DEER Conference

Clean Technology for Diesel Expansion

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Transition of Environmental Issues

Transition of ave. Temperature (1961~1990)

Year

Energy Concerns (Sustainability)

Climate Change (CO2, GHG)

Today

1990  2000  2010  2020

Intensity of Issues
Diesel contributes to CO2 reduction

CO2 Emission from European LDVs

- Accord Diesel
- Accord Gasoline 2.0L
- CR-V Gasoline 2.0L
- FR-V Gasoline 2.0L
- CR-V Diesel
- FR-V Diesel

Curb weight (kg)

CO2 (g/km)
Clean Diesel

1. Current Production EU Diesel
2. Clean Diesel Development Status
3. Diesel Fuel Status
4. Summary

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### Main specification

<table>
<thead>
<tr>
<th>Engine type</th>
<th>N22A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder number</td>
<td>Inline 4 cylinder</td>
</tr>
<tr>
<td>Displacement</td>
<td>2.204 (L)</td>
</tr>
<tr>
<td>BoreXStroke</td>
<td>85X97.1 (mm)</td>
</tr>
<tr>
<td>Valve configuration</td>
<td>DOHC-4v1v</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>16.7</td>
</tr>
<tr>
<td>Fuel injection system</td>
<td>Common-rail</td>
</tr>
<tr>
<td>Maximum fuel pressure</td>
<td>1600 (bar)</td>
</tr>
<tr>
<td>Emission category</td>
<td>EURO-IV</td>
</tr>
<tr>
<td>Maximum power</td>
<td>103/ 4000 (kW/ rpm)</td>
</tr>
<tr>
<td>Maximum torque</td>
<td>340/ 2000 (Nm/ rpm)</td>
</tr>
</tbody>
</table>
Design Concept

Diesels
+ Torque / FE
- Noise / Vibration

"A first-class diesel engine"

Big Torque
Clean
Good FE
Low NV
Core Technologies

High-precision combustion control
- Optimized combustion chamber
- 1600bar common rail system
- Pilot injection
- Swirl control valve
- Electric controlled EGR valve
- EGR cooler
- Variable geometry turbocharger

Light-weight & high-rigidity structure
- ASCT aluminum cylinder block
- Lower block construction
- Top feed cooling circuit
- Offset cylinder
- 2nd order balancer system
- Roller chain system
- Pendulum mount system

Exhaust after-treatment system
- Oxidation & de-NOx catalyst
- Metal foil substrate

SAE paper
2004-01-1316 Development of New 2.2-liter Turbocharged Diesel Engine for the EURO-IV Standards
DPF System

- ECU
- Inlet air throttle
- Variable geometry turbocharger
- Pressure difference sensor
- Closed coupled cat
- Exhaust gas temperature sensor
- DPF
- Close-coupled catalytic converter
Honda diesel series is expanding in EU

DPF series will be expanded quickly

Honda diesel series is expanding in EU
DPF series will be expanded quickly
Clean Diesel

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Clean diesel prototype has a potential to meet Bin5
Premixed Charge Compression Ignition

- Piston bowl and nozzle optimization
- Further cooled EGR
- PCCI operation of fuel injection timing close to TDC

SAE papers
2005-01-0378  PCCI Operation with Early Injection of Conventional Diesel Fuel
2006-01-0920  PCCI Operation with Fuel Injection Timing set close to TDC
Comparison of After Treatment System

**HONDA System**
- Exhaust gas
  - DOC
  - DPF
  - CO/HC
  - PM

**Urea SCR System**
- Exhaust gas
  - DOC
  - CSF/DPF
  - (NH₂)₂CO Dosing Sys
  - Urea Sensor(?)
  - SCR System
    - SCR
    - NH₃
    - Pressure sensor
  - Urea Sensor(?)
  - LNC(Lean NOx Catalyst) System
    - LNC
    - NOx
    - Exhust gas
    - Exhust gas

**Technical assessment**

<table>
<thead>
<tr>
<th>System simplicity</th>
<th>FE penalty</th>
<th>Maintenance</th>
<th>Wide range applicability</th>
<th>for PC application</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNC</td>
<td>○</td>
<td>△</td>
<td>○</td>
<td>△</td>
</tr>
<tr>
<td>SCR</td>
<td>△</td>
<td>○</td>
<td>△</td>
<td>○</td>
</tr>
</tbody>
</table>
Diesel OBD-II System

EU OBD
1. EGR system monitoring
2. DPF monitoring (blocked side only)
3. Air flow sensor monitoring
4. Water temp. sensor monitoring

US OBD-II
1. DOC monitoring
2. LNC monitoring
3. DPF monitoring (leakage side)
4. PCV system monitoring
5. Misfire monitoring
6. Fuel system monitoring
7. Comprehensive comp. monitoring
8. System guarantee in the real world

Development items
1. Diesel LAF sensor
2. Very challenging
3. Very challenging
4. Pressure sensor very challenging
5. Combustion sensor or crank angle sensor
6. Combustion sensor
7. Comprehensive comp. monitoring
8. Rate base

As development progresses, technological challenging points are identified.
Clean Diesel

1. Production EU Diesel Update
2. Clean Diesel Development Status
3. Diesel Fuel Status
4. Summary
Low and wide variation of Cetane number compare to other market.
Influence of Cetane Number

Variation of Cetane Number influence on high EGR rate combustion

Calibrate on 57 Cetane ⇒ Misfire on Cetane 47

Calibrate on 47 Cetane ⇒ Soot increase on Cetane 57

Control system for US Cetane No. variation would be required
Cylinder Pressure Sensor

Detection of Cetane number for Calibration

SAE paper : 2006-01-0180
Study on Ignition Timing Control for Diesel Engines using In-cylinder Pressure Sensor
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Summary

• Diesel clearly has a potential to reduce CO2 emissions but is not as clean as current gasoline.

• Honda has made significant progress in the area of combustion enhancement and after-treatment technology for global expansion of Diesel.

• The improvement of LNC is ongoing. Still heat–resistance is main technological challenge.

• For US market, OBD still remains major technical hurdle.

• Improvement of diesel fuel quality is necessary to maintain good engine performance. European equivalent specification is preferred from developer’s viewpoint.