Development of Diesel Catalysts for Today’s and Tomorrow’s Diesel Engines

AVECC 2004, Beijing, April 27th-29th

Alfred Reck
Guixia Ba
Content of Presentation

- Introduction
- Structured Foils
  - PErforated Foil
  - LS-Foil
- Hybrid Catalyst
- Compact Catalyst
- Pre-Turbo-Catalyst
- PM-Filter Cat
- Summary
Gas Flow and Mass Transfer Coefficient; Laminar and Turbulent Conditions

Basis: Cell Density 800 cpsi, T = 600°C
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PErforated Foil

Properties:

- Cross Flow
- Reduced Heat Capacity
- Reduced Back Pressure
- Improved Efficiency

Radial flow vector in the area of the hole

PE Structure: Improvement of Efficiency and Flow Distribution
Measurement of Flow Distribution

Standard Substrate

PE-Substrate
Comparison of Light Off Behaviour, Standard and PE Substrate
Ø 118 x 74.5 mm / 400 cpsi / 50 µm ( FTP-Cycle )
Comparison of Back Pressure between Standard and Perforated Foils
Flow test bench: substrate $\varnothing$ 98.4 x 101.5 mm, temperature 100°C
Emission Test Program
Cascade System / PE Single Brick
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LS Structure

- Improved Mass Transfer, 
  ➔ Turbulence, Higher Efficiency

- Reduction of thermal Mass 
  ➔ Improved Light Off

- Reduction of Material 
  ➔ Reduction of Cost

Properties of „LS“ Longitudinal Structure
Back Pressure Ø90x120 mm, 40 µm, Winding S/3, uncoated
LS-Catalyst; Catalytic Efficiency
Average FTP Results

<table>
<thead>
<tr>
<th></th>
<th>HC</th>
<th>NOx</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS 200/400</td>
<td>0.02</td>
<td>0.08</td>
<td>0.1</td>
</tr>
<tr>
<td>400 cpsi Standard</td>
<td>0.04</td>
<td></td>
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Construction Principle of the Hybrid Catalyst

1. Brick with low thermal mass
   - Early Light-Off

2. Brick with high thermal mass
   - Good Heat-Storage
Exhaust Gas Temperatures
MVEG Test Cycle

Temperature [°C]

Time [s]

- in front of Turbocharger
- behind Turbocharger
- in front of CCC
- in front of UFC
Efficiency of Hybrid Catalyst
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New Compact Canning Design with Twin Cat and Single Cat
Back-Pressure Measurement
Production Catalyst / New Canning Design

- **Production System:** $A = 8362 \text{ mm}^2$
- **New Canning Design with Hybrid Catalyst:** $A = 7605 \text{ mm}^2$

**Diagram Details:**
- **PTC:** $\varnothing 39 \times 19 \text{ mm} / 200 \text{ cpsi} / 80 \mu\text{m}$
- **Hybrid:** $\varnothing 98.4 \times 40 \text{ mm} / 400 \text{ cpsi} / 30 \mu\text{m} + 95 \text{ mm} / 400 \text{ cpsi} / 80 \mu\text{m}$
- **CCC:** $135.8 \times 78.4 \times 124 / 400 / 4\text{mil}$
- **UFC:** $152.4 \times 101.6 \times 152.4 / 400 / 6.5\text{mil}$

**Graph:**
- **Y-axis:** Pressuredrop [mbar]
- **X-axis:** Massflow [kg/h]
Efficiency of Compac Catalyst

Emission Test on Roller Test Bench, 1,9 ITDI, MVEG
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Preturbo-Catalysts, Turbulent Catalysts

<table>
<thead>
<tr>
<th>1 Turbocharger per Bank</th>
<th>Cylinderhead</th>
<th>Manifold</th>
<th>Preturbo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>PTC-C</td>
<td>PTC-Ms</td>
<td>PTC-Mr</td>
</tr>
<tr>
<td>appr. 60 %</td>
<td>appr 70 %</td>
<td>appr 50 %</td>
<td>appr 30 %</td>
</tr>
</tbody>
</table>

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Pre Turbo Catalysts, Turbulent Applications
PTC Ø 40 x 74,5 mm; 200 cpsi

Space Velocity at Different Engine Operation Points
PTC Ø 40 x 74,5 mm; 200 cpsi
HC Conversion Efficiency
Influence of various PTCs on Torque at full load in a Truck application
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Principle
Session 6

4:15 Uwe Israel, Twin Tec

Retrofit Catalyst Systems for Diesel Engines

Further Details to PM-Filter Cat
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• Structured Foil Material will allow turbulent Catalyst Application
  ➔ High Efficiency, Low Cost, Low Volume

• Hybrid Catalyst gives improved thermal Management
  ➔ Early Light off, High Efficiency

• Compact Canning allows improved thermal Management and saves Space

• Preturbo-Catalysts are turbulent and show high Efficiency at low Cost

• PM-Filter Cat with Efficiency of appr. 40-50% is suited for OEM and Retrofit Application

• Combination of different Techniques is possible and provides most advanced Technology

Summary
Thank you for Your Attention