ADVANCED BOOSTING
EU6d Gasoline Engines
Agenda

- Introduction
- Base Engine Configuration
- Target Boosting Concept
- Simulation Study
- Conclusion
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Introduction

CO₂ challenge

Market share

CO₂ challenge & boosted gasoline engines
Fuel Economy Oriented Technologies

**VCR**

- 13:1
- 9.6:1

Multi-links reaching maturity

**MILLER**

- Intake valve - Otto
- Intake valve - Miller
- Exhaust valve

Part-Load & Full-Load

**DILUTION**

Cooled EGR

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Miller as a main stream technology
Honeywell VNT experience

**Millions of Diesel VNT**

- 1991 Fiat Croma VNT25
- 2015 2-stage VNT GTD12 GTD20

**1050°C VNT « Le Mans »**

- 2011-13 Audi Sport TR4288RV

- Le Mans 24hrs Victory 2011-14 T3 up to 1050°C

60 Millions Diesel VNT Produced

VNT Gas built on Strong Honeywell VNT Experience
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Base Engine Configuration

- 2.0 L gasoline engine
- Direct injection
- Inline 4-cylinder
- 220 kW / 400 Nm at peak
- Compression ratio 9.6
- Twin scroll turbocharger
- Variable intake cam timing
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Target Boosting Concept

• Miller engine cycle → increased boost demand
  ➢ Gasoline VNT + optionally external wastegate (part load)
  ➢ High performance/upsized charge air cooling

• Best full load BSFC below 240 g/kWh

• Geometric CR 13:1
**Turbine Aerodynamics Developments**

**Turbine Map Flow**

**Inertia**

Compared to Diesel, Gasoline Aerodynamics:
- +15% Increased max flow
- -15% Lower Inertia

**Specific VNT Aero for Gasoline**
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Simulation Study – *WOT Performance*

**BMEP - Brake Mean Effective Pressure**

- WG/CR9.6 – Reference
- WG/CR9.6 – Otto cycle
- VNT/CR13 – Miller cycle

**Brake Power**

**Miller ratio**

\[ M_r = \frac{V_{\text{expansion\_displacement}}}{V_{\text{effective\_compression\_displacement}}} \]

**BSFC - Brake Specific Fuel Consumption**

7 g/kWh

**BSFC benefit through Miller + VNT**
Simulation Study – WOT Combustion

- WG/CR9.6 – Reference
- WG/CR9.6 – Otto cycle
- VNT/CR13 – Miller cycle

**Average Pressure P1E**

**Average Total Pressure P1T**

**Knock Induction Time Integral**

**Total Turbine Inlet Temperature (T1T)**

Miller → higher compression on turbocharger
Compressor Lug Lines

Compressor map

WG/CR9.6 – Otto cycle
VNT/CR13 – Miller cycle

Corrected Mass Flow Rate

Miller ➔ High PRC / PRT ➔ VNT ➔ Lower Mass Flow
Simulation Study – Part Load

BSFC benefit even at part load (fuel economy implication)

**BSFC @ 1600 rpm**

- 21 g/kWh !
  - WG/CR9.6 – Otto cycle
  - VNT/CR13 – Miller cycle

**BSFC @ 5000 rpm**

- 28 g/kWh
  - 10 g/kWh
  - 1600rpm
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• Differentiated **GT-POWER** capabilities built at Honeywell

• Knock modeling vital for Millerisation assessment

• Millerisation realized through EIVC
  - BSFC benefit even at part load (lower pumping losses, higher CR)
  - Driving cycle fuel economy improvement
  - High low end torque enabled by two switchable intake cam profiles

• Air flow demand lower due to improved engine efficiency
  - Compressor downsizing

• Lower exhaust enthalpy demands efficient turbine stage
  - Advantage of VNT technology
Thank you for your attention