Audi V8TDI-4,0L-Engine
Development supported by GT-Power
GT Conference 2016
AUDI AG  Torsten Rausch
AGENDA

1. Basic Engine Data
2. Simulation Work Overview – GT-Power
3. Simulation Concept Phase
4. Simulation Predevelopment Phase
5. Simulation Series Development Phase
6. Conclusion
### Audi new V8TDI-4.0L-Engine

#### Basic Engine Data

<table>
<thead>
<tr>
<th></th>
<th>Audi Q7 V8 TDI (Current Generation)</th>
<th>Audi SQ7 V8 TDI (New Generation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transmission</strong></td>
<td>8-gear tiptronic quattro</td>
<td>8-gear tiptronic quattro</td>
</tr>
<tr>
<td><strong>EU-Emission Class</strong></td>
<td>EU5</td>
<td>EU6</td>
</tr>
<tr>
<td><strong>Fuel Consumption</strong></td>
<td>9,2</td>
<td>7,2</td>
</tr>
<tr>
<td><strong>CO(_2) Emission</strong></td>
<td>242</td>
<td>189</td>
</tr>
<tr>
<td><strong>Max. Torque</strong></td>
<td>800</td>
<td>900</td>
</tr>
<tr>
<td><strong>Max. Power</strong></td>
<td>250</td>
<td>320</td>
</tr>
<tr>
<td><strong>Acceleration 0-100 km/h</strong></td>
<td>6,5</td>
<td>4,8</td>
</tr>
<tr>
<td><strong>Max. Speed</strong></td>
<td>243</td>
<td>250 speed-limitation</td>
</tr>
</tbody>
</table>

**Audi Q7 V8 TDI**, 2016 GT Conference, AUDI AG, Torsten Rausch
Audi new V8TDI-4,0L-Engine
Basic Engine Data

<table>
<thead>
<tr>
<th>Speed [rpm]</th>
<th>Power [kW]</th>
<th>Torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>900</td>
<td>150</td>
</tr>
<tr>
<td>1000</td>
<td>320</td>
<td>320</td>
</tr>
<tr>
<td>2000</td>
<td>280</td>
<td>240</td>
</tr>
<tr>
<td>3000</td>
<td>240</td>
<td>200</td>
</tr>
<tr>
<td>4000</td>
<td>200</td>
<td>160</td>
</tr>
<tr>
<td>5000</td>
<td>160</td>
<td>80</td>
</tr>
</tbody>
</table>

Audi V8TDI, GT Conference 2016, AUDI AG, Torsten Rausch
Audi new V8TDI-4,0L-Engine
Simulation Work Overview – GT-Power

Time

Development Work

100%

0%

Concept Phase | Predevelopment | Series Development

1D-Simulation

Hardware / Testbench

Task force i

Task force i+1

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Audi new V8TDI-4,0L-Engine
Simulation Concept Phase

› Systems
  - EGR (1D/3D)
  - Cyl. Head Orientation
  - Air Path Pulsation

› Charger Concepts
  - Two Stage Charging
  - Sequential Turbocharging

› Prediction
  - Torque, Power
  - Swirl
  - Cyl. specific spread in charge

› Geometry
  - Volumes
  - Length / Diameters
  - Geometry of the Recirculation Pipe
Geometry of the Recirculation Pipe

- Determine the optimal diameter
- Diameter is a function of the passive compressor
- Too small diameter generates surge
- Influence of pressure losses along recirculation pipe
- Simulation Result: Optimal Diameter → This information is passed along to the design department.
Sizing of the Turbo Charger
- Size
- Symmetric layout
- Asymmetric layout

Gas exchange
- Valve Timings / Events
- Inlet-/outlet-manifold

Sensitivity studies
- back pressure level
- boost pressure
- pressure loss in the exhaust system
There are two ranges in the simulation:
- back pressure below max. value
- back pressure at the max. value

Simulation Results
Simple way to estimate effects of pressure losses along the exhaust system.

Operating Point 4250 rpm full load

Pressure after Turbine [bar]

Engine Power Loss

Additional Pressure Loss Exhaust System [mbar]
Audi new V8TDI-4,0L-Engine
Simulation Series Development

› **Sizing**
  - fine tuning
    (e. g. turbo charger, recirculation pipe, ...)
  - update GT-model

› **„Task forces“**
  - support in general analysis

› **Engine application**
  - transient simulation
    - **Switch from single turbo to biturbo mode during transients**
Audi new V8TDI-4,0L-Engine
Simulation Series Development

› Cylinder Head
› Audi AVS System
Audi new V8TDI-4,0L-Engine
Simulation Series Development

› Turbo System Sketch
› Single Turbo Mode
Audi new V8TDI-4,0L-Engine
Simulation Series Development

› Turbo System Sketch
› Biturbo Mode
Audi new V8TDI-4,0L-Engine
Simulation Series Development

› Problem
   - noise during shift process between monoturbo mode to biturbo mode

› Transient GT-model
   - optimizing shift strategy
Audi new V8TDI-4,0L-Engine
Simulation Series Development

Results

- Phase 1:
  - 4 cylinders shift first
  - recirculation valve is fully opened

- Phase 2:
  - other 4 cylinders shift
  - recirculation valve closes quickly
Audi new V8TDI-4,0L-Engine
Simulation Work Overview – Conclusion

Development Work

Hardware / Testbench

1D-Simulation

Concept Phase  Predevelopment  Series Development

Time

Task force i

Task force i+1

100 %

0 %
Thank you!
Torsten Rausch

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