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Common Rail Direct Injection

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ABSTRACT: *Usually the diesel engines are available in two different variants. These two variants are commonly known as TDI and CRDI. TDI is an acronym for turbo diesel engine while CRDI is an acronym for common rail diesel engine. Earlier designed engines used the TDI diesel engine. The CRDI engine makes use of the solenoid or piezoelectric valves. These valves allow a fine electronic command over the fuel injection system of the vehicle. The system actually gets the complete control over the fuel injection quantity and also for the amount of time it is supposed to be injected. The CRDI engines also produce a lesser noise compared to the normal TDI engines*

The CRDI engines supply higher levels of fuel atomization. The engine reduces the noise by controlling the control unit of the pilot injection system. The control unit injects a small amount of diesel before the final pilot injection. This methodology ultimately reduces the vibration and explosiveness. The CRDI engines are specifically designed for correct injection timing and quantity of variations in the fuel. The modern CRDI engines utilize as most as five injections every stroke. The modern CRDI engines are less polluting too. The emissions are very less in CRDI engines compared to TDI engines.

Keywords: *CRDI, MPFI, Injection system*

I. INTRODUCTION

CRDI stands for Common Rail Direct Injection meaning, direct injection of the fuel into the cylinders of a diesel engine via a single, common line, called the common rail which is connected to all the fuel injectors .ordinary diesel direct fuel-injection systems have to build up pressure anew for each and every injection cycle, the new common rail (line) engines maintain constant pressure regardless of the injection sequence. This pressure then remains permanently available throughout the fuel line. The engine's electronic timing regulates injection pressure according to engine speed and load. The electronic control unit (ECU) modifies injection pressure precisely and as needed, based on data obtained from sensors on the cam and crankshafts. In other words, compression and injection occur independently of each other. This technique allows fuel to be injected as needed, saving fuel and lowering emissions.

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More accurately measured and timed mixture spray in the combustion chamber significantly reducing unburned fuel gives CRDi the potential to meet future emission guidelines such as Euro V. CRDi engines (Fig 1) are now being used in almost all Mercedes-Benz, Toyota, Hyundai, Ford and many other diesel automobiles.

The start of combustion (SOC) in the combustion chamber has a considerable influence upon all performances of the engine. In this paper, cylinder pressure was investigated as a means for the closed-loop SOC control of a common-rail direct injection (CRDI) diesel engine.

In order to detect the SOC, the crank angle position where the difference pressure became 10 bar was selected as the pressure variable. Using this pressure variable as a feedback variable, an adaptive feed forward control was proposed. The feed forward controller consisted of the radial basis function network (RBFN) and the feedback error learning method, which was used for the training of the network. The proposed SOC control strategy showed a far better regulation performance than that of the linear feedback controller. A further extension of the strategy based on the individual cylinder pressure feedback, the individual cylinder SOC control strategy, effectively reduced cylinder-by-cylinder SOC variation in steady and transient engine operations.

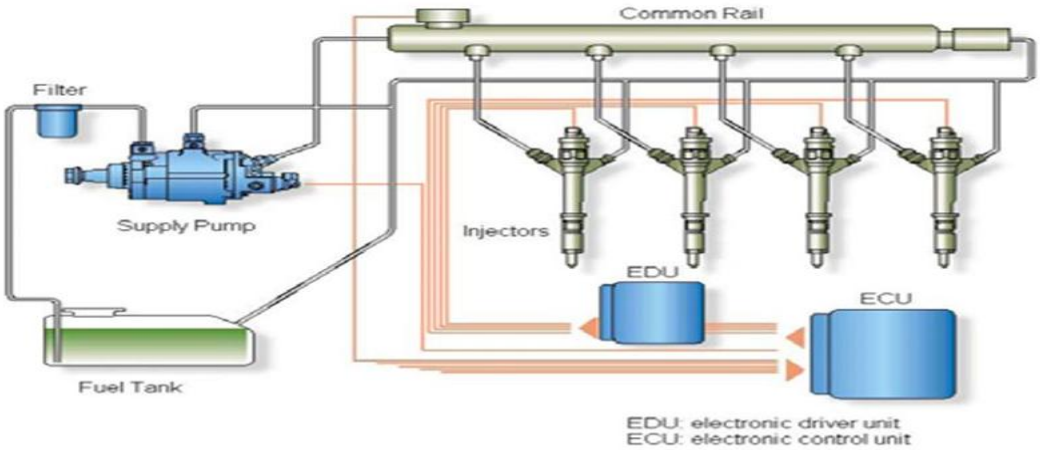

Fig 1. CRDI engines

Older engines make use of a mechanical fuel pump and valve assembly which is driven by the engine crankshaft, usually via the timing belt or chain. These engines use simple injectors which are basically very precise spring-loaded valves which will open and close at a specific fuel pressure. The pump assembly consists of a pump which pressurizes the fuel, and a disc-shaped valve which rotates at half crankshaft speed. The valve has a single aperture to the pressurized fuel on one side, and one aperture for each injector on the other. As the engine turns the valve discs will line up and deliver a burst of pressurized fuel to the injector at the cylinder about to enter its power stroke. The injector valve is forced open by the fuel pressure and the diesel is injected until the valve rotates out of alignment and the fuel pressure to that injector is cut off. Engine speed is controlled by a third disc, which rotates only a few degrees and is controlled by the throttle lever. This disc alters the width of the aperture through which the fuel passes, and therefore how long the injectors are held open before the fuel supply is cut, controlling the amount of fuel injected.

This contrasts with the more modern method of having a separate fuel pump (or set of pumps) which supplies fuel constantly at high pressure to each injector. Each injector then has a solenoid which is operated by an electronic control unit, which enables more accurate control of injector opening times depending on other control conditions such as engine speed and loading, resulting in better engine performance and fuel economy. This design is also mechanically simpler than the combined pump and valve design, making it generally more reliable, and less noisy, than its mechanical counterpart.

Both mechanical and electronic injection systems can be used in either direct or indirect injection configurations

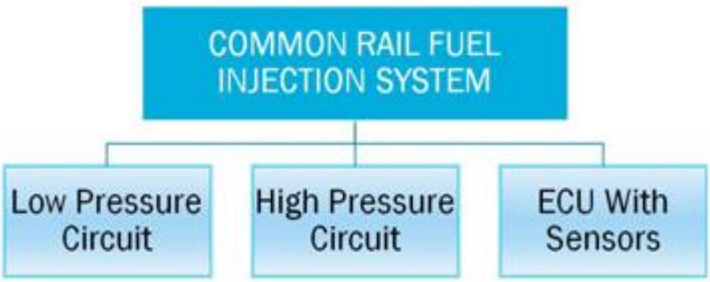

Fig 2. Common Rail Fuel injection system

II. COMMON RAIL DIRECT INJECTION FEATURES

Common rail refers to the single fuel injection line on the CRDI engines (Fig 2). Whereas conventional direct injection diesel engines must repeatedly generate fuel pressure for each injection, in CRDI engines the pressure is built up independently of the injection sequence and remains permanently available in the fuel line. In the CRDI system developed jointly by Mercedes-Benz and Bosch, the electronic engine management system continually adjusts the peak fuel pressure according to engine speed and throttle position. Sensor data from the camshaft and crankshaft provide the foundation for the electronic control unit to adapt the injection pressure precisely to demand.

Common Rail Direct Injection is different from the conventional Diesel engines. Without being introduced to an antechamber the fuel is supplied directly to a common rail from where it is injected directly onto the pistons which ensures the onset of the combustion in the whole fuel mixture at the same time. There is no glow plug since the injection pressure is high. The fact that there is no glow plug lowers the maintenance costs and the fuel consumption. Compared with petrol, diesel is the lower quality fuel from petroleum family. Diesel particles are larger and heavier than petrol, thus more difficult to pulverize. Imperfect pulverization leads to more unburned particles, hence more pollutant, lower fuel efficiency and less power. Common-rail technology is intended to improve the pulverization process. To improve pulverization, the fuel must be injected at a very high pressure, so high that normal fuel injectors cannot achieve it. In common-rail system; the fuel pressure is implemented by a very strong pump instead of fuel injectors. The high-pressure fuel is fed to individual fuel injectors via a common rigid pipe (hence the name of "common-rail")

In the current first generation design, the pipe withstands pressures as high as 1,600 bar or 20,000 psi. Fuel always remains under such pressure even in stand-by state. Therefore whenever the injector (which acts as a valve rather than a pressure generator) opens, the high-pressure fuel can be injected into combustion chamber quickly. As a result, not only pulverization is improved by the higher fuel pressure, but the duration of fuel injection can be shortened and the timing can be more precisely controlled. Precise timing reduces the characteristic “Diesel Knock” common to all diesel engines, direct injection or not. Benefited by the precise timing, common-rail injection system can introduce a "post-combustion", which injects small amount of fuel during the expansion phase thus creating small scale combustion after the normal combustion takes place.

This further eliminates the unburned particles and also increases the exhaust flow temperature thus reducing the pre-heat time of the catalytic converter. In short, "post-combustion" cuts pollutants. The drive torque and pulsation inside the high-pressure lines are minimal, since the pump supplies only as much fuel as the engine actually requires. The high-pressure injectors are available with different nozzles for different spray configurations. Swirler nozzle to produce a cone-shaped spray and a slit nozzle for a fan-shaped spray. The new common-rail engine (in addition to other improvements) cuts fuel consumption by 20%, doubles torque at low engine speeds and increases power by 25%. It also brings a significant reduction in the noise and vibrations of conventional diesel engines. In emission, greenhouse gases (CO2) is reduced by 20%. At a constant level of NOx, carbon monoxide (CO) emissions are reduced by 40%, unburnt hydrocarbons (HC) by 50%, and particle emissions by 60%.CRDI principle not only lowers fuel consumption and emissions possible; it also offers improved comfort and is quieter than modern precombustion engines. Common-rail engines are thus clearly superior to ordinary motors using either direct or indirect fuel-injection systems. This division of labor necessitates a special chamber to maintain the high injection pressure of up to 1,600 bar. That is where the common fuel line (rail) comes in. It is connected to the injection nozzles (injectors) at the end of which are rapid solenoid valves to take care of the timing and amount of the injection. The microcomputer regulates the amount of time the valves stay open and thus the amount of fuel injected, depending on operating conditions and how much output is needed. When the timing shuts the solenoid valves, fuel injection ends immediately. With the state-of-the-art common-rail direct fuel injection used an ideal compromise can be attained between economy, torque, ride comfort and long life.

III. CRDI – FUTURE TRENDS

3.1 Ulra-High Pressure Common –Rail Injections:

Newer CRDI engines feature maximum pressures of 1800 bar. This pressure is up to 33% higher than that of first-generation systems, many of which are in the 1600-bar range. This technology generates an ideal swirl in the combustion chamber which, coupled with the common-rail injectors’ superior fuel-spray pattern and optimized piston head design, allows the air/fuel mixture to form a perfect vertical vortex resulting in uniform combustion and greatly reduced NOx (nitrogen oxide) emissions. The system realizes high output and torque, superb fueleconomy, emissions low enough to achieve Euro Stage IV designation and noise levels the same as a gasoline engines. In particular, exhaust emissions and Nox are reduced by some 50% over the current generation of diesel engines.

3.2 CRDI and Particle Filter:

Particle emission is always the biggest problem of diesel engines. While diesel engines emit considerably less pollutant CO and Nox as well as green house gas CO_2, the only shortcoming is excessive level of particles. These particles are mainly composed of carbon and hydrocarbons. They lead to dark smoke and smog which is very crucial to air quality of urban area, if not to the ecology system of our planet. Basically, particle filter is a porous silicon carbide unit; comprising passageways which has a property of easily trapping and retaining particles from the exhaust gas flow. Before the filter surface is fully occupied, these carbon / hydrocarbon particles should be burnt up, becoming CO_2 and water and leave the filter accompany with exhaust gas flow. The process is called regeneration. Normally regeneration takes place at 550° C. However, the main problem is: this temperature is not obtainable under normal conditions. Normally the temperature varies between 150° and 200°C when the driving in town, as the exhaust gas is not in full flow. The new common-rail injection technology helps solving this problem. By its high pressure, precise injection during a very short period, the common-rail system can introduce a "post combustion" by injecting small amount of fuel during expansion phase. This increases the exhaust flow temperature to around 350°C. Then, a specially designed oxidizing catalyst converter locating near the entrance of the particle filter unit will combust the remaining unburnt fuel come from the "post combustion". This raises the temperature further to 450° C. The last 100°C required is fulfilled by adding an additive called Eolys to the fuel. Eolys lowers the operating temperature of particle burning to 450° C, now regeneration occurs. The liquid-state additive is stored in a small tank and added to the fuel by pump. The PF unit needs to be cleaned up every 80,000 km by high-pressure water, to get rid of the deposits resulting from the additive .

IV. CONCLUSION

In this system it is seen that the CRDI engine developed more power and also increased the fuel efficiency. By using this system there is reduction of noise and Pollutants. Particulates of exhaust are reduced. Exhaust gas recirculation is enhanced and precise injection timing is obtained. More pulverization of fuel is obtained in this system. The powerful microcomputer makes the whole system more perfect and doubles the torque at lower engine speeds.

REFERENCES

[1]. M.L.Mathur & Sharma, 2005 I C Engines. Dhanpat Rai Publication.
[2]. S Srinivasan, 2003, Automotive Engines.
[3]. Robert Bosch 2009 “The common rail Diesel Engine Explained.
[4]. AutoSpeed - Common Rail Diesel Engine Management.