Evaluation of Measurement Technologies for RDE and Fuel Consumption for 2-Wheeler Applications

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Content

- Motivation & Relevance
- Motorcycle Driving Dynamic
- Emission Measurement
Motivation and Relevance

- High number of powered two-wheelers in urban areas
- Increasing share on total emissions
- Discrepancies in-between legislative test cycles and real world driving
- Future RDE legislation?

Load points (P/n) for type approval test WMTC

Load points (P/n) for test type RDE
Real Driving Dynamic

4 typical driving scenarios
• Urban
• Rural
• Motorway
• Sport-oriented roadtrack

→ Derivation of measurement segments
Real Driving Dynamic

\[ (v \cdot a_{pos})_{95} \]

\[ RPA_{Limit} \]

\[ v \cdot a_{pos} \]

\[ v \cdot a_{pos} \text{ limit} \]

\[ RPA \]

Valid

Invalid

Mean 95 percentile \(v'\text{apos}0.1 [W/kg]\)

Mean RPA \([m/s^2]\)

Mean Velocity \([km/h]\)

- PTW - urban
- PTW - rural
- PTW - motorway
- PTW - automotive RDE routes
- PTW - WMTC
- Audi Q7 reference
- Limit automotive
Real Drive Cycle for Test Rig (RDC)

Sport-orientated

Urban
Rural
Motorway

Velocity [km/h]

0 20 40 60 80 100 120 140

0 200 400 600 800 1000 1200 1400 1600 1800 2000

Time [s]
Real Drive Cycle - Significance

Mean values of WMTCs, RDEs, and RDCs.
Real Drive Cycle - Significance
Content

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Measurement Equipment

1. Test object: BMW F800 GT
   EU3 watercooled two cylinder 800 cm$^3$ four-stroke engine
   66 kW at 8000 U/min
   89 Nm at 5800 U/min
   213 kg tare weight
Measurement Equipment

1. Test object: BMW F800 GT
2. PEMS equipment:
   a. GPS
   b. Ambient conditions
   c. Lambda-meter
   d. FC measurement
   e. CAN parameter
   f. Exhaust flow meter
   g. Emissions
   h. System Control
Measurement Equipment
Measurement Equipment
Validation of Measurement Equipment

- Ambient air
- Diluted exhaust gas
- Meas. bags
- Dilution air
- Velocity/time-target
- PEMS
- Exhaust gas
- Break dynamometer
- AMA
  - CO2
  - CO
  - HC
  - NOx
- CVS
- FTIR
- Sensyflow
Validation of Measurement Equipment / EFM
Validation of Measurement Equipment / EFM

Mass flow for low load section

Δ ~15%

Δ ~18%
Validation of Measurement Equipment / EFM

Mass flow for high load section
Validation of Measurement Equipment / Additional Weight

approx. + 80kg
Validation of Measurement Equipment / Additional Weight

Shift of engine operation points
Validation of Measurement Equipment / Additional Weight

Emission deviation w / wo PEMS

- CO2 [g/km]
- CO [g*10e2/km]
- NOx [g*10e2/km]
Validation of Measurement Equipment / Correlation

Emission deviation between different measurement systems (0 = PEMS)
Validation of Measurement Equipment / Correlation

Emission deviation between different measurement systems
Validation of Measurement Equipment / Chassis Dyno

Slip comparison chassis dyno / road
Accumulated emission for sport-oriented real world test segment
Results RDE

CO  NOx  HC
urban  rural  motorway

emission [g/km]

0,575  0,434  0,960
0,109  0,192  0,081
0,038  0,233  0,250

0,120  0,175  0,348
0,080  0,195  0,057

WMTC  RDC  RDE  WMTC  RDC  RDE  WMTC  RDC

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Possible Approach for RDE Measurements

1. Vehicle Class, additional weight, power / weight ratio
Possible Approach for RDE Measurements

1. Vehicle Class, additional weight, power / weight ratio
2. Dynamic Parameter
Possible Approach for RDE Measurements

1. Vehicle Class, additional weight, power / weight ratio
2. Dynamic Parameter
   a. Lambda + Fuel Mass Flow
   b. ECU Intake Air Flow + Fuel Mass Flow
   c. Adaption of existing EFM
Summary & Conclusion

- Motorcycle driving scenarios are very diverse
- Emissions differ strongly between type approval & on-road
- PEMS are available, but suitable for PTW only with restrictions
- Adaptions in weight, size & mass flow measurement necessary
- Integrative measurement methodology for motorcycle RDE?
  - WMTC, RDC incl. referencing + simulation?
  - + 1x RDE?
  - Engine class definition?