Development of Simultaneous Reduction of NOx and PM After-Treatment System (Maintenance Free & without Urea) for Light-Duty and Heavy-Duty Commercial Vehicles





Mitsuru Hosoya [*1] Masahiro Kimura [*1] Hiroshi Hirabayashi [*1] Wataru Koizumi [*1] Yuuiti Yoshida [*1]

1. Overview

The diesel engine has the advantage of high thermal efficiency and low fuel consumption. The diesel engine has been used for commercial vehicles all over the world.

On the other hand, the reduction of NOx and PM (Particulate Matter) emissions from diesel engine has been requested. Urea SCR (Urea Selective Catalytic Reduction) as after-treatment system has been adopted for heavy-duty commercial vehicles in Japan, Europe and USA. However, the urea infrastructure has not been developed well in Japan.

Many light-duty and medium-duty commercial vehicles operate in the limited area. It is also difficult to install a Urea-SCR system on light-duty and medium-duty vehicles, because the size of Urea SCR system is large. Therefore, it is difficult to apply Urea-SCR system to light-duty and medium-duty commercial vehicles.

To resolve this issue, HC-SCR (Hydro-Carbon Selective Catalytic Reduction) System was developed for light-duty and medium-duty commercial vehicles by Hino Motors as the first manufacture in the world. HC-SCR System does not need urea solution and uses diesel fuel as the reducing agent for NOx reduction. HC-SCR System is compact, compared with Urea-SCR system.

.

2. Technical Content

The characteristic of HC-SCR system is to reduce NOx and PM simultaneously in the same catalytic converter without urea solution. And this system does not need the maintenance to supply urea solution. This system reduces NOx emission and PM on the filter (PM regeneration) in the exhaust gases, using diesel fuel.

Figure 1 shows the configuration of New DPR (Diesel Particulate Active Reduction) System as the newly developed system. New DPR was composed of ATC (After Turbo Catalyst), compact catalytic converter, fuel injector, temperature sensors and NOx sensors. The catalytic converter consists of front diesel oxidation catalyst (F-DOC), catalyzed filter (Filter), and HC-SCR catalyst (HC-SCR). New DPR catalytic converter is as almost compact as the original DPR System by optimizing the design.

Diesel fuel as reducing agent is dosed at the upstream of the catalytic converter by the fuel injector. Reaction of NOx reduction is started over F-DOC and HC-SCR in the catalytic converter. F-DOC and HC-SCR in the catalytic converter use a precious metal type to achieve the best performance for NOx reduction efficiency at a low temperature.

On the other hand, it is necessary to increase F-DOC temperature immediately to shorten the regeneration period of DPF. In order to warm up F-DOC quickly at low temperature for PM regeneration, ATC is installed near the engine exhaust out. By supply of diesel fuel for F-DOC, the regeneration period of DPF becomes shortened drastically.

Figure 2 shows the mechanism of catalytic reaction to reduce NOx and PM simultaneously. The PM oxidation temperature becomes lower because PM oxidation is accelerated by the active oxygen of cerium oxide. Furthermore, the reaction of NOx reduction is improved by formation of high active intermediate with the active oxygen of cerium oxide.

Figure 3 demonstrates the reduction efficiency of NOx, PM, NMHC (Non-Methane Hydro-Carbon) and CO over JE05 mode (current diesel exhaust emission regulation mode in Japan). NOx, PM, NMHC and CO emissions were greatly reduced by New DPR System.

3. Summary

New DPR System was adopted for light-duty and medium-duty commercial vehicles. New DPR System is compact and superior for body application. Currently, these vehicles with New DPR System have been manufactured close to 107,000 units in Japan since 2010. In the future, this New DPR will contribute to the environmental improvement for the developing countries.

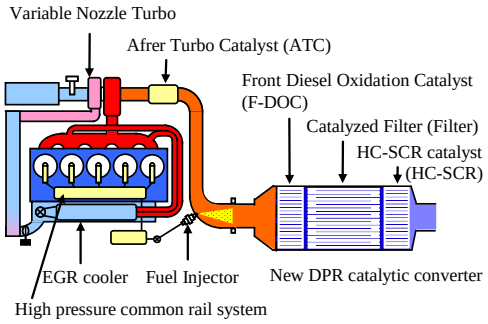

Fig.1 Configuration of the New DPR System

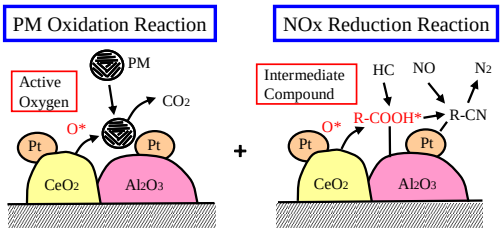

Fig.2 The mechanism of catalytic reaction to reduce NOx and PM simultaneously

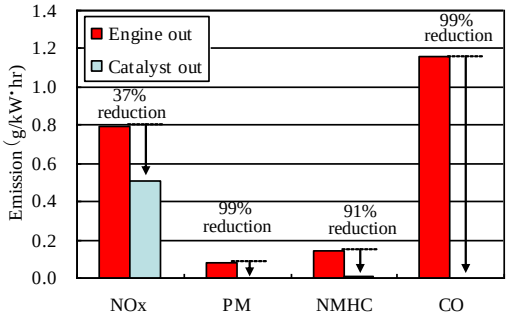

Fig.3 The reduction efficiency of NOx, PM, NMHC, CO over JE05 mode

*1 Hino Moters, Ltd. (3-1-1 Hino-dai, Hino-shi, Tokyo 191-8660, Japan)