Effect of High Temperature Fuel Injection on Atomization Characteristics of Gasoline Direct Injection Injector

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To alleviate the increasing air pollution problem and continuously improve the performance of gasoline direct injection (GDI) engines, researchers are employing various methods, including the optimization of combustion and injection strategies, in addition to the selection of renewable fuels. Better combustion characteristics of engine are expected to achieve by improving the atomization characteristics of GDI injectors. Because smaller droplets accelerate evaporation process, promote a uniform air-fuel mixture formation and, finally control the combustion process. Atomization characteristics can be promoted by high-pressure injection, which has become the development trend of GDI engines. However, it has recently been discovered that the atomization of the fuel will also be greatly promoted under flash boiling conditions Flash boiling occurs when liquid fuel is injected into an ambient environment below its saturation pressure, which can be achieved by increasing the fuel temperature and lowering the ambient pressure. However, for most studies, only the atomization characteristics of the plume center point are measured, but we still lack knowledge of the overall atomization characteristics of the spray. In this study, about 100 measurement points are taken on a plane 30mm below the injector by using Phase Doppler particle analyzer (PDPA), and the overall atomization level and atomization uniformity of the spray under flash boiling and non-flash boiling conditions are analyzed through these measurement points.

The left side in Figure 2 shows spray pattern 30mm below injector tip and the measurement position of spray droplet. The right side in Figure 2 compares the droplet diameters of injector under subcooled and flash boiling conditions. The red symbol connected by solid line represents the saute mean diameter (SMD) calculated at 0.2 ms intervals. As the fuel temperature increases from subcooled conditions to flash boiling conditions, the standard deviation of the SMD at plume center decreases from 5.90 μm to 3.20 μm, and the standard deviation at spray center decreases from 3.73 μm to 1.60 μm. The smaller standard deviation of the SMD under flash boiling conditions means a uniform droplet diameter. A more uniform droplet diameter promotes the synchronous combustion of spray droplets and reduces the burning time, which will improve the instantaneous power of the engine, and reduce the soot particles produced due to insufficient combustion.

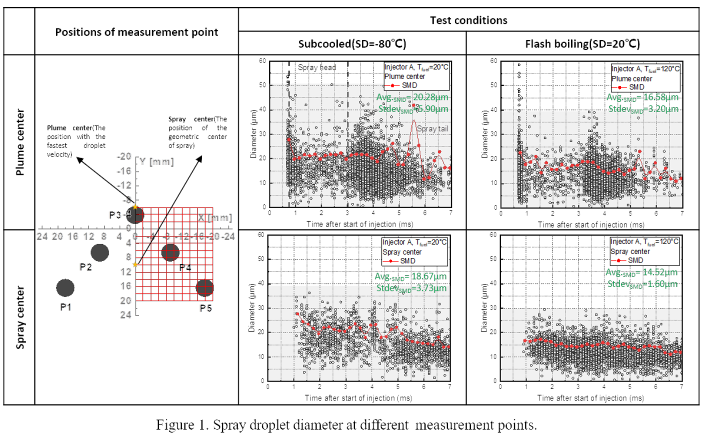

Figure 1. Spray droplet diameter at different measurement points.

[1] Lee Ziyoung, et al., Fuel, 2020, 259: 116209.
[2] Kale Rakesh, et al., SAE Technical Paper, 2018-01-0280.