Exhaust Systems and Emissions

Source: BMW
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- Measurements of Mass Flow Rates
- High Temperature Oven

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Testing of Exhaust Systems

Vehicle-Compliant Setup

Engine
- Engine fitting position
- Transmission
- Engine carriers and mounting brackets

Exhaust Gas Systems
- No mechanical modifications
- Original suspension components
- Leveling according to vehicle coordinates
- Stiff construction of mounting suspension
Testing of Exhaust Systems

Vibration Analysis

- Measurement system Müller-BBM
- Up to 160 channels simultaneously
- Vibration, strain, acoustics, temperature, analog variables
- 3 measurement systems for 220 V and 12 V operation
Testing of Exhaust Systems

Vibration Analysis

Measurement system Müller-BBM,
(max. 160 channels, setup with 3-axis miniature sensors)
Testing of Exhaust Systems

Vibration Analysis

![Graph showing vibration analysis with axes for frequency [Hz], engine speed [rpm], and amplitude [mm].]
Thermal Shock Testing on Engine Test Bench

- **Phase of Hot Operation:** Operating points with maximum exhaust gas temperature (dynamic driving cycles)
- **Phase of Cold Operation:** Standstill or idle (cooling down with or without test bench blower)
  Phases of coasting with overrun cut-off (internal cooling of catalysts and mufflers)
Testing of Exhaust Systems

Thermal Shock Testing / Hot Gas Generator

Gas temperature : Max. 1200 °C
Operating supplement : Natural Gas
Exhaust gas mass flow rate : Up to 1200 kg/h
Exhaust gas back pressure : Max. 500 kPa

Truck Application :
Increase of Mass Flow Rate via Interconnection
2-Axis Stimulation

- Traction: Max. 15 kN/Cyl.
- Amplitude: 0.1 - 150 mm
- Vibration frequency: Max. 100 Hz
- Gas temperature: Max. 1000 °C
- Fuel: Diesel
- Exhaust gas mass flow rate: Max. 250 kg/h
High Temperature Oven

- Preconditioning
- Stabilization
- DPF regeneration
- DPF and catalyst ageing
- Artificial atmosphere

Technical data:
- Up to 1200 °C
- Usable space: 50x50x70 cm
- Injection of N\(_2\), O\(_2\) and H\(_2\)O

Temperature Characteristics at DPF Preconditioning
DPF Development

DPF Testing / Ageing

- Regeneration behaviour at different soot and ash accumulation conditions
- Regeneration options under worst-case conditions
DPF Development

Soot Accumulation

- Cycles according to customer specification
- Automated ageing and regeneration cycles
- Event-related program sequence via Inca communication

Temperature Gradients during Uncontrolled Regeneration
DPF Development

- Ash accumulation cycles with accumulation-related regeneration
- Characterization according to defined ash accumulation
- Rating of regeneration behaviour
- Certification according to ECE, US and further guidelines

Section of ETC Cycle
Temperature Characteristics at Top of DeNox Nozzle
Urea Injection System

Equipment of Exhaust Gas System with several DeNox Injectors

Cooling Element of a DeNox Injector with Thermocouples
Catalyst Testing

- Development of driving cycle with lambda leaps
- Air injection for increase in temperature
- Testing of several samples within one exhaust line
- Exhaust gas analysis via 2-line exhaust gas measurement device
Catalyst Development

Measuring Cycles with additional Air Injection and Lambda Leaps

- Temperature [°C]
- Air Quantity [l/min]
- Lambda [-]
- O₂ [%]

Runtime [s]

Laufzeit [s]

Laufzeit [s]
Thermal Imaging

Thermal Imaging of Exhaust Gas Components

Temperatures at Nominal Output
Stream Lab

- Adjustment of exhaust mass flow rate and exhaust gas back pressure
- Optimization of geometry of flow
- Spatial twist and tumble measurement
- Maximum mass flow rate: 400 kg/h

Tippelmann Test Bench
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