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Development of New Generation 3.3-Liter Clean Diesel Engine (First Report)

- Value enhanced by a large-displacement inline six-cylinder engine and pursuit of ideal combustion -

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For realization of carbon neutrality, society is moving toward renewable energy generation and the use of renewable fuel is considered to be an option for the future. With this in mind, the authors aim to realize multi-solutions through electrification and improvement in the thermal efficiency of the internal combustion engine (ICE) to reduce CO2 in a realistic and effective way. As part of this effort, seven items were identified as control factors of the thermal efficiency of the ICE and activities to bring them to their ideal states have been taking place (Fig. 1 Roadmap). A new engine was developed as the second step of the diesel engine evolution with the aim of bringing “combustion duration” and “combustion timing” closer to the ideal states by expanding lean PCI (Premixed Charge Compression Ignition) operating range from the first step.

Fig. 2 shows the new engine technology concept to realize the aim, and Fig. 3 shows verification results that indicate improvements in torque performance, NOx emissions and brake specific fuel consumption. The engine displacement was increased from 2.2 liters of the previous engine to 3.3 liters so that the combustion evolved in pursuit of the ideal would lead to enhanced driving feel and lower fuel consumption and emissions. With the increase in displacement, the engine torque was increased to 550 Nm high enough to run a large SUV powerfully. At the same time, the maximum mean effective pressure was decreased compared with the previous engine, which enabled the use of large-volume EGR up to high load and resulted in a significant reduction in NOx. In addition, the decrease in mean effective pressure in the practical torque range and newly developed DCPCI (Distribution Controlled Partially-premixed Compression Ignition) using dual zone egg-shaped combustion chamber expanded the PCI operating range to the medium load region. Friction loss is usually larger with a large-displacement engine, but thanks to the Pmax-lowering combustion technology inherited from the previous engine and improved engine structural technologies such as steel pistons, the engine has achieved friction loss even smaller than that in a former four-cylinder engine. With these technologies, the brake specific fuel consumption of the engine is 8 to 10% lower than that of the previous 2.2-liter engine.

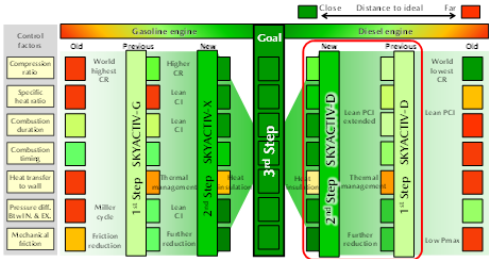

Fig.1 Evolution Roadmap to ideal ICE

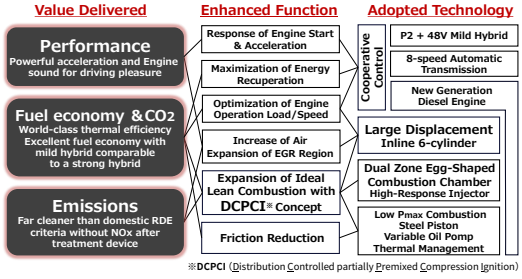

Fig.2 Development and Technology Concept of New 3.3-Liter Clean Diesel Engine

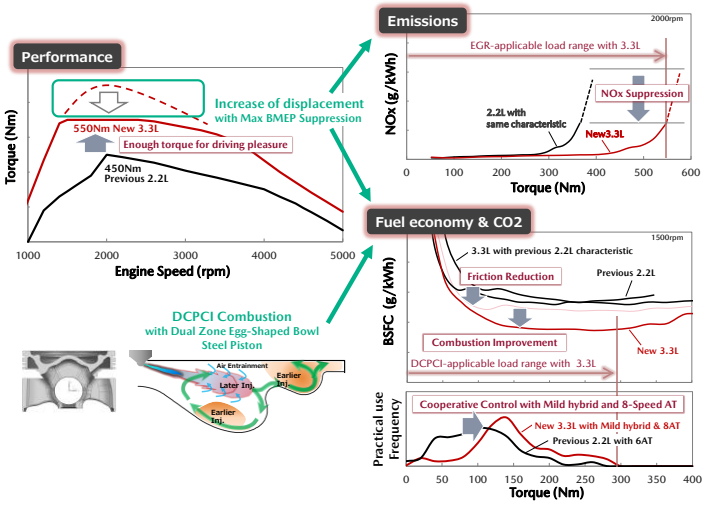

Fig.3 Improvement in Torque Performance, NO Emissions and Fuel Consumptions of New 3.3-Liter Clean Diesel Engine