Road transport emission estimation

ARTEMIS Transport Emission Models and Inventory Systems

support from the European Commission - DG TREN
Several national bodies
COST346 action

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Review of the road transport chapter / Artemis issues (1)

- Gaps with national figures
  - bulk emissions (g/kg fuel), vehicle fleet and mileage
  - Adjustments / validation? Methodological issues (fleet composition)?
- Cold start - the approach is based on old method and data (veh. usage)
  - New approaches in ARTEMIS, to derive an updated method
- HDV / buses: load factors and empty running available in ARTEMIS
- Emissions functions f(average speed) - Passenger cars
  - Two sets of functions in ARTEMIS/COPERT4, 2 scientific bases
  - Confusion for the users, incoherencies in international comparisons
  - To conduct a comparison, quality index f(measured data - model)
- Emissions functions - Light duty vehicles, 2-wheelers
  - Full sets of functions (up to Euro3) based on consistent measurements in ARTEMIS
- Non-regulated pollutants and Speciation - Air Conditioning, auxiliaries
  - Important measurements data sets/approaches in ARTEMIS - to do a status
Review of the road transport chapter / Artemis issues (2)

- New emission data
  - ARTEMIS enabled a significant collection of emission data
  - In European common and harmonized databases
  - New emissions data are and will be available from National measurements
    → To continue the management and update of these European Databases

- Limit of the average speed approach
  - Strong influence of the acceleration and dynamic-related parameters
  - "Transport management" could act more on the dynamic than on the speed
    - speed limit management, speed control,
    - urban traffic management, Eco-driving, etc.

- A “traffic situation” approach has been developed in ARTEMIS
  - Considers both speed and acceleration influences
  - Detailed and coherent applications at local / regional / national levels
  - Aggregated traffic situations considering shares into congested-, heavy-, free-traffic (instead of unique average speed figures)
  - Opens to issues such as congestion analysis, road network management (speed limits, roads classification, etc.)

ARTEMIS: a large range of contrasted driving cycles
Cars emissions - Typology of the driving cycles / conditions

Average acceleration (m/s²)

Ref. Test Cycles

Urban, Congested, low speeds
Urban, Congested, stops
Urban, Free-flow, unsteady

Urban, Dense
Urban, Free-flowing

Urban, Stop&go

Rural, Unsteady
Motorway, Unsteady
Motorway

Rural, Unsteady
Motorway, Unsteady
Motorway, High speed
Motorway

Rural, Main roads, unsteady
Rural, Main roads
Rural, Steady

Rural

Motorway, Stable

Urban, Free-flowing

Motorway, High speed

Urban

Influence of the dynamic of the driving condition

g eq. NO₂/km

emission per test pattern

NOx - diesel Euro 3

Average speed (km/h)
Influence of the dynamic of the driving condition

Limit of a model based only on the average speed
Controversial issue on the emissions functions

- Average speed (km/h)
- g eq. NO2/km
- NOx - diesel Euro 3
- Stable speed
- Variable speed
- Unique model based on test pattern
- Copert4 function (10 km/h speed range)
- Polynomial (Variable speed)
- Polynomial (Stable speed)

Limit of the Copert4 form of the function

- Average speed (km/h)
- g eq. NO2/km
- Emission per 10 km/h speed range
- Function based on speed range
- Point with high dynamic
- Good adjustment at the extremes
- Points with low dynamic
- No possibility to consider the speed variability
Traffic situation approach - principles (road transports)

- Strategic network (motorways, major roads)
- Inner and local traffic

Urban: Strategic network (motorways, major roads)

Urban motorways primary distributors

District level

+ gradient, sinuosity

Rural: Inner and local traffic

Urban

Rural

Traffic (veh/h)

Free-flow

Heavy

Near saturation

Congestion

Speed

0 30 60 90

2000 4000 6000 8000

Representative speed curve

0 0 200 times

Emission model (per category of vehicle)

Emission

ARTEMIS: Emission estimation at different scales (road transport)

- Detailed traffic situations
  - The emission takes into account of the dynamic of the traffic conditions
  - A certain complexity:
    - Identification of the traffic situations
    - Mileage distribution

- Macroscopic (urban, rural, motorway) and composites situations (aggregation of detailed situations)

- Average speed approach
Traffic situations - Speed data (cars example)

Urban, district distributor, 70 km/h

Emissions estimation approach - passenger cars

- Analyse a traffic situation as regards driving conditions
- Compute the emissions from this dependency (combination of cycles)

Test patterns - Driving cycles

Traffic situations - Speed curves

Correspondence Analysis

Axis 1

Axis 2

Axis 3

Traffic situation TSi

Test Cycles
Traffic Situation emissions estimation (cars)

Urban trunk road, speed limit: 50 km/h

Urban motorway, speed limit: 110 km/h

Traffic Situation emissions estimation (HD-Trucks)

Articulated truck, EURO3, 40 tons, half-loaded
Traffic Situation: Fuel consumption estimation (cars)

Fuel Consumption (g/km)

0 30 60 90

Diesel-Euro3 Petrol-Euro3 Diesel-Euro3 Petrol-Euro3

Free-flowing traffic Heavy traffic Near saturation Stop & go

Urban trunk road, 50 km/h Urban motorway, 110 km/h