



Spray, Metering and Calibration

The purpose of engine calibration is to ensure that the engine has the right combination of fuel, air and ignition timing to deliver the required vehicle operation. Optimal engine operation improves performance, fuel economy and emissions.

Fuel metering means the fuel is delivered and injected into the engine at the right time and in the correct quantity. The fuel is atomized as it is sprayed from the injector and forms the desired spray pattern within the cylinder for optimum combustion. Therefore, the injection pressure, nozzle design, and engine control system all impact the effectiveness of these functions.

Gasoline Direct Injection systems use two pumps. The first is a low-pressure pump to bring the fuel from the tank to the engine; the second pump compresses the fuel to the high pressure necessary for injection. GDI engines need high fuel injection pressure to ensure good atomization and mixing of fuel and air in the cylinder. We have seen an evolution in injector nozzle design from single hole to increasingly sophisticated multi-hole injectors. These use multiple smaller holes which in turn provide better atomization and mixing. In particular, smaller fuel droplets correlate to lower soot or particulate emissions as larger fuel droplets do not always burn completely. Therefore, the particulate mass and particle number is reduced, which is a key requirement in meeting emissions legislation.

All GDI injectors are electronically controlled by the engine control unit, and today - most are solenoid-based. The solenoid design uses copper coils and magnets to create a magnetic field to lift the injector needle open and allow the fuel to flow. A few injector designs are piezo-based, using a stack of quartz crystals which physically pulse when supplied with an electrical current. They are more accurate and consistent in controlling the needle and fuel flow, which helps to optimize combustion. However, they are also more expensive than solenoid-based systems, so most OEMs have not adopted the piezo-electric injectors.

Controlling combustion precisely allows car manufacturers to meet tougher CO2 and emissions legislation. In these increasingly sophisticated combustion systems, optimised fuel delivery is key. Fuel needs to be injected in the correct quantity, correct location and sufficiently atomised. Deposit build-up in and around the injector nozzle holes impacts combustion, much more so than with older, PFI engine designs. Good quality additized fuel will reduce deposits and restore optimised engine performance.

It's also important to remember, the demands of higher fuel injection pressure also requires gasoline with good lubricity – which is another area where fuel additives can provide measurable benefits.

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