講演番号	128

文献番号	20226128

Development of 2.0L Inline-4-Cylinder Gasoline Direct Injection Engine

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KEY WORDS: **heat engine, spark ignition engine, performance/fuel economy/efficiency** [A1]

A new hybrid system 2.0 L engine was developed for use in C-segment and D-segment cars. Development of this new system, since it is a hybrid system, naturally aimed to provide it with good fuel efficiency and environmental performance, but it also aimed for enhancement of driving marketability. As a new model engine making up part of the hybrid system, it was developed with expansion of the high thermal efficiency region, compliance with national emissions laws and regulations, and a high levels of cabin quietness as goals.

In addition to the Atkinson cycle and cooled exhaust gas recirculation (EGR) of previous models, the new model engine adopted an in-cylinder direct fuel injection system. A high fuel injection pressure of 35 MPa was adopted as a specification for the in-cylinder direct fuel injection system. The intake and exhaust ports, combustion chamber, and other such components were newly designed to match with adoption of the in-cylinder direct fuel injection system. By achieving high-speed combustion, this engine realized a mechanical compression ratio of 13.9, making for a higher compression ratio than previous models. The configuration of in-cylinder flow, fuel injection timing, and fuel injection frequency, together with changes in the exhaust ports and the water jackets around the exhaust ports, realized stoichiometric combustion across a broad operating range.

In order to achieve higher-speed combustion than previous models while also satisfying the demand for quietness in the assembled vehicle, development was pursued with the radiation noise target for the stand-alone engine set to the same level as in previous models. The crankshaft was newly designed, the main journal diameter was changed from 50 to 55 mm, and the stiffness of the cylinder block and other such components was increased in order to achieve this noise and vibration performance. In order to reduce engine radiation noise, the air intake system devices were relocated to the rear and acoustic absorbent material was applied.

The combustion specifications were changed from previous models to enhance fuel economy and reduce exhaust emissions while also pursuing a new design for quietness. This yielded the following results:
1) The 35 MPa in-cylinder direct fuel injection system, high-tumble intake port, and optimized combustion chamber design both expanded the stoichiometric operation range over previous models and realized maximum power output of 104 kW and maximum torque of 182 Nm.
2) The in-cylinder flow provided by a high-tumble port combined with optimized injection spray form and multi-stage injection contributed to achieve adhesion amount of fuel to the lowest possible level and to achieve low emission.
3) Increased the stiffness of the cylinder block and the crankshaft, and optimal placement of acoustic absorbent material achieved noise and vibration performance equal to or higher than previous models.

As a result of the above, the developed engine offers high fuel economy performance as a hybrid system while supporting hybrid engine control for enhanced driving dynamics.

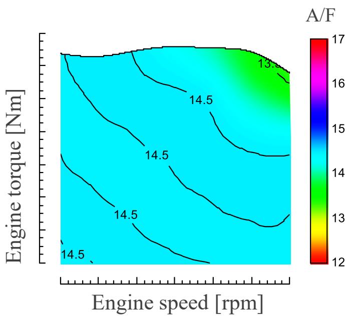

Fig. 1 A/F comparison

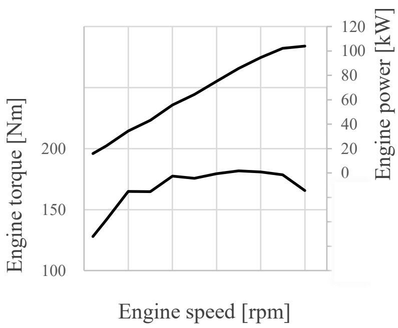

Fig. 2 Engine performance and torque curve

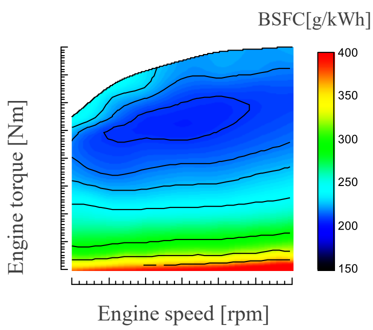

Fig. 3 Engine BSFC comparison