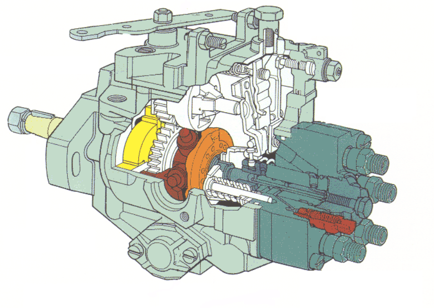
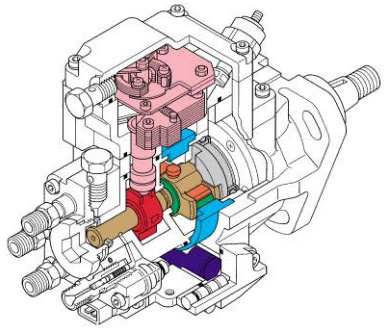
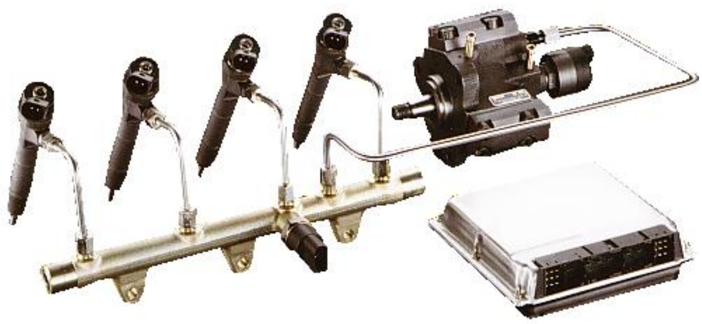
Engine Management Diesel 1







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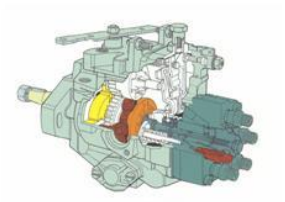
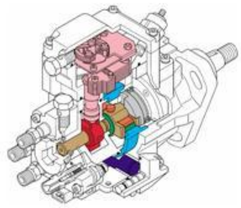
Differences between diesel and gasoline engines

Item	Diesel Engine	Gasoline Engine
Thermodynamic efficiency	~35-40%	~22-25%
Ignition	Compression heat (Internal)	Ignition System (External)
max. revolutions per minute (rpm)	~4500	~5500
Compression ratio	~22:1	~10:1
Emission		
HC+NOx	~1,10g/km	~1,4g/km
SO_2 + Particle	~0,22g/km	-
CO	~1,00g/km	~2,7g/km

Development steps of diesel engine control systems



Distributor Pump (Conventional)



Distributor Pump (Electronic Controlled)

Common Rail Direct Injection (CRDI)

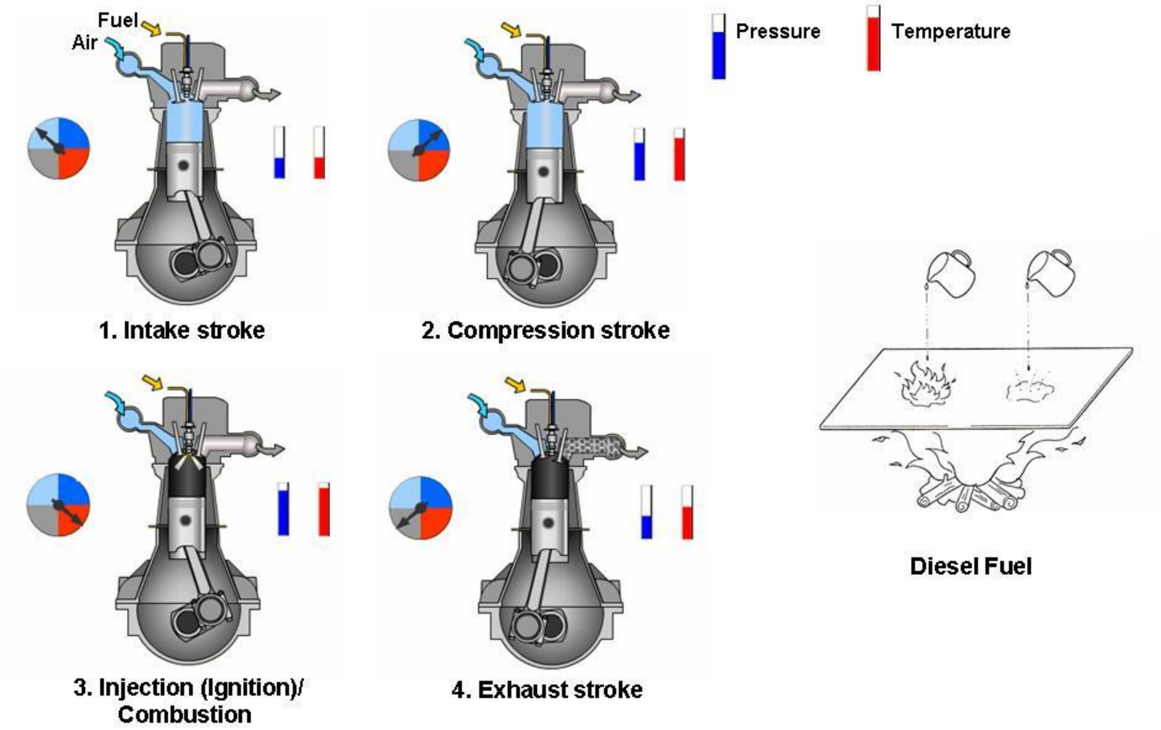
Major Differences between Diesel and Gasoline Engines

Being as Compression Ignition (CI) engines only draw in air, they are able to compress this to a level which is considerably higher than that in the spark ignition engine (SI) using an air fuel mixture. With its overall efficiency figure, the diesel engine rates as the most efficient combustion engine. The resulting low fuel consumption, coupled with the low level of pollutants in the exhaust gas and the considerably reduced level of noise, all serve to underline the diesel engine's significance.

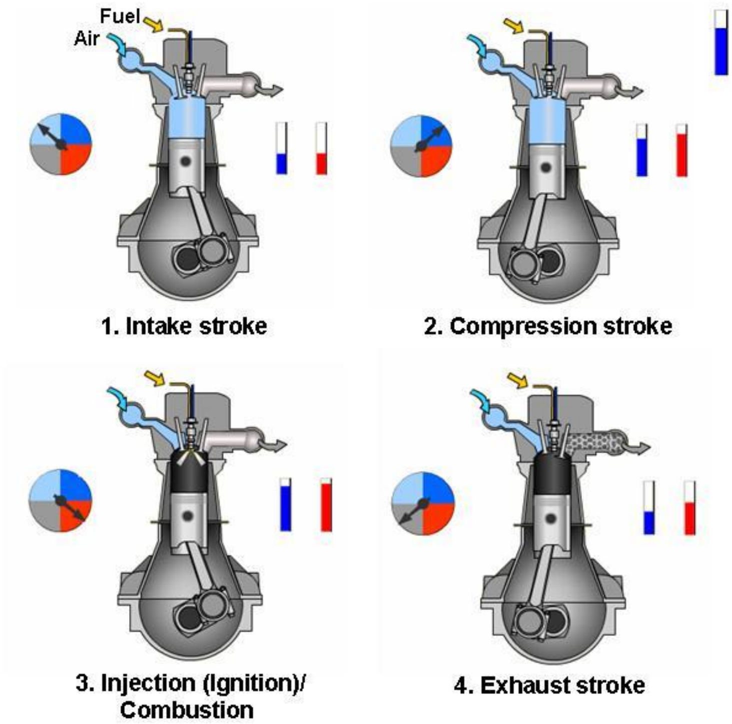
Development Steps of Diesel Engine Control Systems

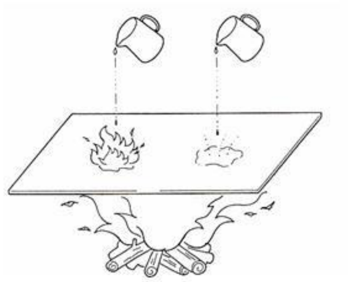
Higher and higher demands are being made on the diesel engine's injection system as a result of the increasingly severe regulations governing exhaust and noise emissions and the need for lower fuel consumption. Looking at the engine control system in the beginning, the control was made by mechanical means, such as the distributor pump. With this systems it was very difficult to acquire optimal engine efficiency with simultaneously satisfying emission control regulations. The next development stage was the Electronically Controlled Distributor Pump (COVEC-F) from Zexel. The latest generation of diesel injection system is the Common Rail Direct Injection (CRDI) which nowadays consist of various sensors detecting the operating conditions of the engine. Actuators are used to influence the operating conditions accordingly, both processed by an electronic device, the control unit. The control unit is processing the data acquired by the sensors in order to determine the best operating conditions and then drives the actuators accordingly. Lets start with the basic engine operation to understand the control requirements precisely.

Basics about combustion



As mentioned before, the Diesel Engine is a Compression Ignition (CI) engine. The mixture is usually formed inside the combustion chamber. The injectors are installed inside the cylinder head and inject the fuel directly into the combustion chamber, in which it mixes with air. During the first stroke, the downward movement of the piston draws in un-throttled air through the open intake valve. During the second stroke, the so called compression stroke, the air trapped in the cylinder is compressed by the piston (32-55bar) which now is moving upwards. The compression ratio is around 25:1. In this process, the air heats up to temperatures around 800C°. At the end of the compression stroke the nozzle injects fuel into the heated air. The injection pressure varies between 250 – 1600 bar, depending on engine load condition and injection system used. Following the ignition delay, at the beginning of the third stroke the finally atomized fuel ignites as a result of auto ignition and burns almost completely. The cylinder charge heats up even further and the cylinder pressure increases again. The energy released by the combustion is applied to the piston. The piston is forced downwards and the combustion energy is transformed into mechanical energy. In the fourth stroke, the piston moves up again and drives out the burnt gases through the open exhaust valve. A fresh charge of air is drawn in again and the working cycle is repeated.




Diesel Fuel

Diesel Fuel

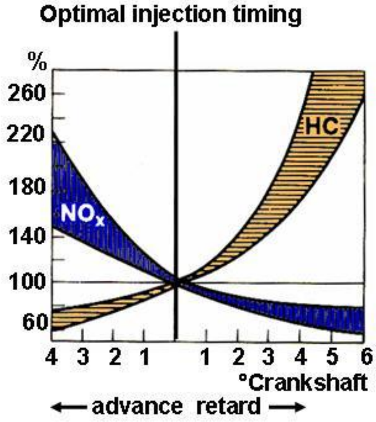
Diesel or Diesel fuel is a specific fractional distillate of fuel oil (mostly petroleum) that is used as fuel in a diesel engine. As a hydrocarbon mixture, it is obtained in the fractional distillation of crude oil between 250 °C and 350 °C at atmospheric pressure. Diesel fuel is considered to be a fuel oil and is about 18% denser than gasoline. Diesel fuel, however, often contains higher quantities of sulfur. In Europe, emission standards have forced oil refineries to reduce the level of sulfur in diesel fuels since they are harmful for the environment. Sulfur prevents the use of catalytic diesel particulate filters to control diesel particulate emissions. However, lowering sulfur also reduces the lubricity of the fuel, meaning that additives must be put into the fuel to help lubricate injection system components. Diesel contains approximately 18% more energy per unit of volume than gasoline, which, along with the greater efficiency of diesel engines, contributes to fuel economy.

Bio-Diesel

Bio-Diesel can be obtained from vegetable oil and animal fats. Bio-Diesel is a non-fossil fuel and consists of alkyl (usually methyl) esters instead of the alkane and aromatic hydrocarbons of petroleum derived diesel. However, KIA Motors does not recommend the usage of Bio-Diesel in any diesel engine.

Influence of mixture composition

Exhaust gas constituents		at idle	at maximum power
Oxides of nitrogen (NOx)	vol.%	0.005.....0.025	0.06.....0.15
Hydrocarbons (HC)	vol.%	0.05.....0.06	0.02.....0.06
Carbon monoxide (CO)	vol.%	0.01.....0.045	0.035....0.2
Carbon dioxide (CO_2)	vol.%	.....3.5	.....12.0
Steam	vol.%	....3.0	......11.0
Oxygen (O_2)	vol.%	....16.0	...10.0
Nitrogen (N)	vol.%	remainder	remainder
Soot	mg/m³	~20	~200
Exhaust temperature	°c	100....200	550....750




Turbocharger


Intercooler

A variety of different combustion deposits are formed when diesel fuel is burnt. These reaction products are dependent upon engine design, injection system design, engine power output and working load. In the first place water (H_2O) and harmless carbon dioxide (CO_2) are generated. In relatively low concentrations, the following substances are also produced:

- Carbon monoxide (CO)
- Unburned hydrocarbons (HC)
- Nitrogen oxides (NOx)
- Sulfur dioxide (SO_2) and sulfuric acid (H_2SO_4)
- Soot particles

When the engine is cold, the exhaust gas constituents which are immediately noticeable are the non oxidized or only partly oxidized hydrocarbons which are visible in the form of white or blue smoke, and the strongly smelling aldehydes.

Exhaust gas constituents		at idle	at maximum power
Oxides of nitrogen (NOx)	vol.%	0.005.....0.025	0.06.....0.15
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Carbon monoxide (CO)	vol.%	0.01.....0.045	0.035....0.2
Carbon dioxide (CO_2)	vol.%	.....3.5	.....12.0
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Nitrogen (N)	vol.%	remainder	remainder
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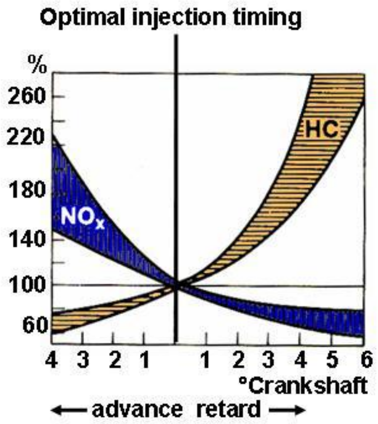



Turbocharger


Intercooler

Influence of mixture composition

The following contribute to the reduction of fuel consumption and exhaust gas emissions:

- Fuel atomization (high injection pressures)
- Injection sequence characteristics
- Precision manufactured injection nozzles
- Fuel injection pumps with precise fuel metering
- Modified combustion chambers
- Precisely defined fuel spray geometry

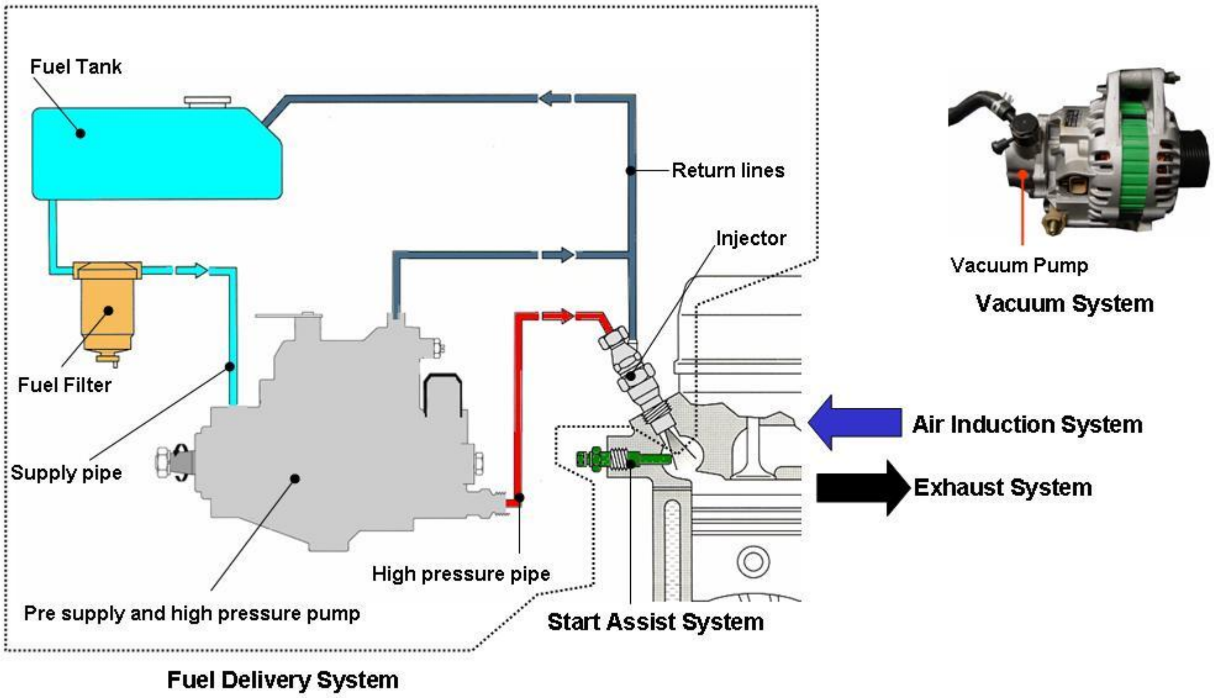
Apart from the above mentioned points, optimal injection timing is decisive for reducing exhaust emissions in a diesel engine. The start of combustion is primarily determined by the start of injection. Retarded injections reduces emissions of oxygen and nitrogen. Over retarded injections increases the emission of hydrocarbons. Deviations of the start of injection from the nominal value by 1° of crankshaft angle can increase the emission of NOx or HC by approximately 15%.

This high sensitivity requires that the start of injection is precisely set. The most favorable setting for the start of injection can be precisely maintained by an electronic controlled system.

Turbocharger/Intercooler

As the temperature of the intake air increases on engines with turbochargers, there is a rise in the combustion temperature and thus in the emission of oxides of nitrogen. In engines fitted with turbochargers, the cooling of the compressed air is an effective way of reducing the formation of oxides of nitrogen. Another way for reducing NOx is to use Exhaust Gas Recirculation (EGR).

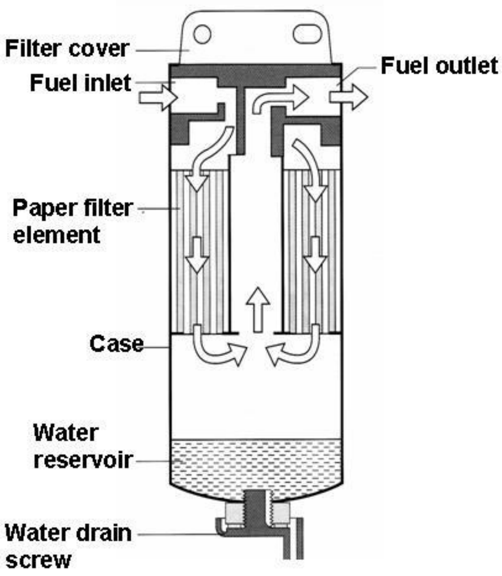
Subsections of the diesel injection system



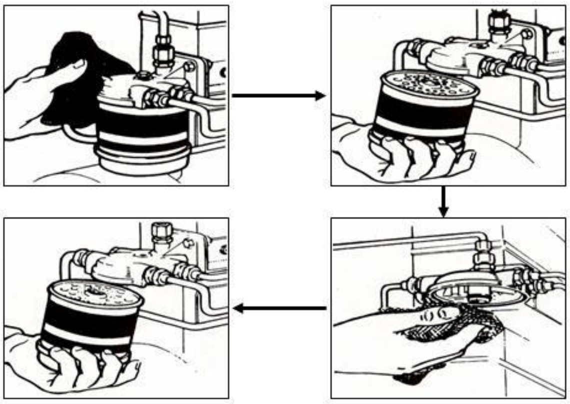
On a diesel fuel injection system fuel supply and delivery is divided into low pressure and high pressure delivery. The Diesel Injection system in general consists of the following main sections:

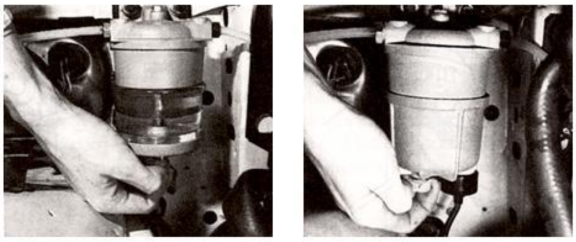
- Fuel Delivery System, including fuel tank, supply lines, fuel filter, pre-supply pump (either electrical type or mechanical type), high pressure pump and high pressure pipe.
- Start Assist System, including glow plugs and glow plug control unit (either separate or located inside the Engine Control Module)
- Air Induction System, including Air Filter and Exhaust Gas Recirculation
- Exhaust System, including Oxidation Catalyst and Particulate Filter (only CRDI)
- Electronic Control System, including Sensors and Actuators (only Electronically Controlled Distributor pump and CRDI)
- Vacuum System

Fuel filter and water separator




Water Separator Warning Lamp


Fuel Filter replacement


Water drain procedure

Contaminants in the fuel can lead to damage at the injection system. This, therefore, necessitates the use of a fuel filter which is specifically aligned to the requirements of the particular injection system, otherwise faultless operation and long service life cannot be guaranteed. Diesel fuel can contain water either in bound form (emulsion) or in free form (for example condensation of water due to temperature changes). If this water enters the injection system, it can lead to damage as a result of corrosion.

Water Separator Warning Lamp
The increasing number of diesel engines used in passenger cars has led to the demand for an automatic warning device which indicates to the driver when water must be drained out of the fuel filter.

Water Drain Procedure
The Diesel Injection System needs a fuel filter with water reservoir, from which water must be drained at regular intervals or when the water separator warning lamp is illuminated. Open the drain plug to drain the water from the water reservoir. If no water comes out, open the air bleeding plug on top of the filter element. Please refer to the Shop Manual for more detailed information.