

TOKYO MOTOR SHOW 2002

1,800-bar Common Rail System

Diesel-powered vehicles involve excellent fuel economy and power, and the popularity is high especially in Europe – about 35 percent on European roads have diesel engines. The automotive industry is currently gearing up for strict emission regulations worldwide. The key issue with diesel engines is how to reduce concentrations of harmful substances in emission, such as nitrogen oxides (NOx) and particulate matter (PM). DENSO has been developing various diesel engine management systems and components to reduce the harmful substances.

In 2001, DENSO developed a 1,800-bar common rail system that realized a high injection pressure – 1,800 bar, the highest in the world –, and comfortably cleared EURO 4 emission regulation with the system. In Europe, this system was installed in the vehicle MPV manufactured by Mazda Motor Corporation in June 2002. Also, the Mazda's Atenza, launched in September 2002, is equipped with this system. DENSO will start full-scale production of this system in Hungary in 2003 and in Thailand in 2004.

DENSO's 1,800-bar common rail system is composed of: a supply pump, a common rail with a high pressure sensor, solenoid injectors, and a high-speed 32 bit engine electronic control unit (ECU) integrated with electronic injector driver unit (EDU).

In the common rail system, fuel is pressurized by a supply pump, transferred to a common rail through pipes, accumulated in the common rail, and then injected into combustion chambers by the solenoid injectors. Accumulating fuel at the common rail allows of not only pressurizing fuel at a higher pressure but also controlling fuel pressure and injection timing irrespective of engine speed. The fuel pressure in the common rail is detected by the high-pressure sensor, and controlled by adjusting an electromagnetic valve of the supply pump to match an optimum value preset in accordance with engine speed and load. This enables high-pressure injection even at a low engine speed and allows fuel to be atomized sufficiently at any engine speed range, thereby reducing the amount of PM in emission.

Main components of DENSO's new common rail system have the following features.

Supply Pump

DENSO's common rail system can inject fuel at up to 1,800 bar, significantly reducing the concentration of PM in emission. This high fuel injection pressure is generated by the supply pump that is the lightest supply pump in the world for common rail systems and smaller than a conventional one. Adopting an outer cam structure rather than an inner cam structure and DENSO's coating and ultra precise processing technologies allow the supply pump to generate such high pressure. Using aluminum for the pump housing realizes the world's lightest supply pump, and arranging cylinders in a line perpendicular to the cam shaft reduces the size.

Solenoid Injectors

DENSO developed solenoid injectors having improved response properties, thereby shortening the interval of injections and realizing multiple injections at one fuel combustion. DENSO's new injectors can inject fuel at an interval of 0.4 milliseconds with a required small quantity. The injectors allow the system to perform five injections during each combustion stroke. The five times multiple injections having predetermined fuel quantities reduce PM and NOx in emission, and realize quietness equivalent to gasoline powered engines.

The five times multiple injections are named pilot, pre, main, after, and post injections, respectively. The pilot injection, well before ignition, provides time for fuel and air to mix. The subsequent pre injection shortens ignition delay in the main injection and thereby reduces generation of NOx, noise and vibration. The after injection that happens a split-second after the main injection reburns any remaining PM. Then, the post injection helps manage the temperature of the exhaust gas, which makes the exhaust processing in the after-treatment system more effective.

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Engine ECU integrated with EDU

DENSO's engine ECU for the new common rail system monitors variations in injection quantity among the injectors and variation of each injector during its operation, and correct them. As a result, the system can keep performing injections with required small fuel quantities, at high accuracy during its operation.

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