Internal Combustion Engine Technology

Approaches to Sustainability Challenges in the Field of Internal Combustion Engine Technology

At HKS, our initiative,**"A New Approach to a Sustainable Society through the High Efficiency of Legacy Engines,"** focuses primarily on engines manufactured in the 1990s. We are developing high-efficiency technologies—including high compression ratios, pre-chamber combustion, and enhanced knock resistance compatible with CN (carbon neutral) fuels. To date, we have achieved a maximum net thermal efficiency of **40.6%** *1

*1: Using the RB26 engine for the Skyline GT-R.

New Approach to a Sustainable Society through the High-Efficiency of Legacy Engines

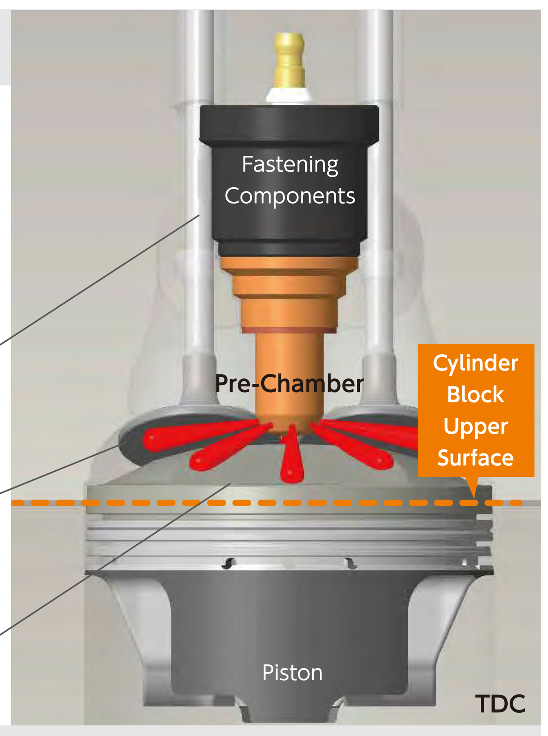
Improving the efficiency of engines in existing vehicles allows us to continue utilizing these vehicles. In doing so, resource consumption and CO_2 emissions associated with the manufacture and disposal of new vehicles are reduced. This contributes to lowering the overall environmental load across the entire life cycle (LCA). We consider this retrofit - based approach—leveraging HKS' s unique expertise—as a key step toward realizing a sustainable society.

Legacy Engine Efficiency Enhancement Technologies

High Compression Ratio & Layout

Considering a layout that can achieve a high compression ratio while making effective use of the base engine.

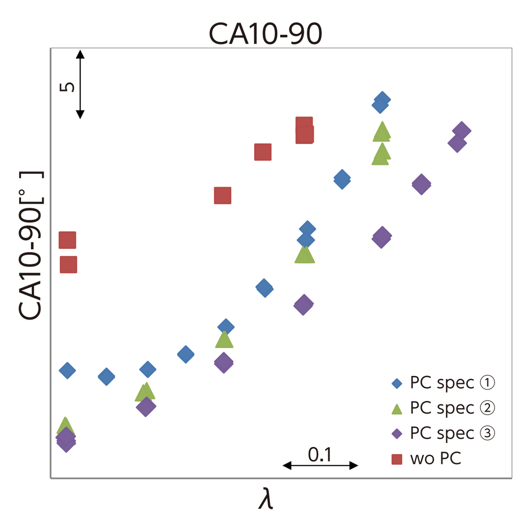
Fastening Components	To allow the installation direction of the pre-chamber to be adjusted arbitrarily, the fastening structure was changed to one that employs separate components (a two-piece construction).
Nozzle Direction	Due to the high compression ratio, the combustion chamber becomes more confined; therefore, the nozzle direction is adjusted arbitrarily to reduce heat loss from the walls and suppress auto-ignition in the unburned regions.
Piston Protrusion Structure	To improve the compression ratio and enhance the combustion chamber shape, a design is adopted in which the top of the piston protrudes from the surface of the cylinder block.

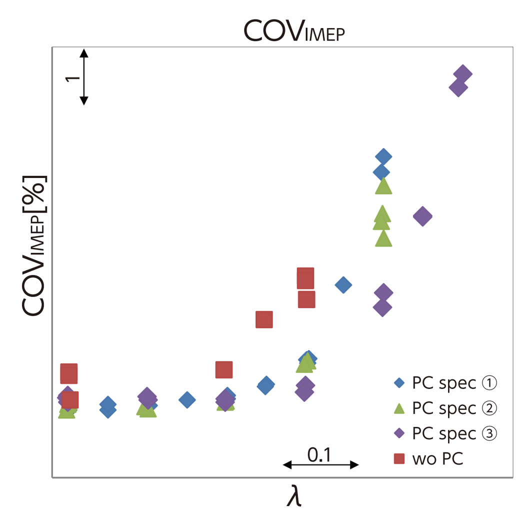


- By adopting a piston protrusion structure, a maximum compression ratio of 17.0 is achieved.
- By modifying the pre-chamber fastening method and implementing a structure that allows the pre-chamber nozzle direction to be adjusted arbitrarily, heat loss from the walls is reduced and auto ignition in unburned regions is suppressed.

Pre-Chamber Combustion

A parameter study regarding the pre-chamber specifications was conducted.





Pre-Chamber Specification

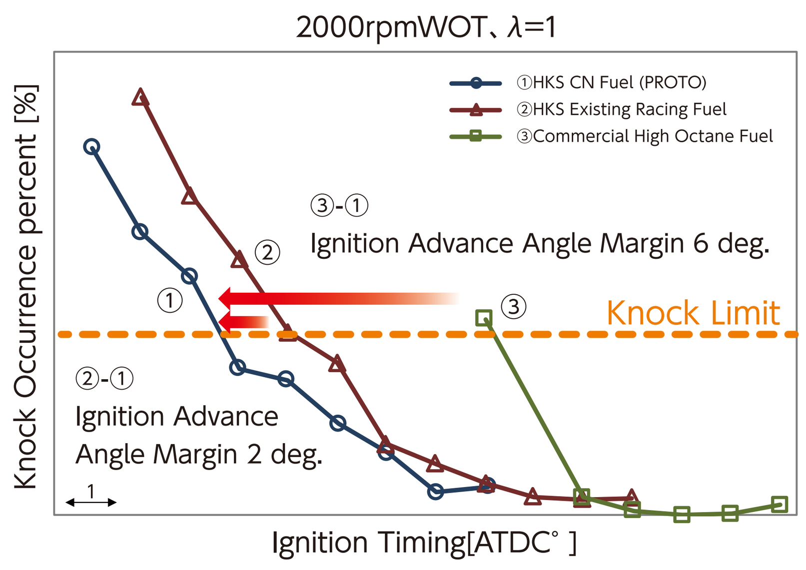
①8 nozzles, small volume
②10 nozzles, small volume
③10 nozzles, large volume

By increasing the number of nozzles and the pre-chamber volume, both the combustion duration and the lean limit are enhanced. With the adoption of an pre-chamber compared to a configuration without one (i.e., a conventional spark plug setup):
- The combustion duration (CA10-90) is shortened by more than 10°
- The lean limit (COV) is increased by approximately λ0.2.

Carbon Neutral Fuel

Knock Limit Performance Confirmed Using CN Fuel *2

*2 Bioethanol-based Fuel



① The use of HKS CN fuel improves the knock limit performance
② Under these conditions, compared to HKS' s existing racing fuel, an ignition timing advance effect of approximately 2° was observed
③ Under these conditions, compared to commercial high-octane fuel, an ignition timing advance effect of approximately 6° was observed.

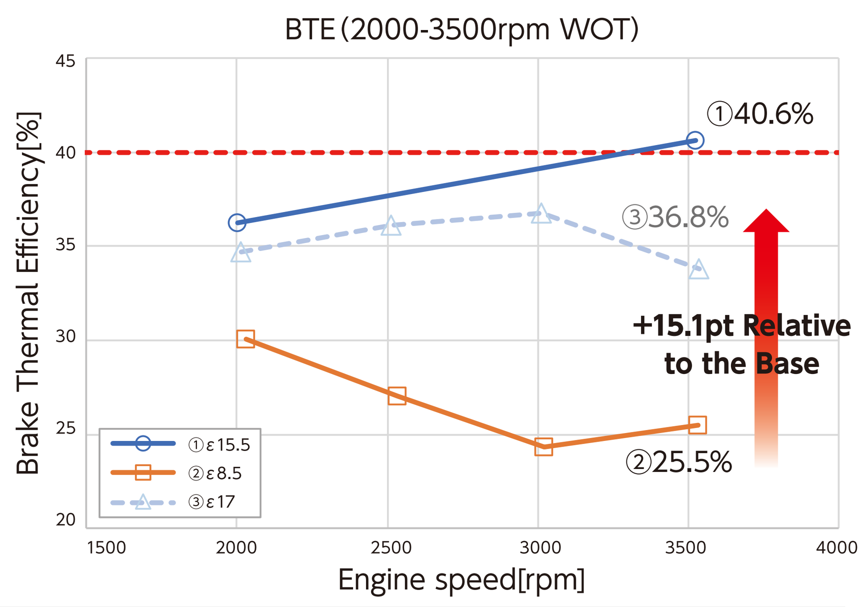
Maximum Brake Thermal Efficiency

Comparison of WOT Maximum Thermal Efficiency in the WLTC Operating Region

Maximum Thermal Efficiency Comparison

① **HKS High Efficiency Specification (ε15.5, PC) BTEmax: 40.6% at 3500 rpm *3**
② HKS Conventional Specification (ε8.5, wo PC) BTEmax: 25.5% at 3500 rpm *3
③ HKS High Efficiency Specification (ε17.0 PC) BTEmax: 36.8% at 3000 rpm *3

*3 Fuels used: ① ③ HKS CN Fuel, ② Commercial High Octane Fuel



① In the specification with a compression ratio of 15.5 and an pre-chamber, a maximum thermal efficiency of 40.6% was achieved-a 59% improvement compared to the base specification (②).
③ In the specification with a compression ratio of 17.0 and an pre-chamber, the thermal efficiency was lower than that of specification ① due to knock limit and decreased torque.

Newly Developed Components

Piston (2-Piece Structure)

By adopting a 2-piece piston structure, the compression height has been reduced. As a result, friction losses caused by piston movement are significantly decreased. Additionally, the 2-piece design greatly enhances design flexibility, allowing for features such as weight reduction and advanced cooling configurations.

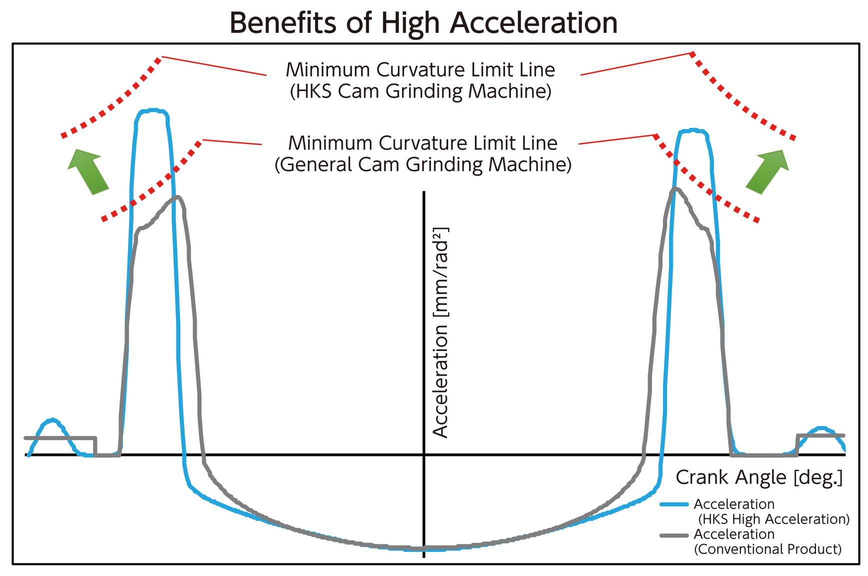
Assembly-Type 2-Piece Piston

Note:
The photo is of an HKS branded product designed for the RB26 engine.

Camshaft (3D, High Acceleration Profile)

HKS has introduced a cam grinding machine capable of 5-axis precision grinding. As a result, it is now possible to grind 3D cam profiles that are tailored to radial valve layouts, as well as high acceleration cam profiles featuring an ultra small radius (R).

Benefits of High Acceleration



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