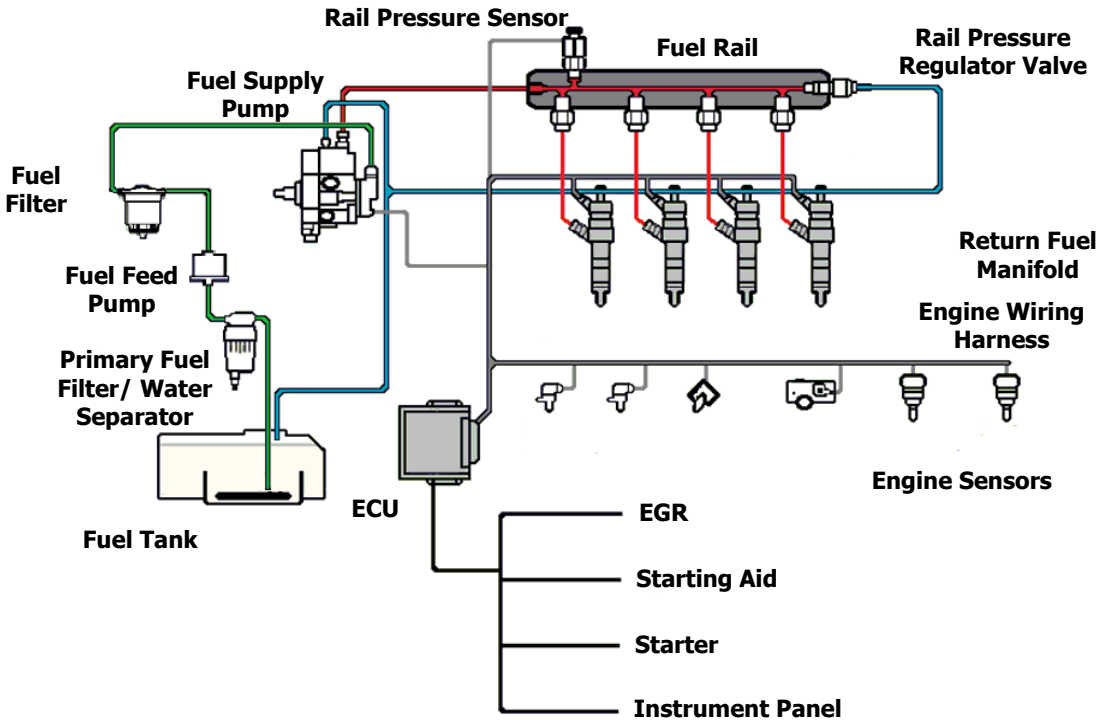
8. **Fuel Return Manifold**

9. **Engine Sensors**
   Engine Speed (Crank and Cam)
   Accelerator (Throttle) Position
   Intake Manifold (Pressure and Temperature)
   Engine Coolant Temperature
   EGR Valve Sensors (Pressure and Temperature)

10. **ECU (Engine Control Unit)**

11. **ECU Outputs**

Common Rail Fuel System



Fuel Tank

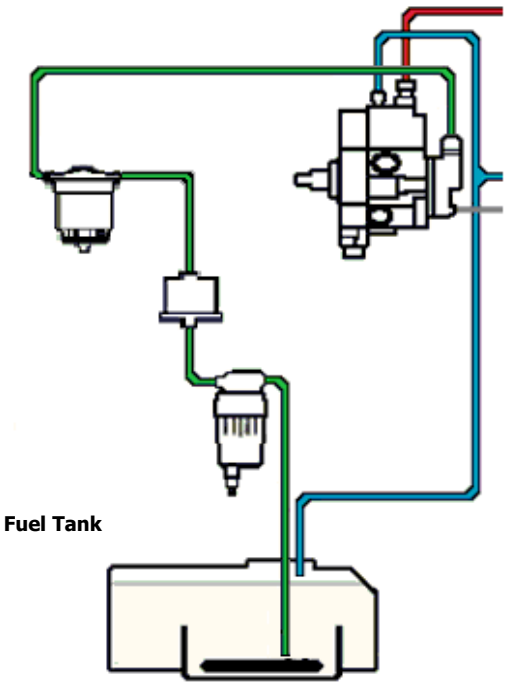
1. **Fuel Tank**
   Fuel Storage

   De-aeration

   Cooling

   Tank to Supply Pump is called the 'low pressure' system (In green)

   Drain the fuel tank every 250 hours to remove condensation and debris



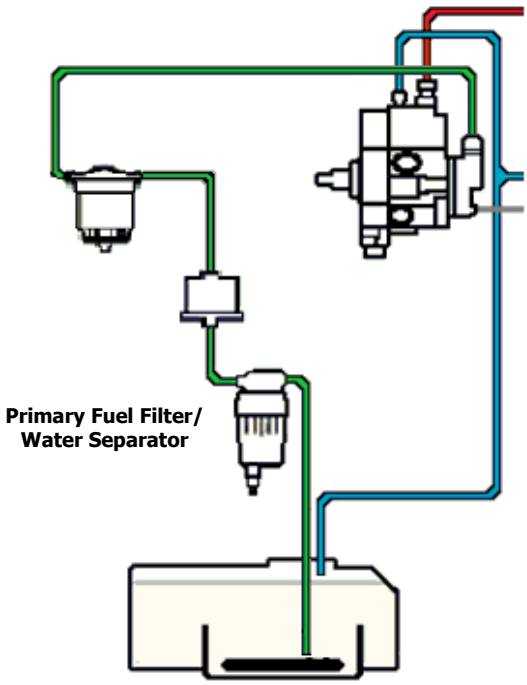
Primary Fuel Filter and Water Separator

2. Filter and Water Separator

Remove any water that may have accumulated in the tank due to condensation or at delivery

Check and drain the primary filter and water separator daily

Clean the primary filter and water separator every 500 hours

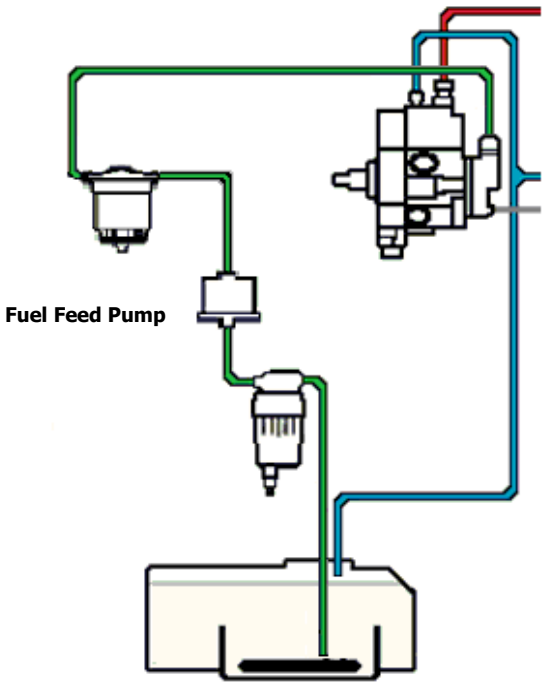


Fuel Feed Pump

3. Fuel Feed Pump

Mechanical or electric

Keeps a head pressure on the supply pump to prevent fuel starvation



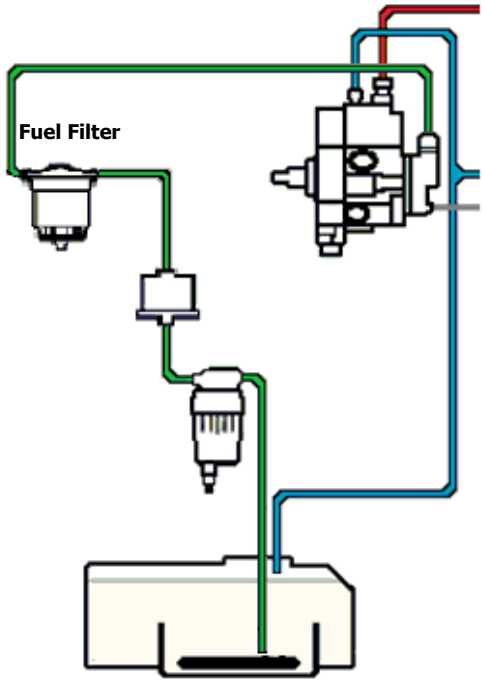
Fuel Filter

4. On Engine Fuel Filter

Smaller mesh than the primary filter

Final filter before the supply pump

Replace fuel filter every 500 hours



Fuel Supply Pump – Bosch CP4

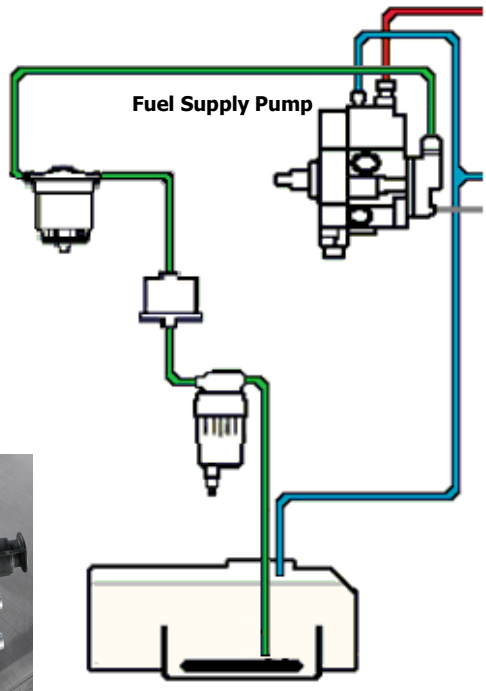
5. Fuel Supply Pump

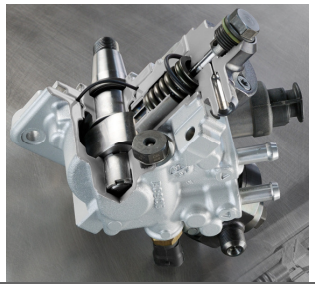
Able to supply fuel at up to about 240 MPa (29,400 psi)

One (1) piston/cyllinder

Does not feed separate injectors, provides fuel to Common Rail

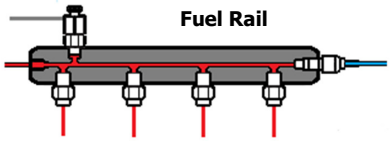
Equipped with an intake or suction control valve to adjust the volume of fuel delivered to the rail





Fuel Rail

6. Fuel (Common) Rail
Provides a continuous supply of fuel to injectors at high pressure



Acts as snubber to dampen supply pump pressure pulses

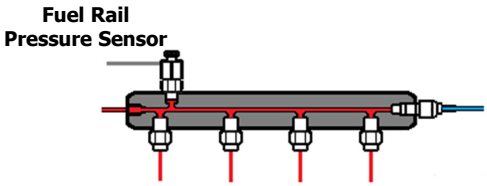
Equipped with a rail pressure sensor, pressure relief valve, and fittings for attaching high pressure lines

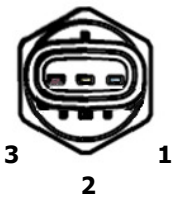
Do not exchange individual components on the fuel rail, replace the entire rail assembly

High pressure fuel lines MAY NOT be reused

Fuel Rail Pressure Sensor

7. Fuel Rail Pressure Sensor
Provides feed-back signal of the current fuel rail pressure to the ECU





Located on the front of the rail

Pin 1 – 5VDC reference voltage

Pin 2 – 0 – 4.8VDC pressure signal

Pin 3 – Circuit ground

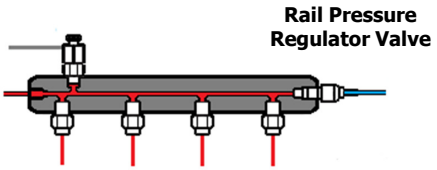
Rail Pressure Regulator Valve

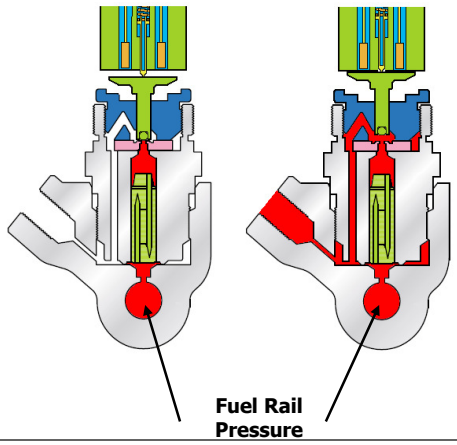
8. Rail Pressure Regulator Valve

Located at the back of the rail

Controls the rail target pressure as determined by the ECU

Solenoid valve is activated by the ECU when the rail pressure exceeds the target for any given set of conditions



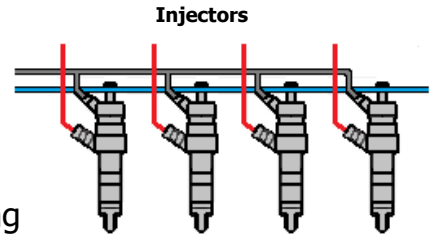


Injectors

9. Injectors

Located in the engine cylinder head

Controlled by the ECU to maintain the best fuel volume and injection event timing for all operating conditions

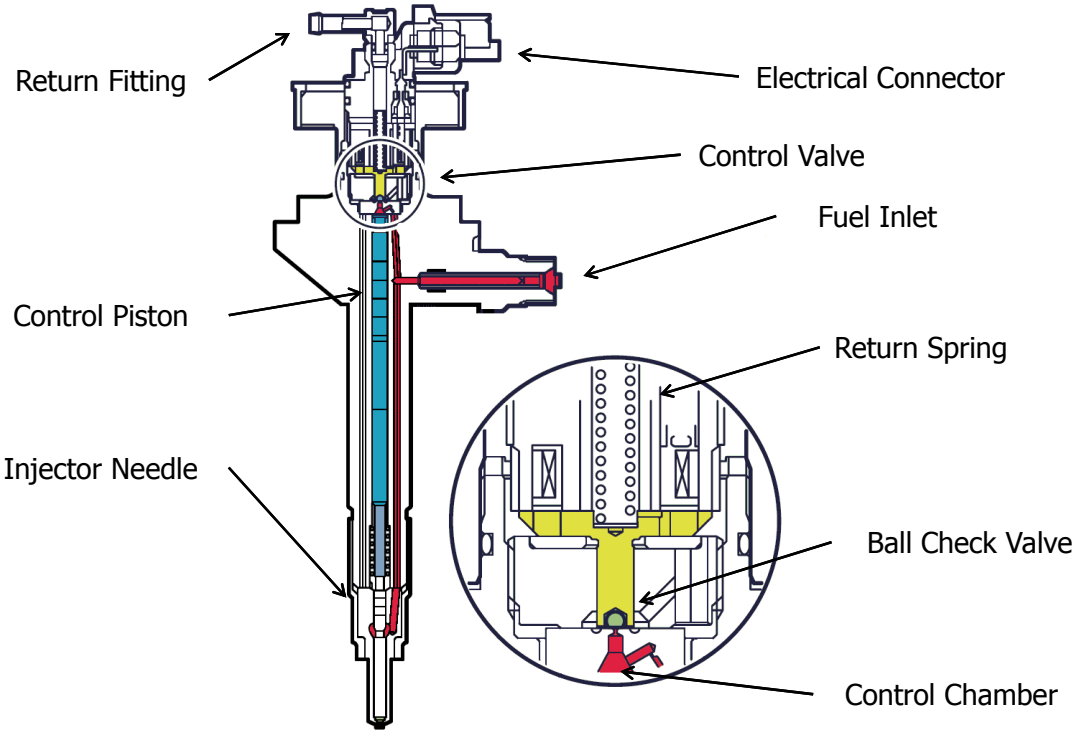


The injectors, fuel rail, fuel lines into and out of the rail are sometimes referred to as the 'high pressure' fuel system

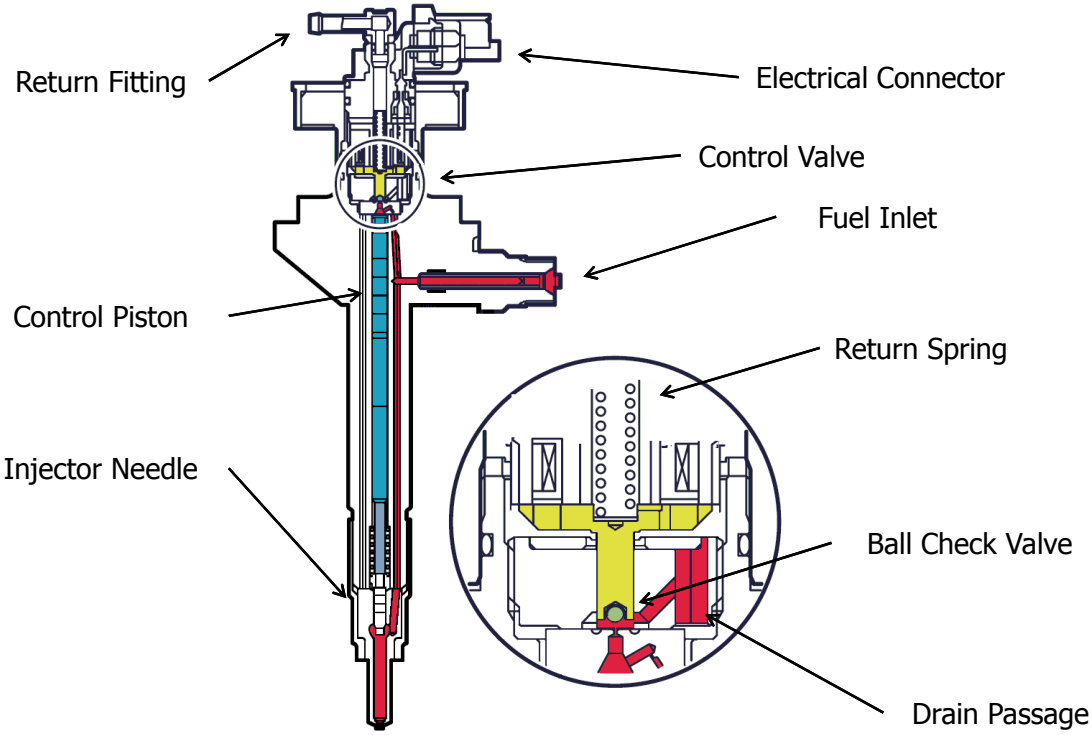
Possible to inject fuel more than one time in the injection event. Bosch uses one injection event (Main) during normal operation and two events (Main and Post) during cold engine situations to reduce smoke and emissions.

Trim data recorded at time of manufacture – Must be up dated if injector is replaced

Injectors

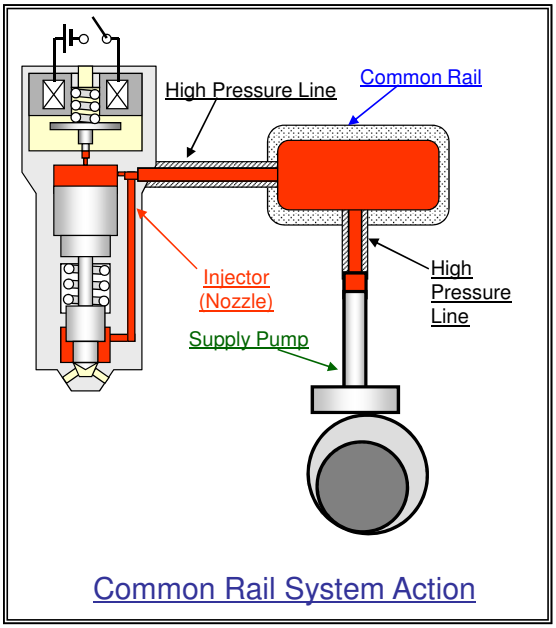


Injectors



Injectors

Common Rail Injection System



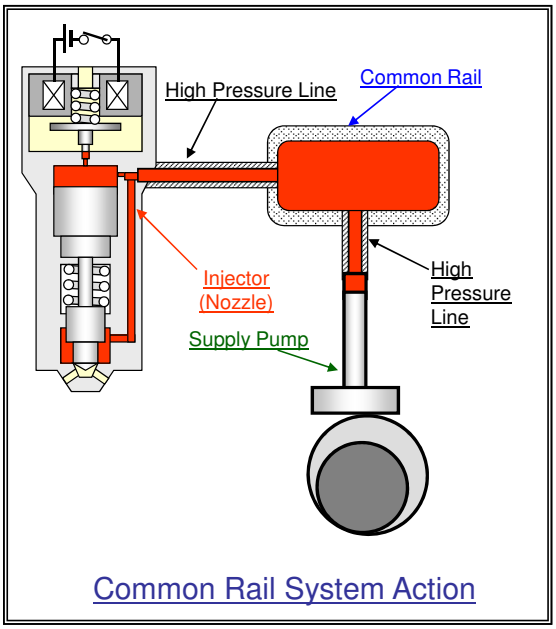
Common Rail System Action

On common rail injection system...

- Pressurized fuel is stored in common rail.
- Solenoid not activated

Injectors

Common Rail Injection System



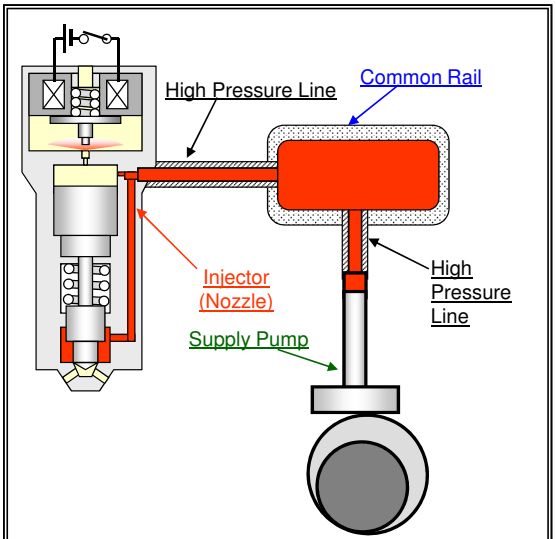
Common Rail System Action

On common rail injection system...

- Solenoid activated

Injectors

Common Rail Injection System



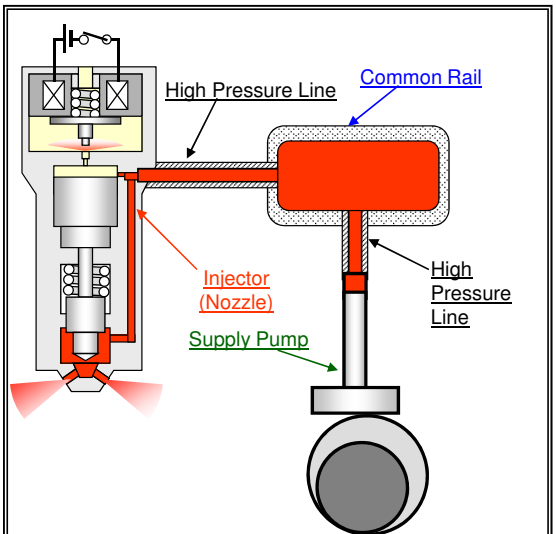
Common Rail System Action

On common rail injection system...

- Solenoid activated allows nozzle needle to lift.

Injectors

Common Rail Injection System



Common Rail System Action

On common rail injection system...

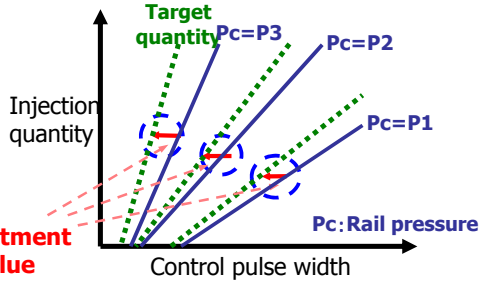
- Pressurized fuel is stored in common rail.
- Fuel injection is controlled by electronic solenoid valve.

- Amount, timing and pressure can be controlled independently.
  ⇒ flexible control
- Multiple injection available by activating solenoid valve several time.

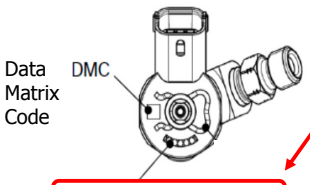
Injector Trim Data

The trim data for guaranteeing predetermined injection quantity for every individual injector is indicated. And these data are registered in the ECU

Injector characteristics



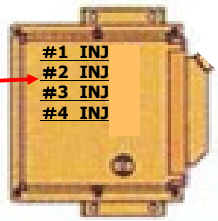
Top of injector（Bosch）



Adjustment Value

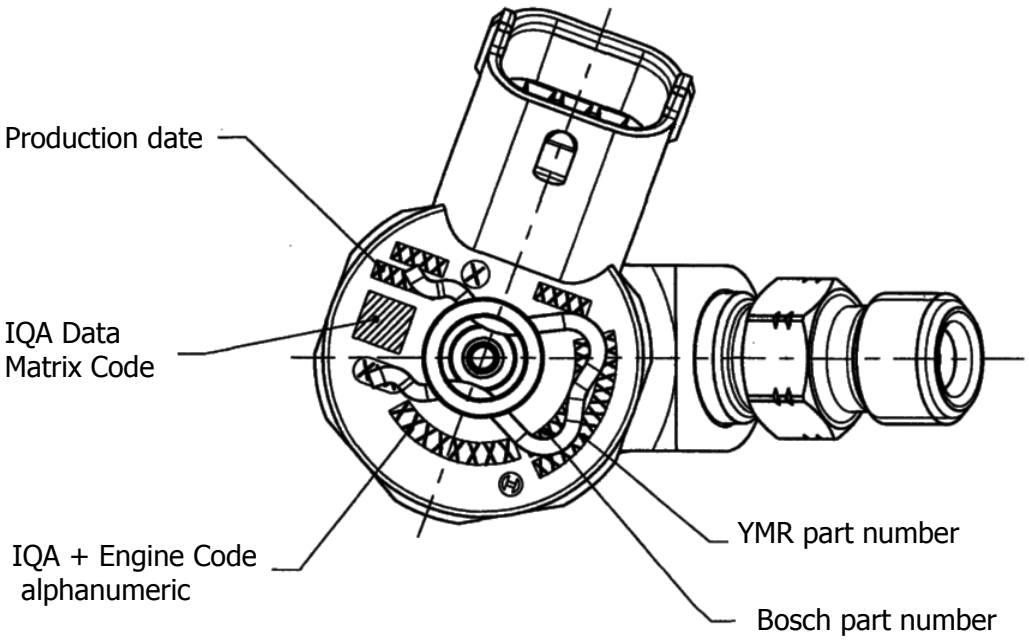
Alpha-num-code

ECU

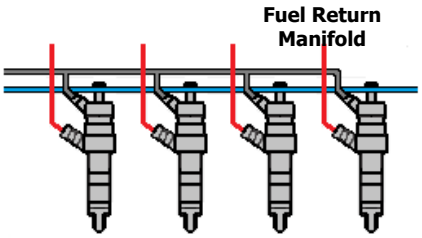


ECU has an injector Trim data for each cylinder.
At the time of injector exchange, the trim data in ECU needs to be rewritten using the Yanmar SmartAssist-Direct (SA-D).

Injector Trim Data



Fuel Return Manifold



10. Fuel Return Manifold

Located at the top of the injectors

Injectors are connected to both the high pressure system (Red) and the fuel return system (Blue)

Fuel return manifold carries away fuel that was not injected for combustion

Injector fuel return manifold connects to a filter and pump bypass system which carries fuel back to the pump inlet or back to the tank for cooling

Engine Sensors

11. Engine Sensors

Engine Speed
- Crankshaft and Camshaft Sensors

Operator Demand
- Accelerator (Throttle) Position Sensor

Intake Air
- Intake Manifold Pressure and Temperature Sensors

Engine Coolant
- Engine Coolant Temperature Sensor

DPF

DPF overview

Diesel Particulate Filter (DPF)

DOC
(Diesel Oxidize Catalyst)

- Oxidize HC, CO
- Generate NO->NO_2

SF
(Soot Filter)

- Trap PM

<Mission>

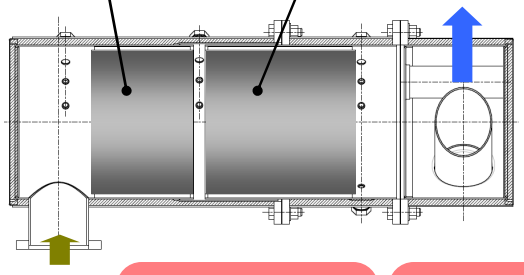
- Comply to PM Regulation
- Guarantee 3,000hrs Maintenance Interval

+

<Value>

- Higher Reliability for Industrial Use
- Lower Fuel Consumption
- Easier Installation

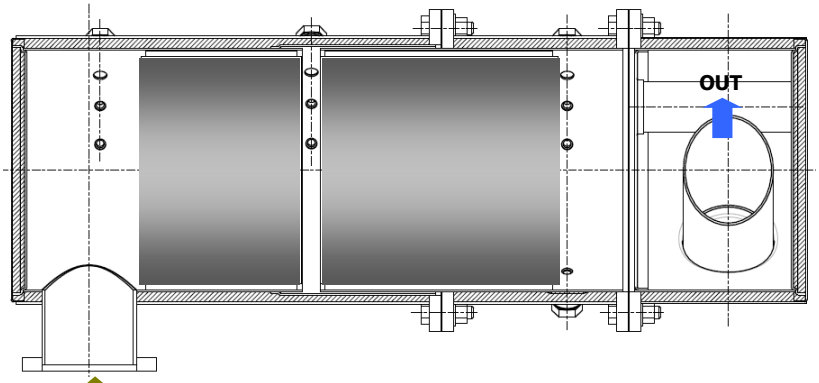
<Structure>



Optimized Structure | Original Regeneration Control | Optimized Layout

DPF overview

Optimized Structure



<Emission Related Component>

<Application Part>

Prepare Option

- Outlet Orientation
- Silencer Capacity Change

DPF overview

Original Regeneration Control

YANMAR Regeneration System

Regeneration by Assist Device

- Intake Throttle

  Intake Air Control

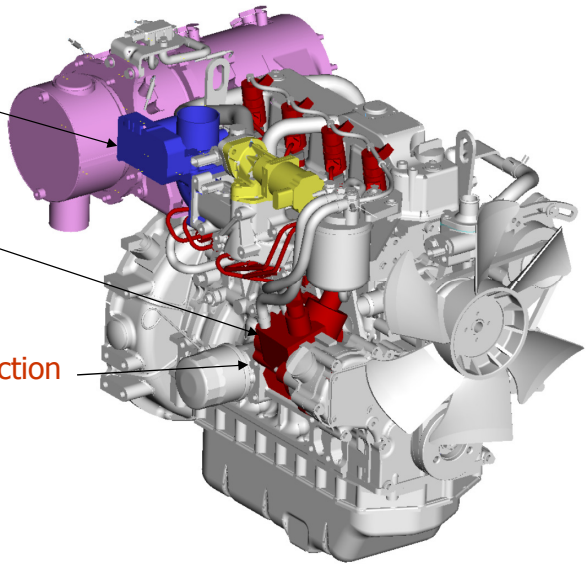
- Common Rail

  Injection Timing

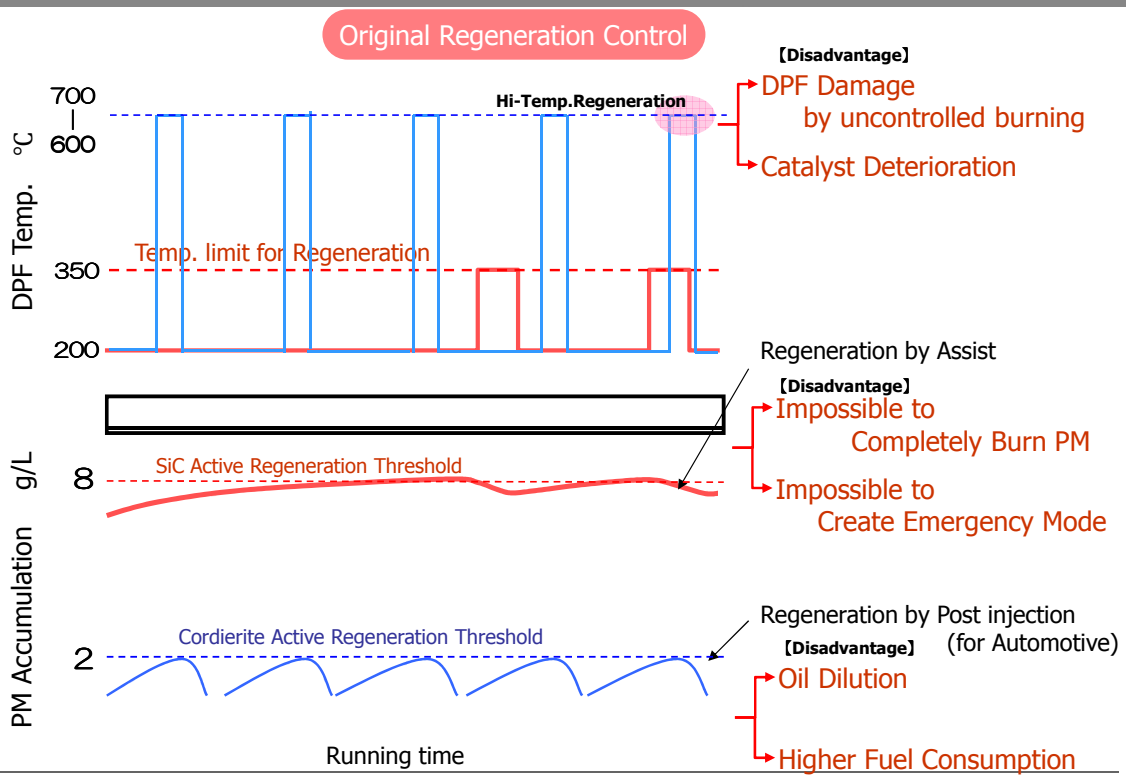
Regeneration by Common Rail Injection

- Common Rail

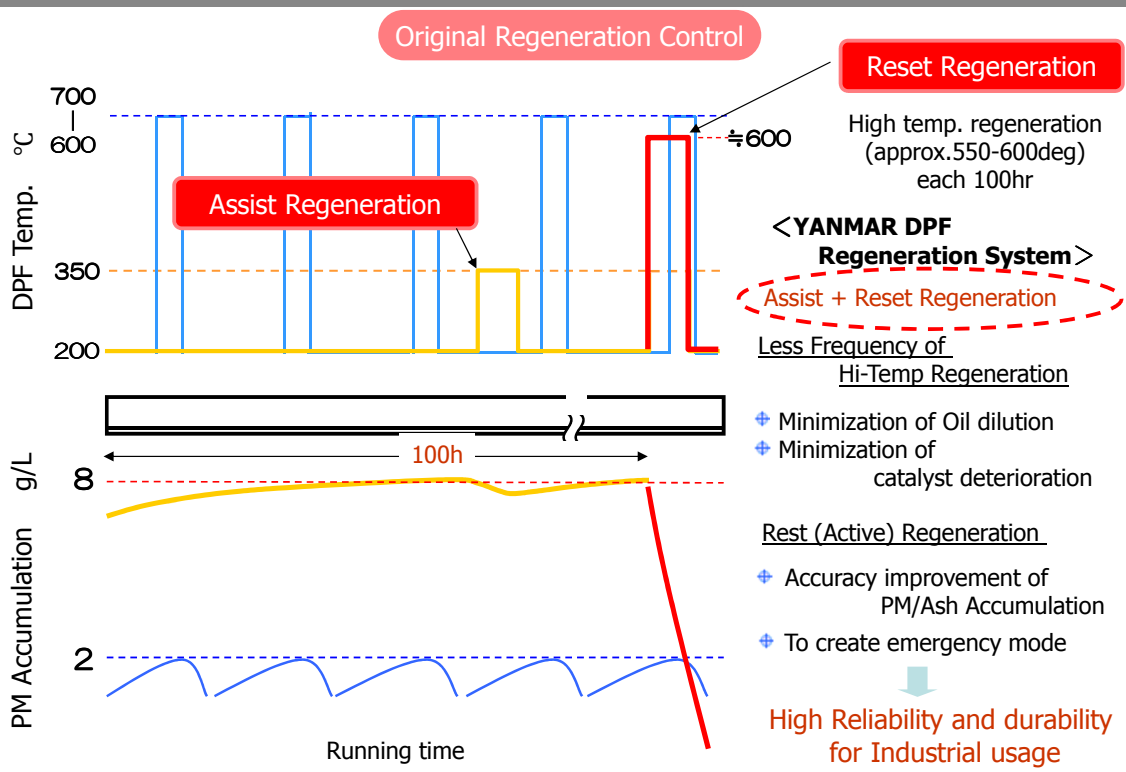
  Post Injection



DPF overview



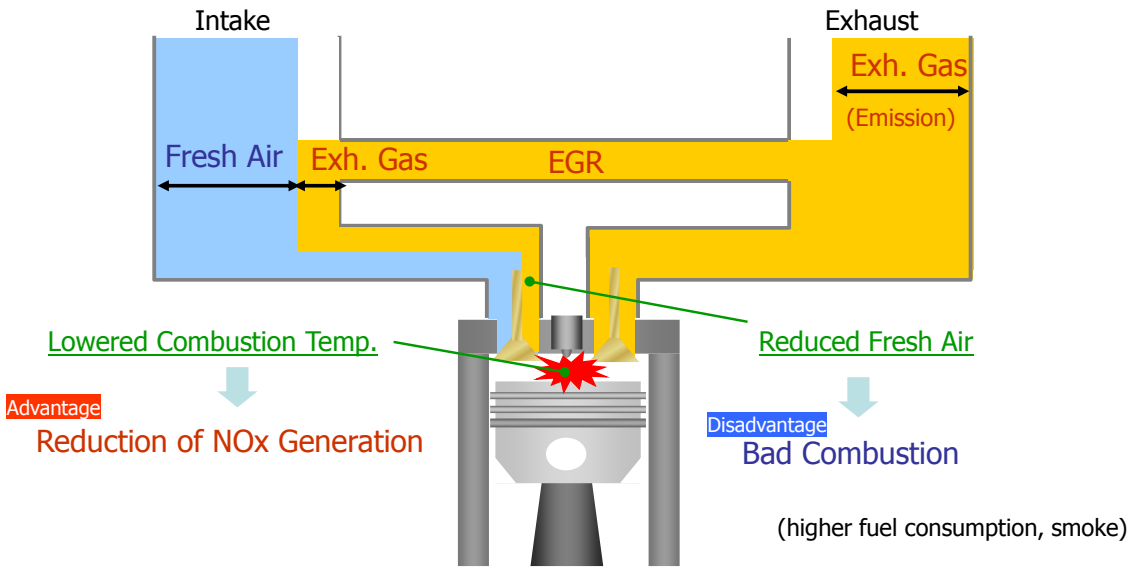
DPF overview



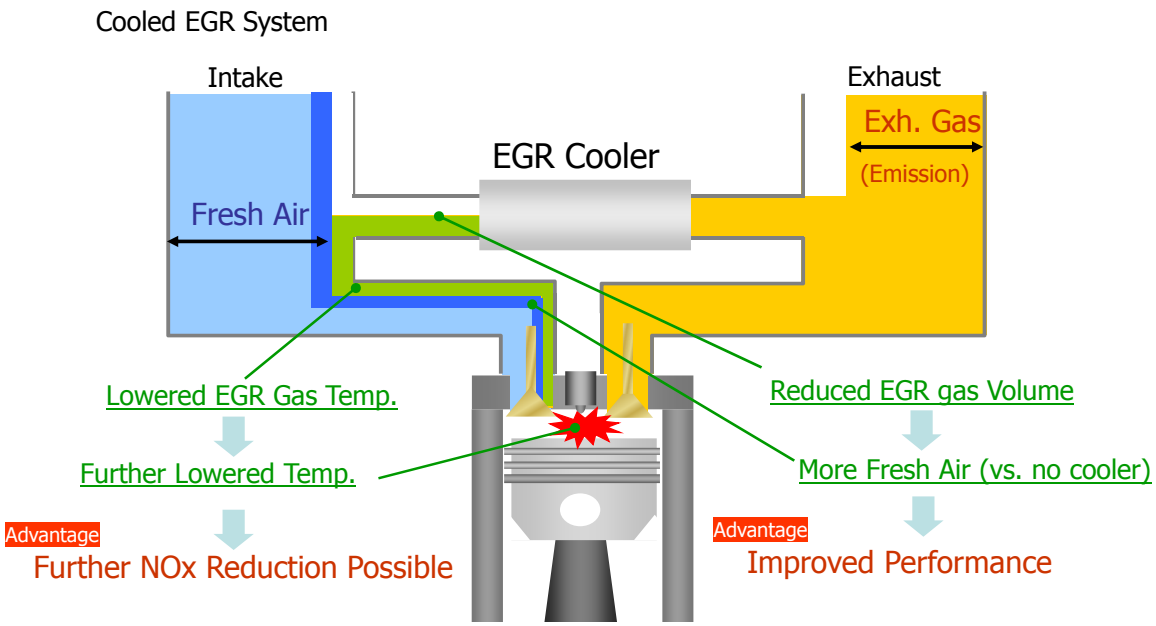
EGR

EGR overview

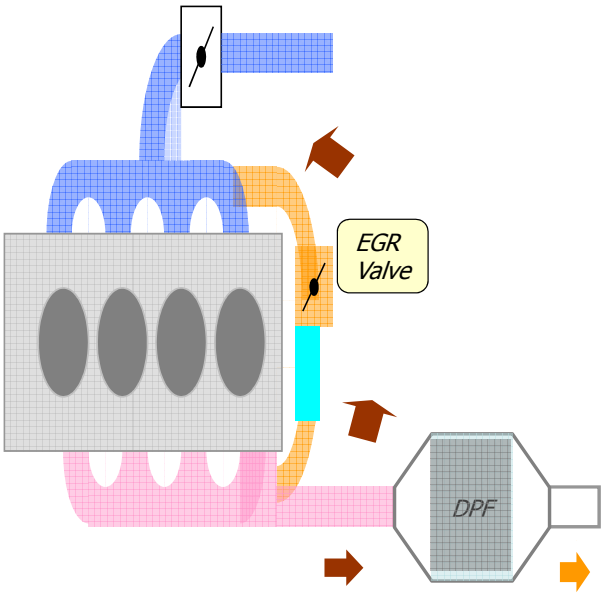
Exhaust Gas Re-circulation



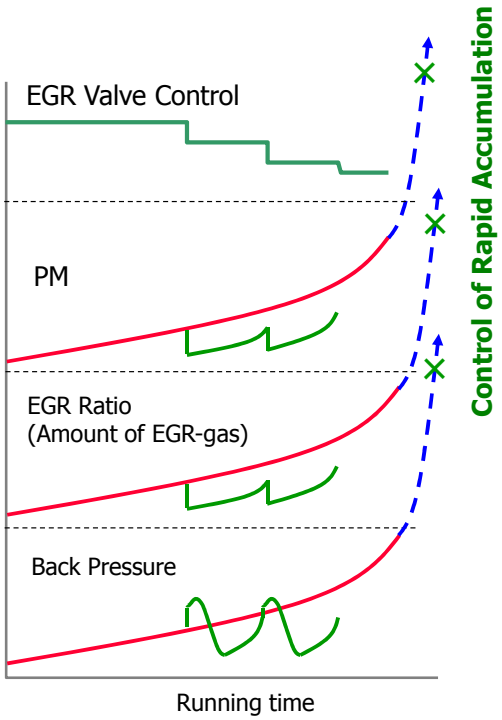
EGR overview



EGR overview

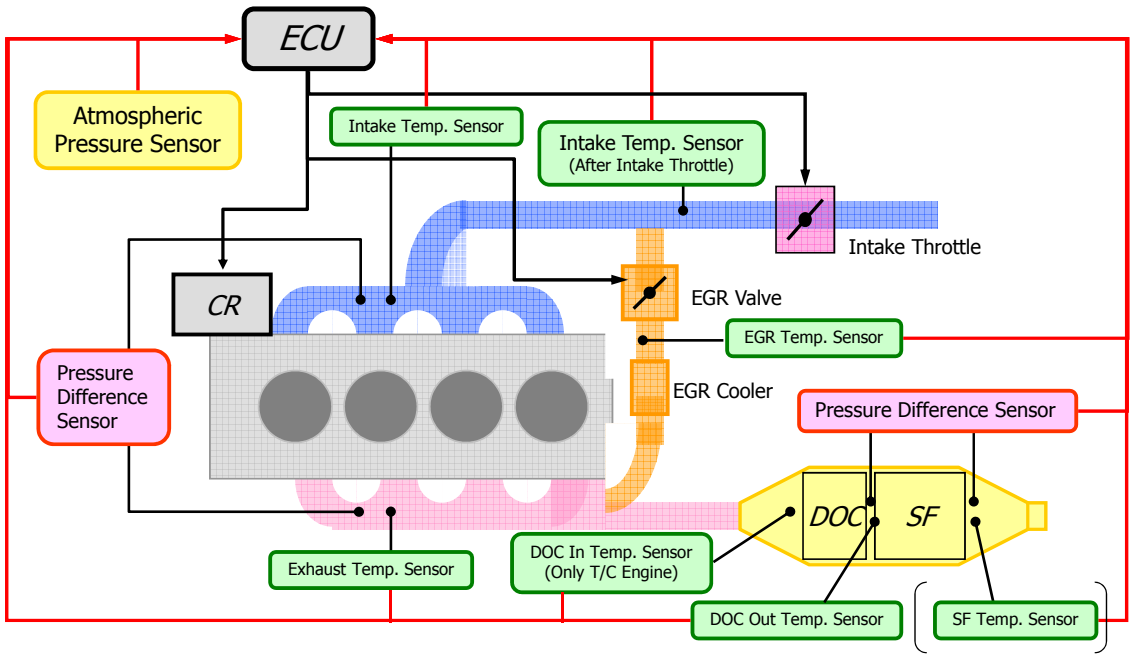


Minimization of Frequent Regeneration
➡ Low fuel consumption and High reliability
Downsizing of DPF size



Total engine management

Total engine management



THANK YOU FOR YOUR ATTENTION.

YANMAR