

# ESTEC 1NR-FKEエンジンの開発

Development of ESTEC 1NR-FKE



トヨタ自動車(株)

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**TOYOTA**

## 発表の構成

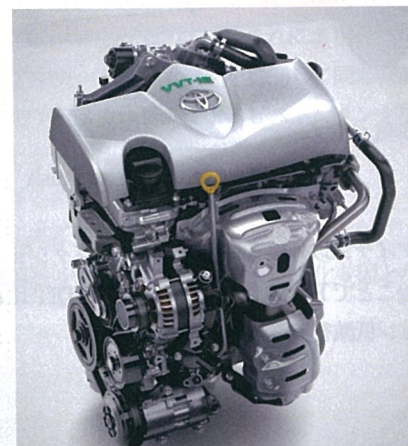
### 1. 背景

### 2. 1NR-FKEエンジンコンセプト

### 3. 熱効率向上技術

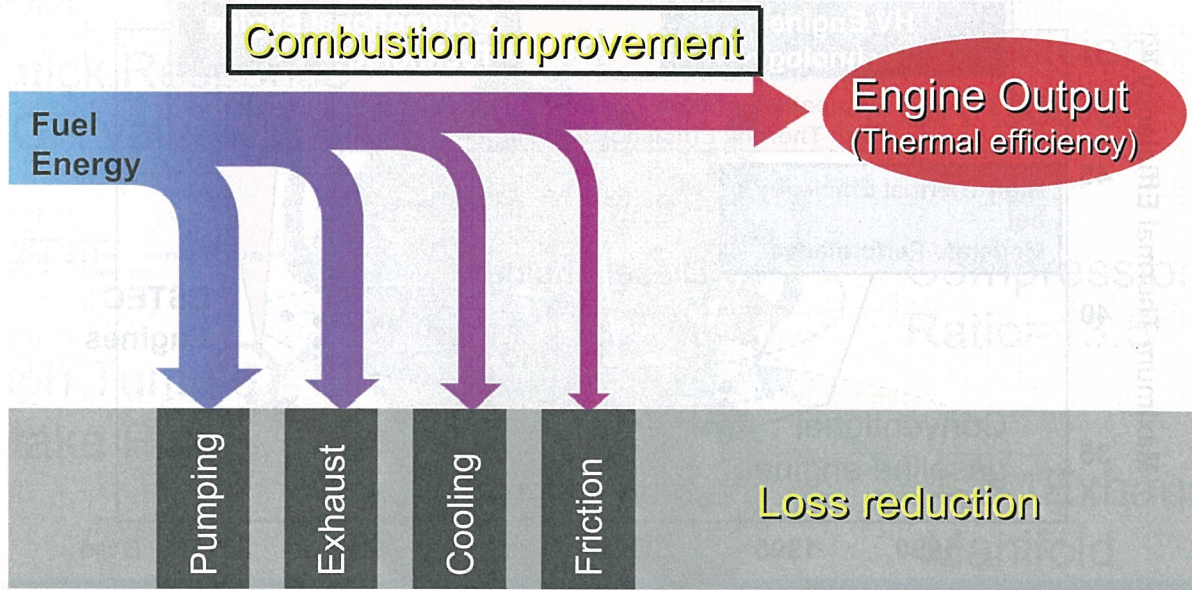
### 4. 1NR-FKEエンジン性能

### 5. まとめ



# 1. 背景

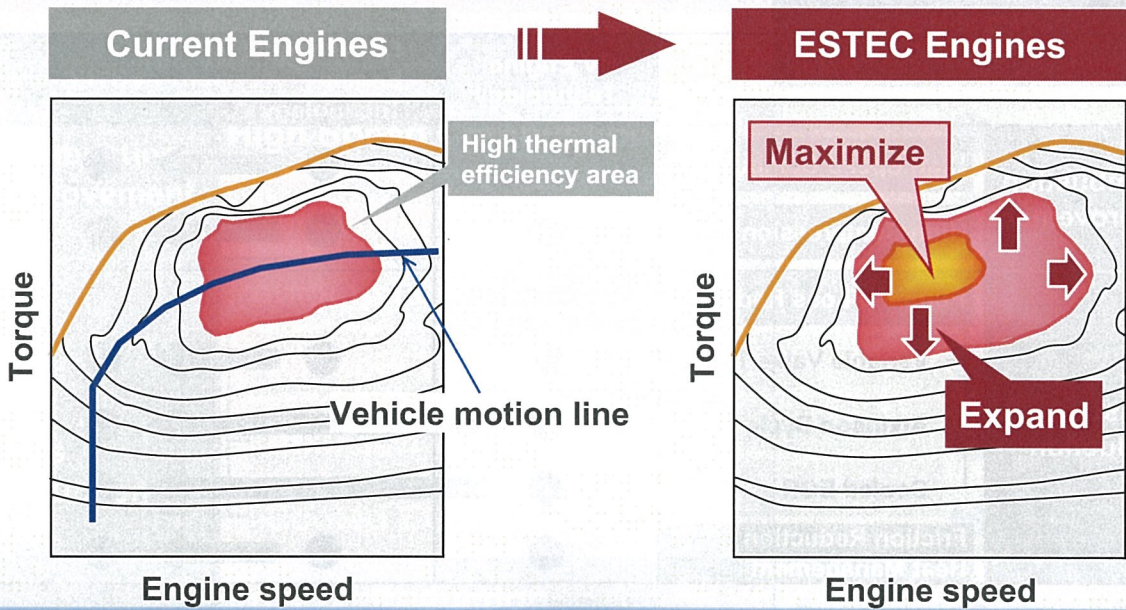
## エンジン熱効率



Combustion improvement and loss reduction are important for high thermal efficiency

# 1. 背景

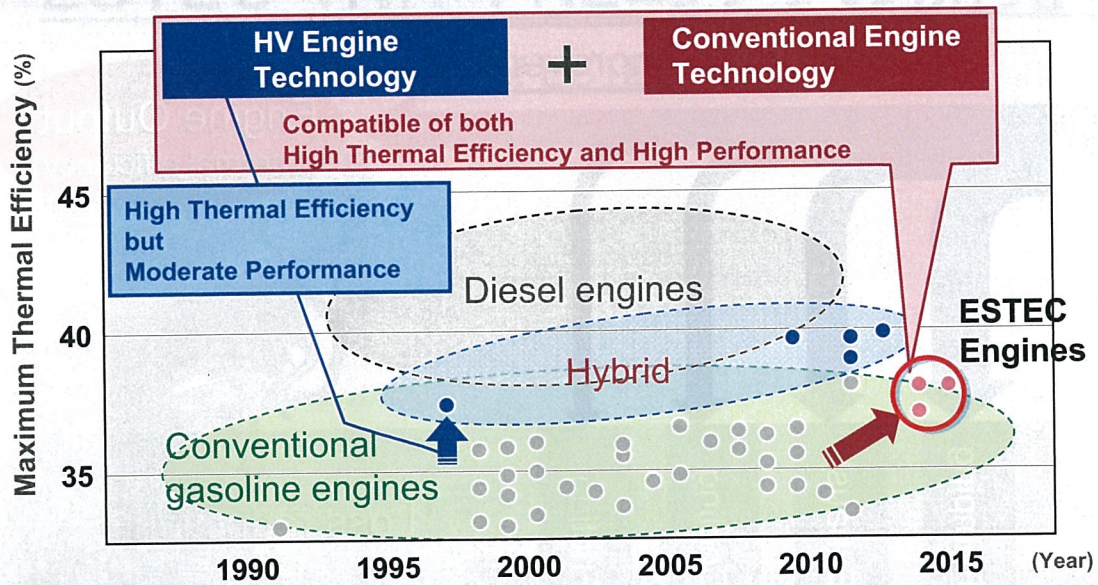
## 燃料消費率MAP



Both raising thermal efficiency and expanding high thermal efficiency area are achieved

# 1. 背景

## 最高熱効率トレンド



The maximum thermal efficiency of ESTEC engines reached the same level as the first Hybrid engine

# 1. 背景

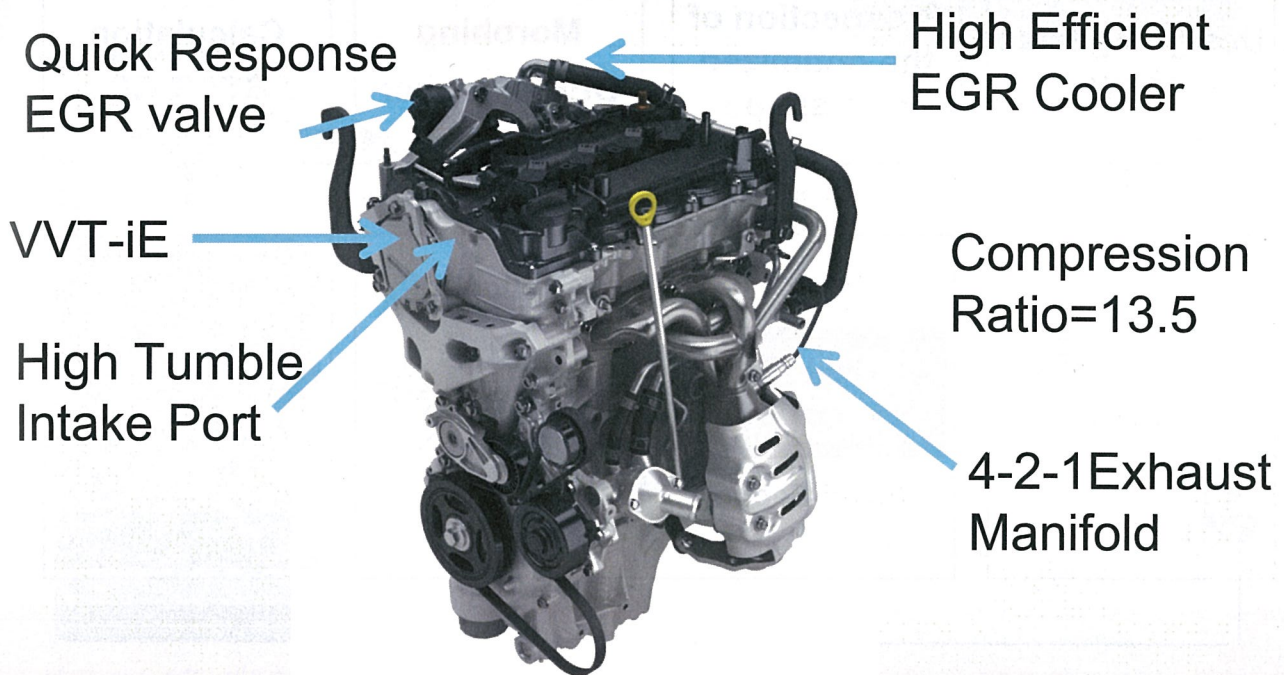
## ESTEC織込み技術

		HV Engine Technology	Conventional Engine Technology	ESTEC
Combustion Improvement	High Speed Combustion		● →	●
	High Compression Ratio	●	● →	●
Loss Reduction	Pumping Loss Reduction			
	Variable Valve Timing	●	● →	●
	Atkinson Cycle	●	→	●
	Cooled EGR	●	→	●
	Friction Reduction Heat Management	●	● →	●

ESTEC integrated HV and conventional engines' technologies

## 2. 1NR-FKEエンジンコンセプト

### ESTEC 1NR-FKE外観と織込み技術



## 3. 熱効率向上技術

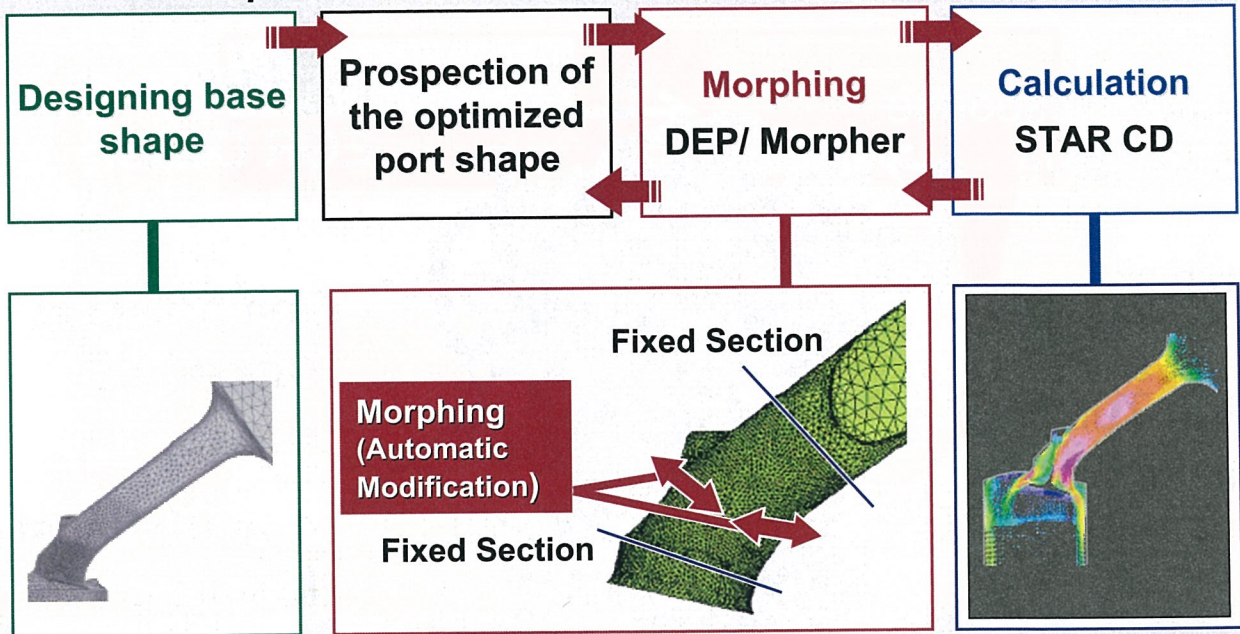
### 3-1. 高速燃焼

		ESTEC
Combustion Improvement	High Speed Combustion	●
	High Compression Ratio	●
Loss Reduction	Pumping Loss Reduction	●
	Variable Valve Timing	●
	Atkinson Cycle	●
	Cooled EGR	●
	Friction Reduction Heat Management	●

### 3. 熱効率向上技術

#### 3-1. 高速燃焼

-CFD optimization of intake port with morphing technologies -

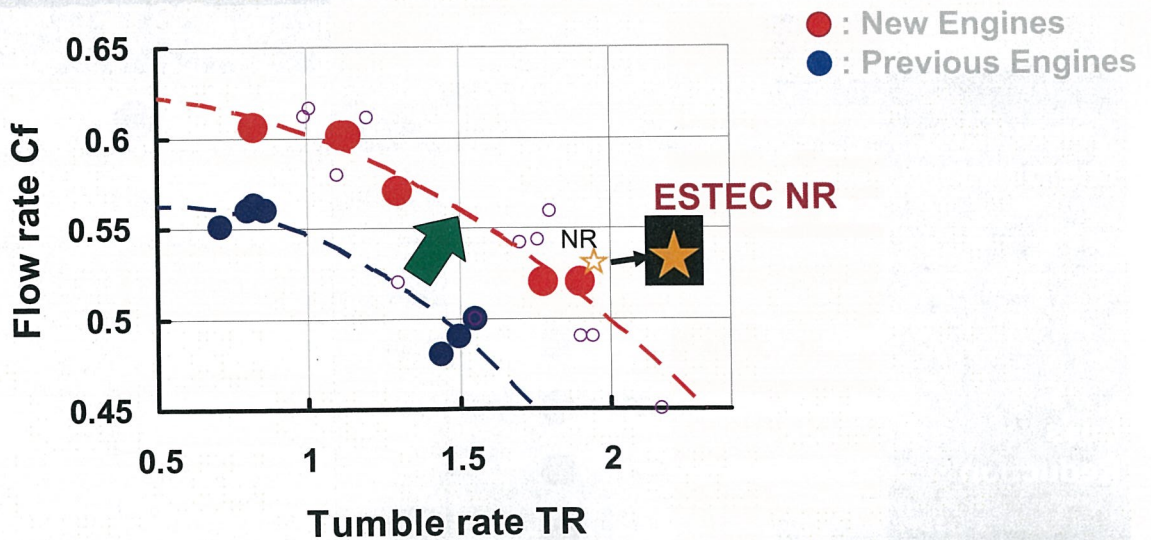


Morphing technology can enhance to improve intake port flow.

### 3. 熱効率向上技術

#### 3-1. 高速燃焼

-CFD optimization of intake port with morphing technologies -



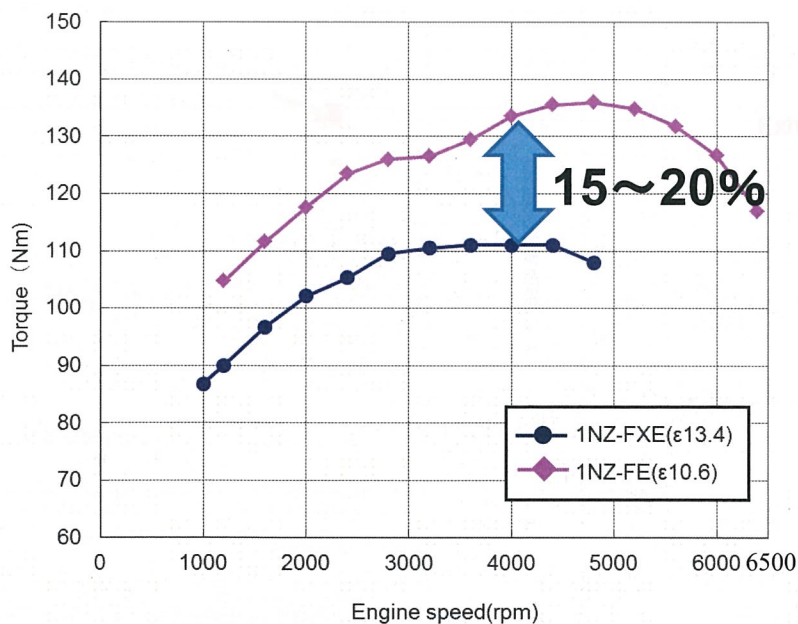
ESTEC NR engine improved high tumble and flow rate. Realized rapid combustion to raise thermal efficiency.

### 3. 熱効率向上技術 3-2. 高圧縮比

		ESTEC
Combustion Improvement	High Speed Combustion	●
	High Compression Ratio	●
Loss Reduction	Pumping Loss Reduction	
	Variable Valve Timing	●
	Atkinson Cycle	●
	Cooled EGR	●
	Friction Reduction Heat Management	●

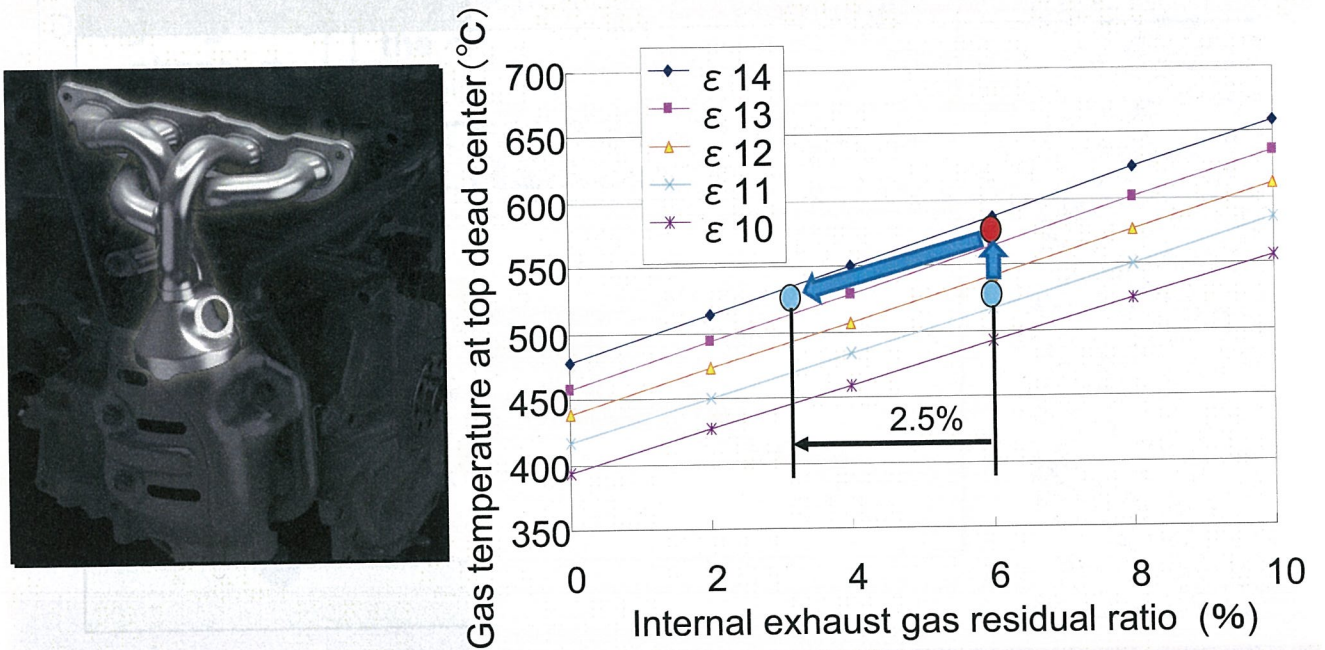
### 3. 熱効率向上技術 3-2. 高圧縮比

Torque reduction by High Compression Ratio



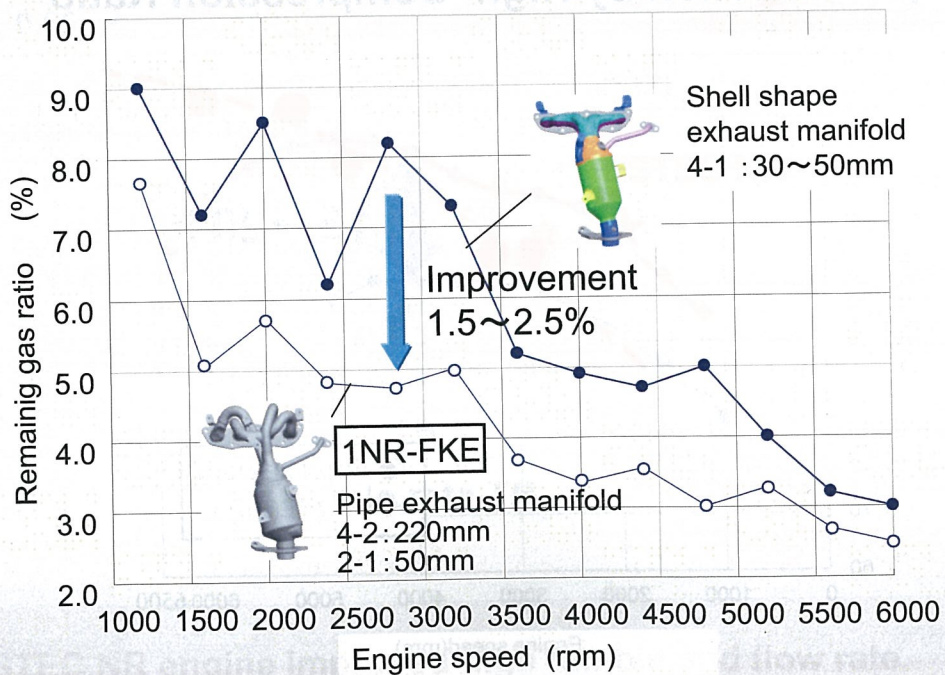
### 3. 熱効率向上技術 3-2. 高圧縮比

Trade Off with Residual Gas Ratio and Compression Ratio



### 3. 熱効率向上技術 3-2. 高圧縮比

Scavenging Effect by Exhaust Manifold

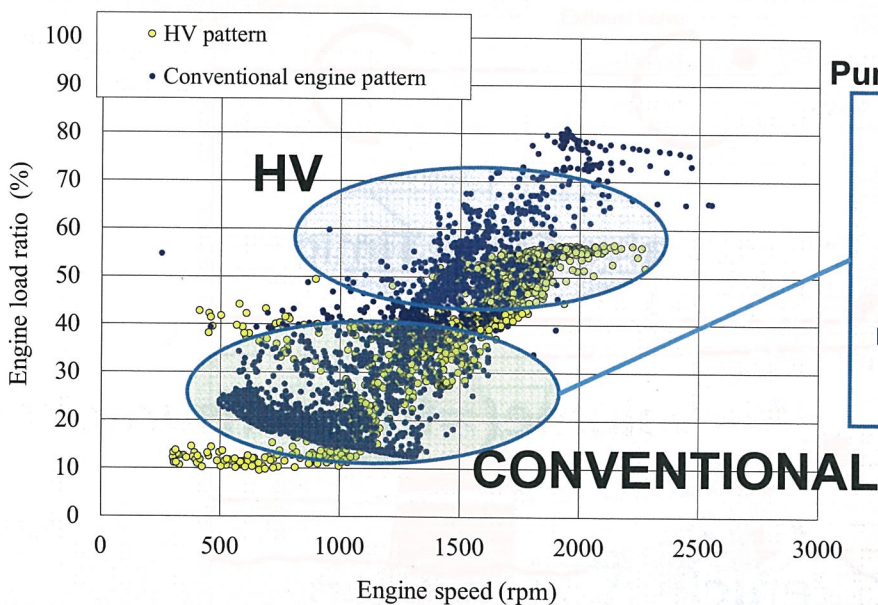


### 3. 熱効率向上技術 3-3. 電動VVT, アトキンソンサイクル

		ESTEC
Combustion Improvement	High Speed Combustion	●
	High Compression Ratio	●
Loss Reduction	Pumping Loss Reduction	
	Variable Valve Timing	●
	Atkinson Cycle	●
	Cooled EGR	●
	Friction Reduction Heat Management	●

### 3. 熱効率向上技術 3-3. 電動VVT, アトキンソンサイクル

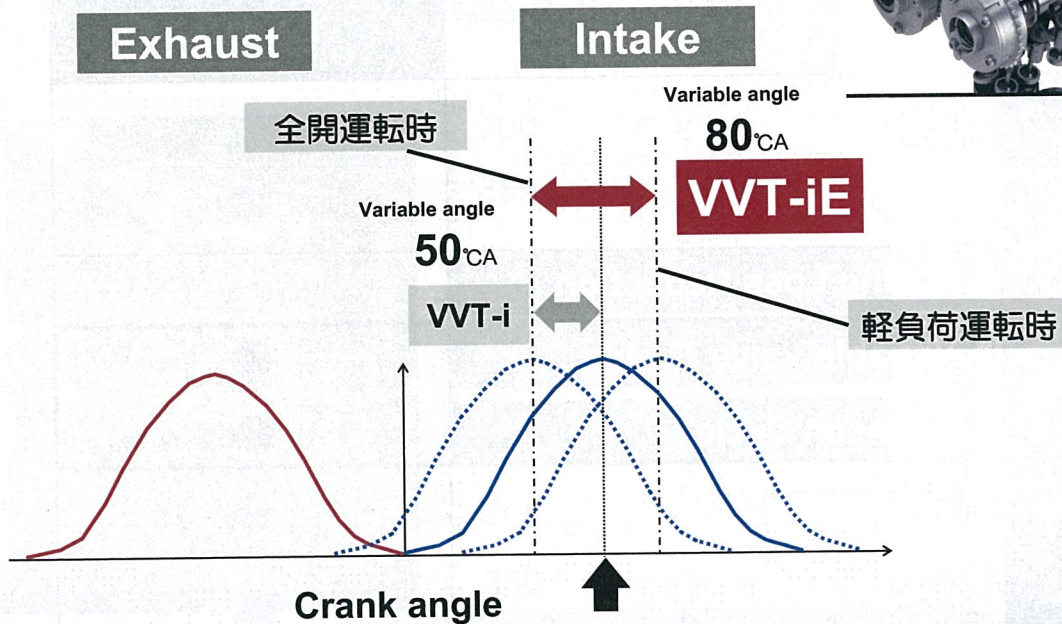
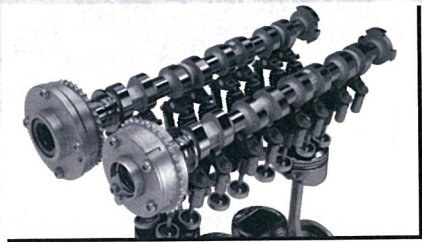
Engine Operation Map



**Thermal efficiency in low load area is relatively more important.  
To retard in-valve timing is the most effective to improve thermal efficiency in this area.**



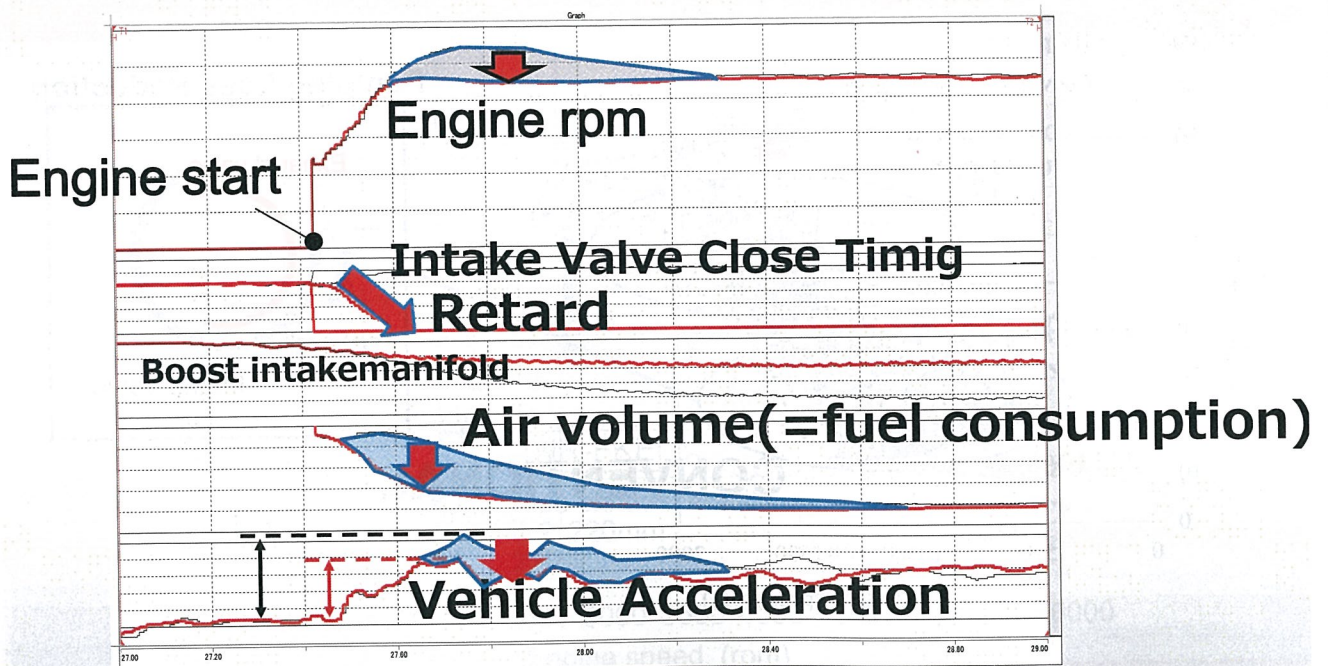
3. 熱効率向上技術  
3-3. 電動VVT, アトキンソンサイクル



Wider variable angle realized Atkinson cycle

3. 熱効率向上技術  
3-3. 電動VVT, アトキンソンサイクル

Transient control of engine with VVT-iE



### 3. 熱効率向上技術 3-4. クールト EGR

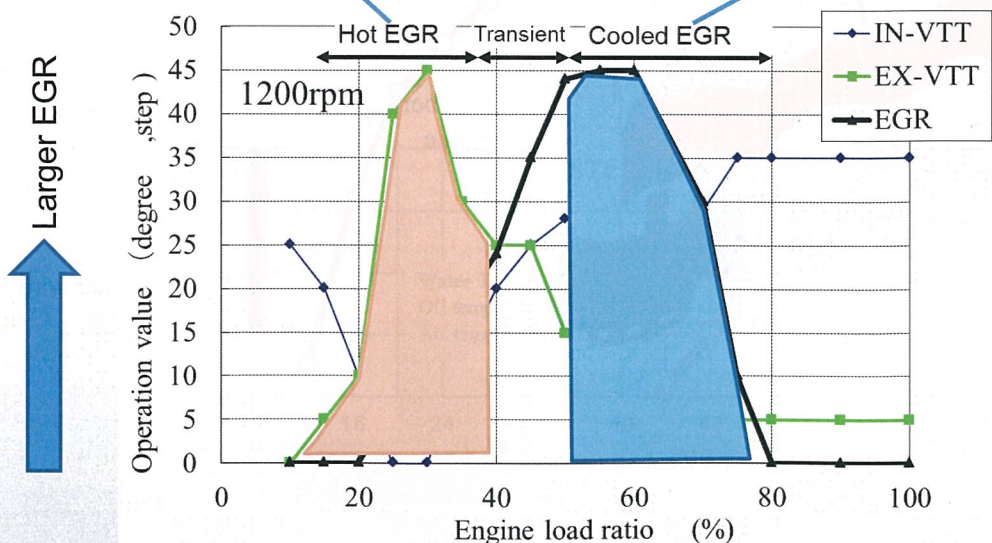
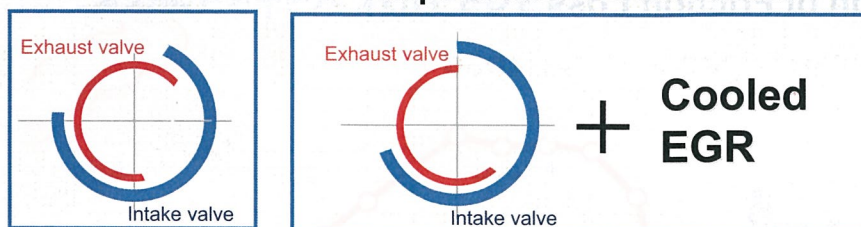
		ESTEC
Combustion Improvement	High Speed Combustion	●
	High Compression Ratio	●
Loss Reduction	Pumping Loss Reduction	
	Variable Valve Timing	●
	Atkinson Cycle	●
	Cooled EGR	●
Friction Reduction Heat Management		●

### 3. 熱効率向上技術 3-4. クールト EGR

#### Optimized EGR & VVT

- Pumping Loss Reduction
- Improvement of Knock limit

Pumping Loss Reduction

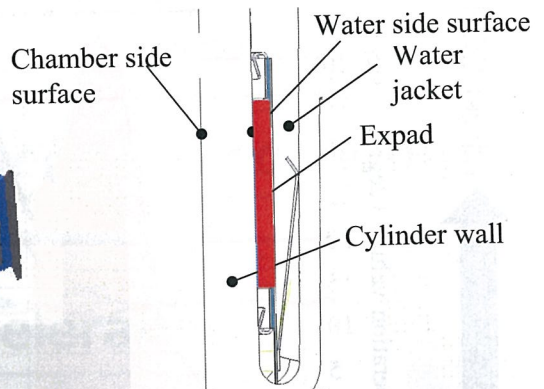
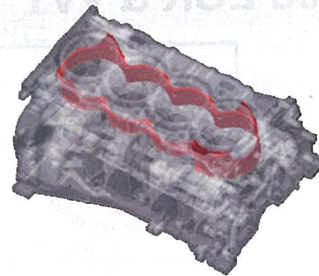
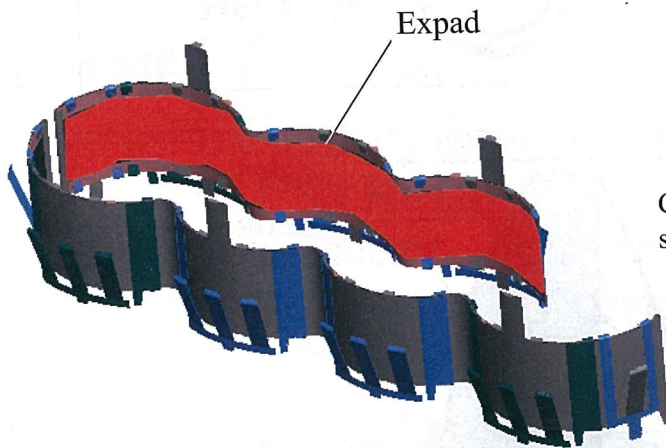


3. 熱効率向上技術  
3-5. メカニカルフリクション低減

		ESTEC D-4S
Combustion Improvement	High Speed Combustion	●
	High Compression Ratio	●
Loss Reduction	Pumping Loss Reduction	●
	Variable Valve Timing	●
	Atkinson Cycle	●
	Cooled EGR	●
Friction Reduction Heat Management		●

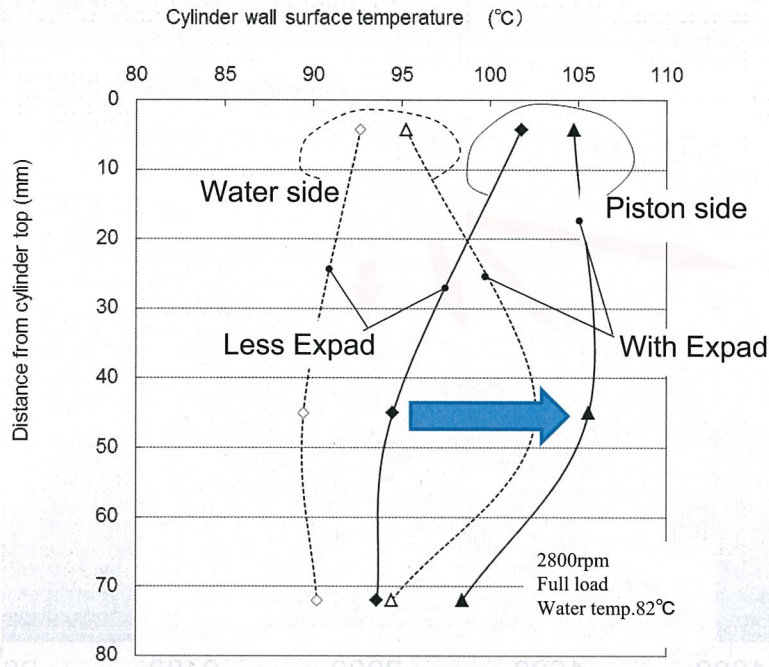
3. 熱効率向上技術  
3-5. メカニカルフリクション低減

Reduction of Friction Loss  
Water Jacket Spacer with Expad



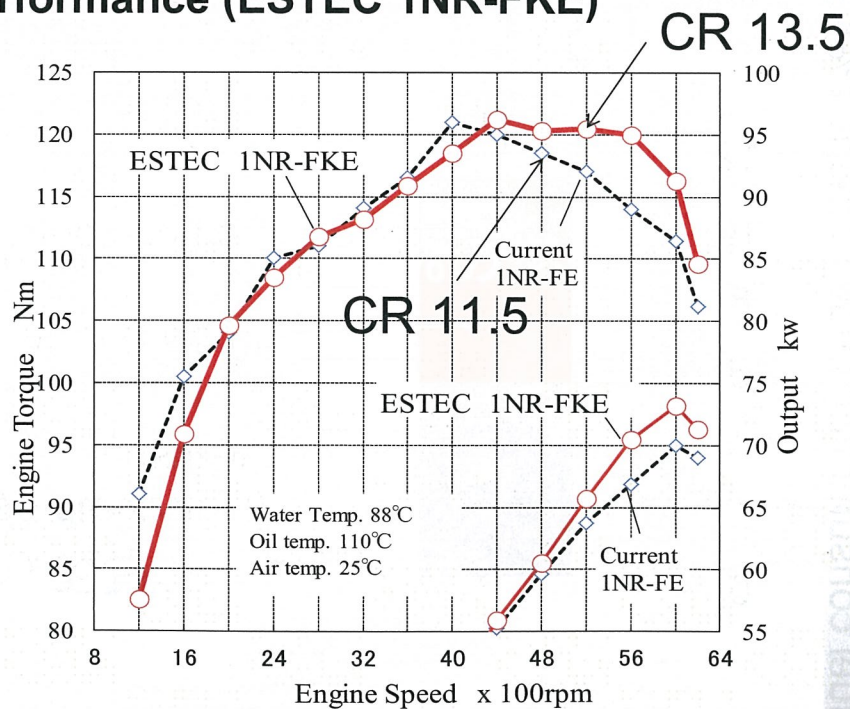
### 3. 熱効率向上技術 3-5. メカニカルフリクション低減

#### Cylinder Wall Temperature



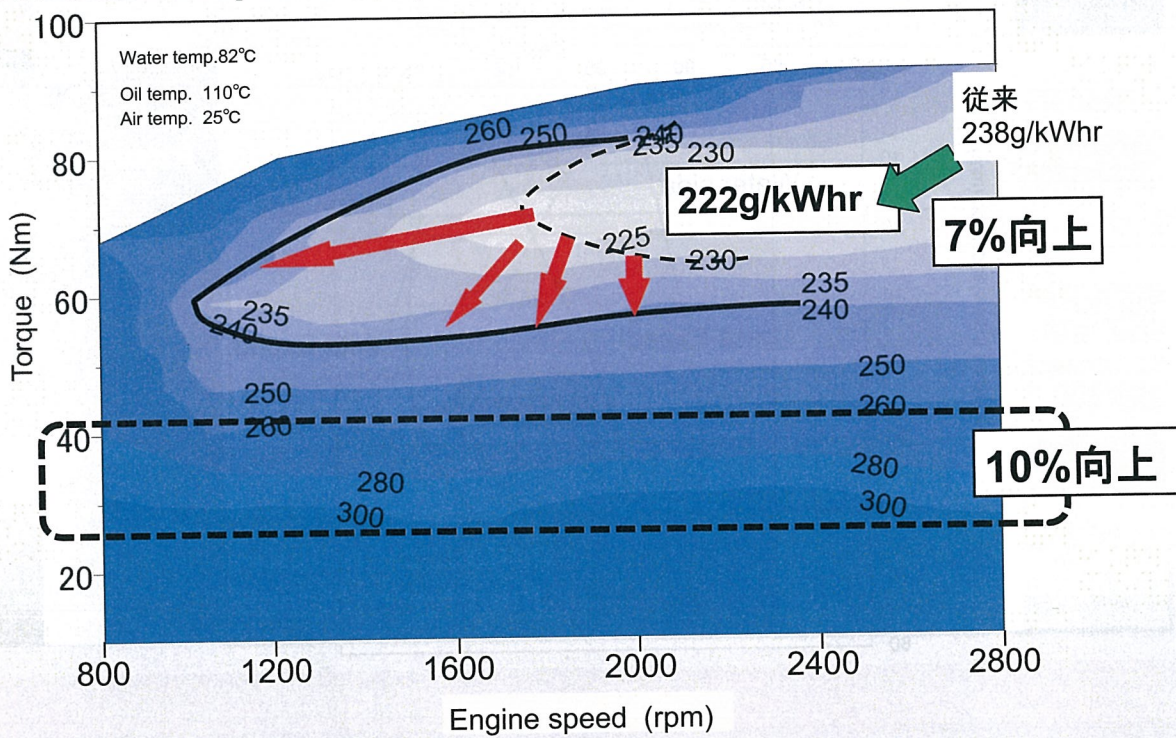
### 4. 1NR-FKEエンジン性能 4-1. 全負荷性能

#### Engine performance (ESTEC 1NR-FKE)



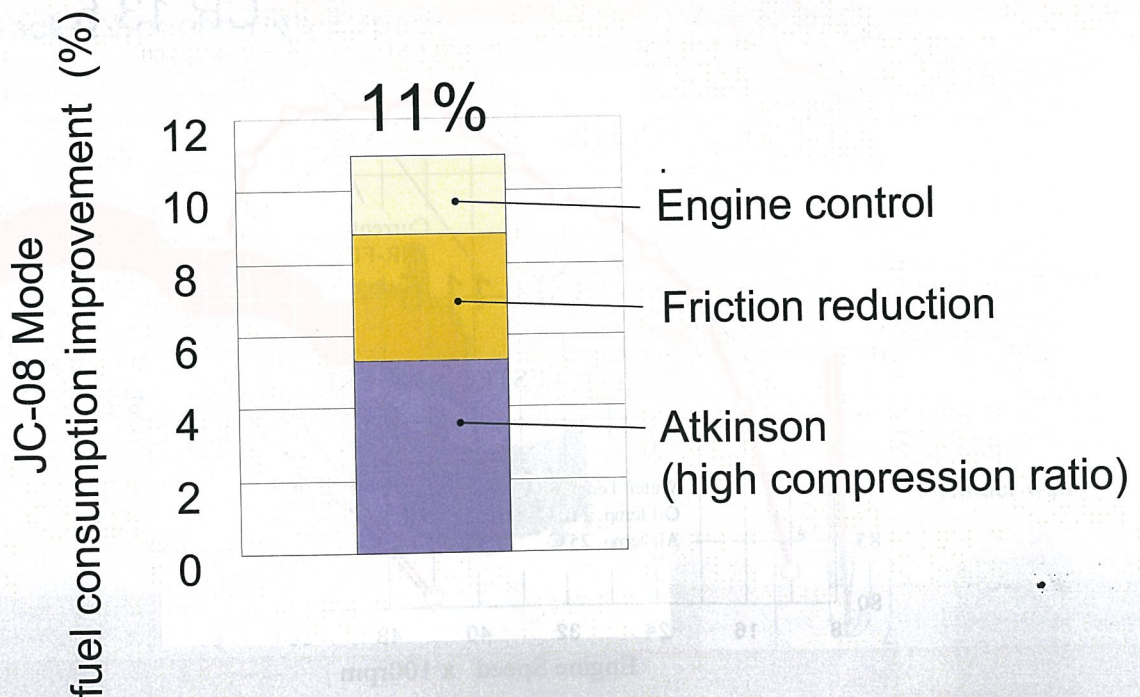
## 4. 1NR-FKEエンジン性能 4-2. 燃費

### Fuel Consumption Map



## 4. 1NR-FKEエンジン性能 4-2. 燃費

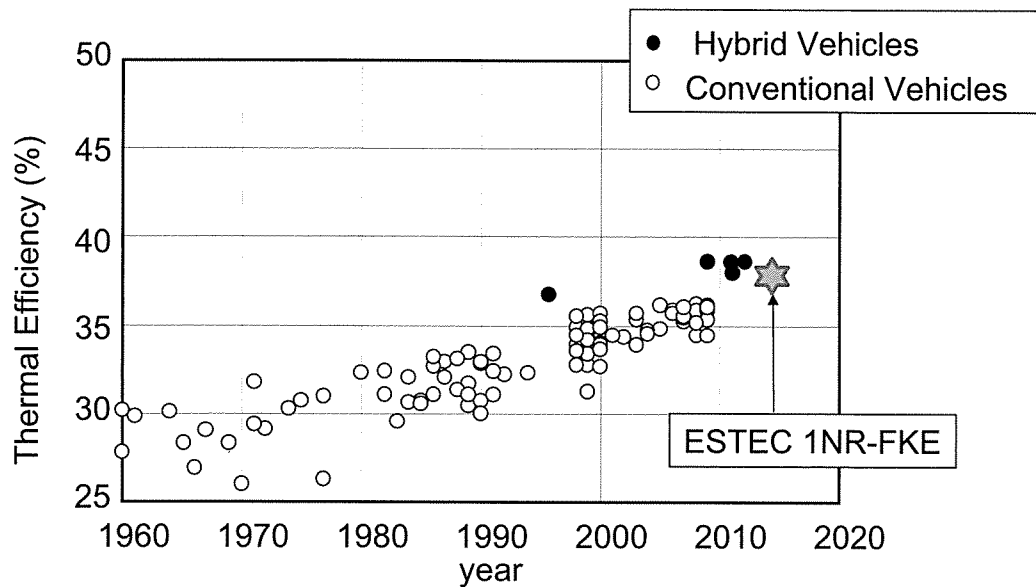
### Fuel Consumption Improvement in JC-08 mode



## 4. 1NR-FKEエンジン性能

### 4-2. 燃費

#### Maximum thermal efficiency



## 5. まとめ

1. アキソンサイクル化やフリクション低減などにより  
ESTEC 1NR-FKEの最高熱効率<sup>①</sup>はHVエンジン同  
水準の38%を達成.
2. JC08モード<sup>②</sup>において11%の燃費向上を実現.
3. 4-2-1エキゾーストマニホールド<sup>③</sup>による掃気効果など  
により, 高圧縮比化にも関わらず, 従来エンジンと  
同等の全負荷性能を達成.